



CONFIGURATION GUIDE

FastIron Ethernet Switch Layer 3 Routing Configuration Guide, 08.0.30mb

Supporting FastIron Software Release 08.0.30mb

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Document Conventions

The following tables list the text and notice conventions that are used throughout this guide.

TABLE 1 Text conventions

Convention	Description	Example
monospace	Identifies command syntax examples.	device(config)# interface ethernet 1/1/6
bold	User interface (UI) components such as screen or page names, keyboard keys, software buttons, and field names	On the Start menu, click All Programs .
<i>italics</i>	Publication titles	Refer to the <i>Ruckus Small Cell Release Notes</i> for more information

Notes, Cautions, and Warnings

Notes, cautions, and warning statements may be used in this document. They are listed in the order of increasing severity of potential hazards.

NOTE

A NOTE provides a tip, guidance, or advice, emphasizes important information, or provides a reference to related information.

CAUTION

 A CAUTION statement alerts you to situations that can be potentially hazardous to you or cause damage to hardware, firmware, software, or data.

DANGER

 A DANGER statement indicates conditions or situations that can be potentially lethal or extremely hazardous to you. Safety labels are also attached directly to products to warn of these conditions or situations.

Command Syntax Conventions

Bold and italic text identify command syntax components. Delimiters and operators define groupings of parameters and their logical relationships.

Convention	Description
bold text	Identifies command names, keywords, and command options.
<i>italic</i> text	Identifies a variable.
[]	Syntax components displayed within square brackets are optional.
{ x y z }	Default responses to system prompts are enclosed in square brackets.
{ x y z }	A choice of required parameters is enclosed in curly brackets separated by vertical bars. You must select one of the options.
x y	A vertical bar separates mutually exclusive elements.
< >	Nonprinting characters, for example, passwords, are enclosed in angle brackets.
...	Repeat the previous element, for example, <i>member</i> [<i>member</i> ...].
\	Indicates a “soft” line break in command examples. If a backslash separates two lines of a command input, enter the entire command at the prompt without the backslash.

Document Feedback

Ruckus is interested in improving its documentation and welcomes your comments and suggestions.

You can email your comments to Ruckus at: docs@ruckuswireless.com

When contacting us, please include the following information:

- Document title and release number
- Document part number (on the cover page)
- Page number (if appropriate)
- For example:
 - Ruckus Small Cell Alarms Guide SC Release 1.3
 - Part number: 800-71306-001
 - Page 88

Ruckus Product Documentation Resources

Visit the Ruckus website to locate related documentation for your product and additional Ruckus resources.

Release Notes and other user documentation are available at <https://support.ruckuswireless.com/documents>. You can locate documentation by product or perform a text search. Access to Release Notes requires an active support contract and Ruckus Support Portal user account. Other technical documentation content is available without logging into the Ruckus Support Portal.

White papers, data sheets, and other product documentation are available at <https://www.ruckuswireless.com>.

Online Training Resources

To access a variety of online Ruckus training modules, including free introductory courses to wireless networking essentials, site surveys, and Ruckus products, visit the Ruckus Training Portal at <https://training.ruckuswireless.com>.

Contacting Ruckus Customer Services and Support

The Customer Services and Support (CSS) organization is available to provide assistance to customers with active warranties on their Ruckus Networks products, and customers and partners with active support contracts.

For product support information and details on contacting the Support Team, go directly to the Support Portal using <https://support.ruckuswireless.com>, or go to <https://www.ruckuswireless.com> and select **Support**.

What Support Do I Need?

Technical issues are usually described in terms of priority (or severity). To determine if you need to call and open a case or access the self-service resources use the following criteria:

- Priority 1 (P1)—Critical. Network or service is down and business is impacted. No known workaround. Go to the **Open a Case** section.
- Priority 2 (P2)—High. Network or service is impacted, but not down. Business impact may be high. Workaround may be available. Go to the **Open a Case** section.
- Priority 3 (P3)—Medium. Network or service is moderately impacted, but most business remains functional. Go to the **Self-Service Resources** section.
- Priority 4 (P4)—Low. Request for information, product documentation, or product enhancements. Go to the **Self-Service Resources** section.

Open a Case

When your entire network is down (P1), or severely impacted (P2), call the appropriate telephone number listed below to get help:

- Continental United States: 1-855-782-5871
- Canada: 1-855-782-5871
- Europe, Middle East, Africa, and Asia Pacific, toll-free numbers are available at <https://support.ruckuswireless.com/contact-us> and Live Chat is also available.

Self-Service Resources

The Support Portal at <https://support.ruckuswireless.com/contact-us> offers a number of tools to help you to research and resolve problems with your Ruckus products, including:

- [Technical Documentation](https://support.ruckuswireless.com/documents)—<https://support.ruckuswireless.com/documents>
- [Community Forums](https://forums.ruckuswireless.com/ruckuswireless/categories)—<https://forums.ruckuswireless.com/ruckuswireless/categories>
- [Knowledge Base Articles](https://support.ruckuswireless.com/answers)—<https://support.ruckuswireless.com/answers>

Preface

Contacting Ruckus Customer Services and Support

- [Software Downloads and Release Notes](https://support.ruckuswireless.com/software)—<https://support.ruckuswireless.com/software>
- [Security Bulletins](https://support.ruckuswireless.com/security)—<https://support.ruckuswireless.com/security>

Using these resources will help you to resolve some issues, and will provide TAC with additional data from your troubleshooting analysis if you still require assistance through a support case or RMA. If you still require help, open and manage your case at https://support.ruckuswireless.com/case_management

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Supported hardware and software

This guide supports the following product families for FastIron release 08.0.30:

- FastIron X Series devices (chassis models):
 - FastIron SX 800
 - FastIron SX 1600
- Brocade FCX Series (FCX) Switch
- Brocade ICX™ 6610 (ICX 6610) Switch
- Brocade ICX 6430 Series (ICX 6430)
- Brocade ICX 6450 Series (ICX 6450)
- Brocade ICX 6650 Series (ICX 6650)
- Brocade ICX 7250 Series (ICX 7250)
- Brocade ICX 7450 Series (ICX 7450)
- Brocade ICX 7750 Series (ICX 7750)

For information about the specific models and modules supported in a product family, refer to the hardware installation guide for that product family.

NOTE

The Brocade ICX 6430-C switch supports the same feature set as the Brocade ICX 6430 switch unless otherwise noted.

NOTE

The Brocade ICX 6450-C12-PD switch supports the same feature set as the Brocade ICX 6450 switch unless otherwise noted.

What's new in this document

The following table describes information added to this guide for FastIron software releases 08.0.30mb.

TABLE 2 Summary of enhancements in FastIron release 08.0.30mb

Feature	Description	Location
DHCP option 43 and option 60	Brocade devices running as DHCP servers can be configured with Option 43 and Option 60.	IP Configuration
Static MAC address to IP address mapping	Based on the client MAC address you can statically configure the IP address to the MAC-address in the DHCP server.	IP Configuration

About This Document

What's new in this document

TABLE 2 Summary of enhancements in FastIron release 08.0.30mb (continued)

Feature	Description	Location
Updated content for defect fix	Replaced the "Configuring a link-local IPv6 address on an interface" section with two sections (rewritten for clarity): <ul style="list-style-type: none">• Enabling IPv6 on an interface• Configuring a link-local IPv6 address on an interface	Refer to <ul style="list-style-type: none">• Enabling IPv6 on an interface on page 162• Configuring a link-local IPv6 address on an interface on page 163
Updated content for defect fix	Re-wrote the "Configuring an IP helper address" section.	Configuring an IP helper address on page 81
Updated content for defect fix	The accept mode functionality enables a VRRP nonowner master device to respond to ping, Telnet, and traceroute packets, but the device will not respond to SSH packets. When the device acting as the master device is not the IP address owner (the device with the interface whose actual IP address is used as the virtual device's IP address), the master device accepts only the ARP packets sent to the virtual IP address. When accept mode is configured, the master device responds to ping, TELNET, and traceroute packets sent to the virtual IP address even when the master device is not the IP address owner.	Refer to Accept mode for backup VRRP devices on page 545
General edits	Implemented general edits throughout the Multi-VRF chapter.	Multi-VRF

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Basic IP configuration

IP is enabled by default. Basic configuration consists of adding IP addresses for Layer 3 switches, enabling a route exchange protocol, such as the Routing Information Protocol (RIP).

NOTE

The terms Layer 3 switch and router are used interchangeably in this chapter and mean the same.

NOTE

References to chassis-based Layer 3 switches apply to the FSX 800 and FSX 1600.

If you are configuring a Layer 3 switch, refer to [Configuring IP addresses](#) on page 35 to add IP addresses, then enable and configure the route exchange protocols, as described in other chapters of this guide.

If you are configuring a Layer 2 switch, refer to [Configuring the management IP address and specifying the default gateway](#) on page 96 to add an IP address for management access through the network and to specify the default gateway.

The rest of this chapter describes IP and how to configure it in more detail. Use the information in this chapter if you need to change some of the IP parameters from their default values or you want to view configuration information or statistics.

IP configuration overview

Ruckus Layer 2 switches and Layer 3 switches support Internet Protocol version 4 (IPv4) and IPv6. IP support on Ruckus Layer 2 switches consists of basic services to support management access and access to a default gateway.

Full Layer 3 support

IP support on Ruckus full Layer 3 switches includes all of the following, in addition to a highly configurable implementation of basic IP services including Address Resolution Protocol (ARP), ICMP Router Discovery Protocol (IRDP), and Reverse ARP (RARP):

- Route exchange protocols:
 - Routing Information Protocol (RIP)
 - Open Shortest Path First (OSPF)
 - Border Gateway Protocol version 4 (BGP4)

IP Configuration

IP configuration overview

- Multicast protocols:
 - Internet Group Management Protocol (IGMP)
 - Protocol Independent Multicast Dense (PIM-DM)
 - Protocol Independent Multicast Sparse (PIM-SM)
- Router redundancy protocols:
 - Virtual Router Redundancy Protocol Extended (VRRP-E)
 - Virtual Router Redundancy Protocol (VRRP)

IP interfaces

NOTE

This section describes IPv4 addresses. For information about IPv6 addresses on FastIron X Series devices, refer to the "IPv6 addressing overview" section in the *FastIron Ethernet Switch Administration Guide*.

Ruckus Layer 3 switches and Layer 2 switches allow you to configure IP addresses. On Layer 3 switches, IP addresses are associated with individual interfaces. On Layer 2 switches, a single IP address serves as the management access address for the entire device.

All Ruckus Layer 3 switches and Layer 2 switches support configuration and display of IP addresses in classical subnet format (for example, 192.168.1.1 255.255.255.0) and Classless Interdomain Routing (CIDR) format (for example, 192.168.1.1/24). You can use either format when configuring IP address information. IP addresses are displayed in classical subnet format by default but you can change the display format to CIDR. Refer to [Changing the network mask display to prefix format](#) on page 127.

Layer 3 switches

Ruckus Layer 3 switches allow you to configure IP addresses on the following types of interfaces:

- Ethernet ports
- Virtual routing interfaces (used by VLANs to route among one another)
- Loopback interfaces
- GRE tunnels

Each IP address on a Layer 3 switch must be in a different subnet. You can have only one interface that is in a given subnet. For example, you can configure IP addresses 192.168.1.1/24 and 192.168.2.1/24 on the same Layer 3 switch, but you cannot configure 192.168.1.1/24 and 192.168.1.2/24 on the same Layer 3 switch.

You can configure multiple IP addresses on the same interface.

The number of IP addresses you can configure on an individual interface depends on the Layer 3 switch model. To display the maximum number of IP addresses and other system parameters you can configure on a Layer 3 switch, refer to "Displaying and modifying system parameter default settings" section in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*.

You can use any of the IP addresses you configure on the Layer 3 switch for Telnet, Web management, or SNMP access.

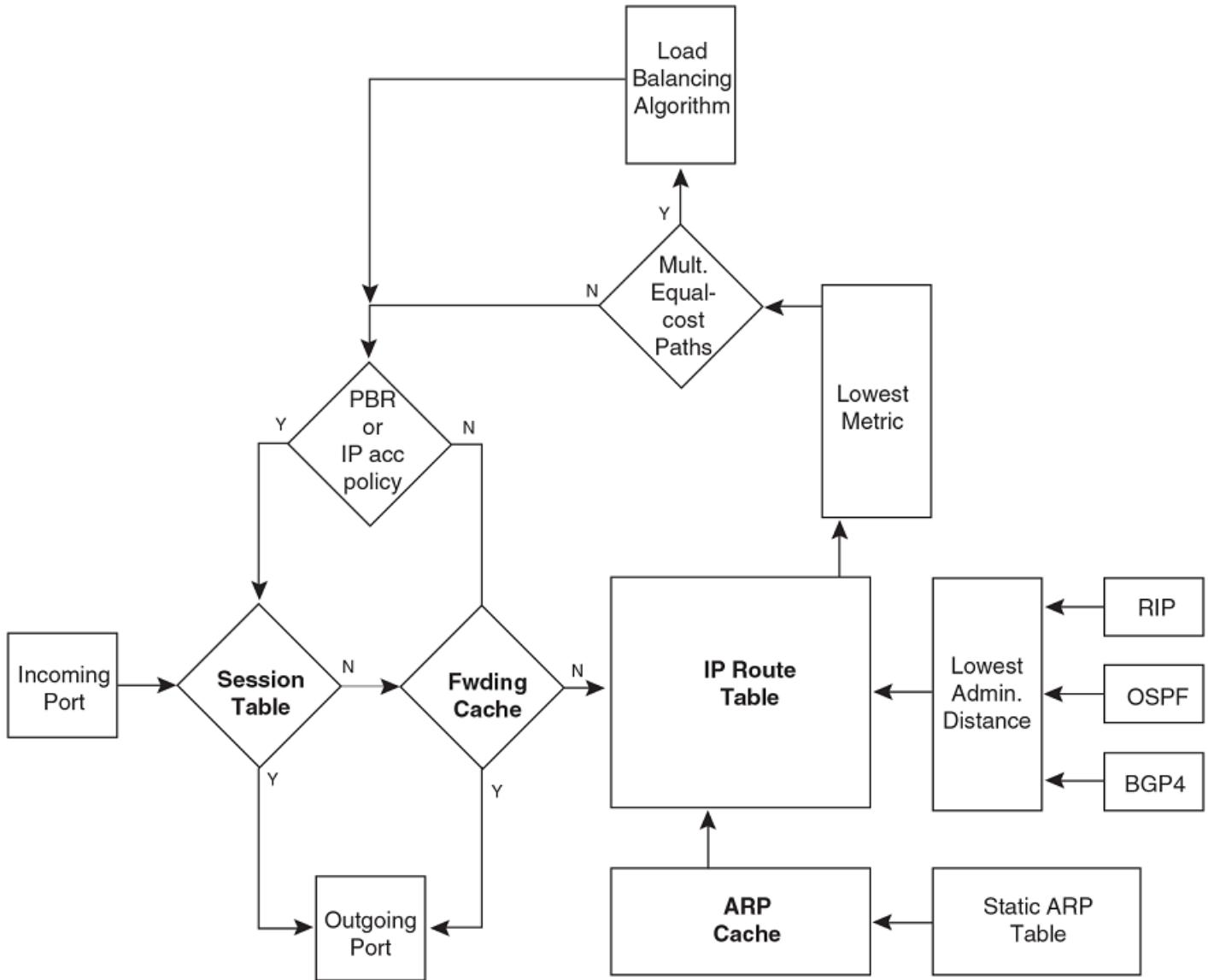
Layer 2 switches

You can configure an IP address on a Ruckus Layer 2 switch for management access to the Layer 2 switch. An IP address is required for Telnet access, Web management access, and SNMP access.

You also can specify the default gateway for forwarding traffic to other subnets.

IP packet flow through a Layer 3 switch

FIGURE 1 IP Packet flow through a Ruckus Layer 3 switch



- When the Layer 3 switch receives an IP packet, the Layer 3 switch checks for filters on the receiving interface. If a deny filter on the interface denies the packet, the Layer 3 switch discards the packet and performs no further processing, except generating a Syslog entry and SNMP message, if logging is enabled for the filter.
- If the packet is not denied at the incoming interface, the Layer 3 switch looks in the session table for an entry that has the same source IP address and TCP or UDP port as the packet. If the session table contains a matching entry, the Layer 3 switch immediately forwards the packet, by addressing it to the destination IP address and TCP or UDP port listed in the session table entry and sending the packet to a queue on the outgoing ports listed in the session table. The Layer 3 switch selects the queue based on the Quality of Service (QoS) level associated with the session table entry.

IP Configuration

IP configuration overview

3. If the session table does not contain an entry that matches the packet source address and TCP or UDP port, the Layer 3 switch looks in the IP forwarding cache for an entry that matches the packet destination IP address. If the forwarding cache contains a matching entry, the Layer 3 switch forwards the packet to the IP address in the entry. The Layer 3 switch sends the packet to a queue on the outgoing ports listed in the forwarding cache. The Layer 3 switch selects the queue based on the Quality of Service (QoS) level associated with the forwarding cache entry.
4. If the IP forwarding cache does not have an entry for the packet, the Layer 3 switch checks the IP route table for a route to the packet destination. If the IP route table has a route, the Layer 3 switch makes an entry in the session table or the forwarding cache, and sends the route to a queue on the outgoing ports:
 - - If the running-config contains an IP access policy for the packet, the software makes an entry in the session table. The Layer 3 switch uses the new session table entry to forward subsequent packets from the same source to the same destination.
 - If the running-config does not contain an IP access policy for the packet, the software creates a new entry in the forwarding cache. The Layer 3 switch uses the new cache entry to forward subsequent packets to the same destination.

The following sections describe the IP tables and caches:

- ARP cache and static ARP table
- IP route table
- IP forwarding cache
- Layer 4 session table

The software enables you to display these tables. You also can change the capacity of the tables on an individual basis if needed by changing the memory allocation for the table.

ARP cache and static ARP table

The ARP cache contains entries that map IP addresses to MAC addresses. Generally, the entries are for devices that are directly attached to the Layer 3 switch.

An exception is an ARP entry for an interface-based static IP route that goes to a destination that is one or more router hops away. For this type of entry, the MAC address is either the destination device MAC address or the MAC address of the router interface that answered an ARP request on behalf of the device, using proxy ARP.

ARP cache

The ARP cache can contain dynamic (learned) entries and static (user-configured) entries. The software places a dynamic entry in the ARP cache when the Layer 3 switch learns a device MAC address from an ARP request or ARP reply from the device.

The software can learn an entry when the Layer 2 switch or Layer 3 switch receives an ARP request from another IP forwarding device or an ARP reply. Here is an example of a dynamic entry:

IP Address	MAC Address	Type	Age	Port
1 10.95.6.102	0000.00fc.ea21	Dynamic	0	6

Each entry contains the destination device IP address and MAC address.

Static ARP table

In addition to the ARP cache, Layer 3 switches have a static ARP table. Entries in the static ARP table are user-configured. You can add entries to the static ARP table regardless of whether or not the device the entry is for is connected to the Layer 3 switch.

NOTE

Layer 3 switches have a static ARP table. Layer 2 switches do not.

The software places an entry from the static ARP table into the ARP cache when the entry interface comes up.

Here is an example of a static ARP entry.

Index	IP Address	MAC Address	Port
1	10.95.6.111	0000.003b.d210	1/1/1

Each entry lists the information you specified when you created the entry.

IP route table

The IP route table contains paths to IP destinations.

NOTE

Layer 2 switches do not have an IP route table. A Layer 2 switch sends all packets addressed to another subnet to the default gateway, which you specify when you configure the basic IP information on the Layer 2 switch.

The IP route table can receive the paths from the following sources:

- A directly-connected destination, which means there are no router hops to the destination
- A static IP route, which is a user-configured route
- A route learned through RIP
- A route learned through OSPF
- A route learned through BGP4

The IP route table contains the best path to a destination:

- When the software receives paths from more than one of the sources listed above, the software compares the administrative distance of each path and selects the path with the lowest administrative distance. The administrative distance is a protocol-independent value from 1 through 255.
- When the software receives two or more best paths from the same source and the paths have the same metric (cost), the software can load share traffic among the paths based on destination host or network address (based on the configuration and the Layer 3 switch model).

Here is an example of an entry in the IP route table.

Destination	NetMask	Gateway	Port	Cost	Type
10.1.0.0	255.255.0.0	10.1.1.2	1/1/1	2	R

Each IP route table entry contains the destination IP address and subnet mask and the IP address of the next-hop router interface to the destination. Each entry also indicates the port attached to the destination or the next-hop to the destination, the route IP metric (cost), and the type. The type indicates how the IP route table received the route.

To increase the size of the IP route table for learned and static routes, refer to the section "Displaying and modifying system parameter default settings" in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*:

- For learned routes, modify the *ip-route* parameter.
- For static routes, modify the *ip-static-route* parameter.

IP Configuration

IP configuration overview

IP forwarding cache

The IP forwarding cache provides a fast-path mechanism for forwarding IP packets. The cache contains entries for IP destinations. When a Ruckus Layer 3 switch has completed processing and addressing for a packet and is ready to forward the packet, the device checks the IP forwarding cache for an entry to the packet destination:

- If the cache contains an entry with the destination IP address, the device uses the information in the entry to forward the packet out the ports listed in the entry. The destination IP address is the address of the packet final destination. The port numbers are the ports through which the destination can be reached.
- If the cache does not contain an entry and the traffic does not qualify for an entry in the session table instead, the software can create an entry in the forwarding cache.

Each entry in the IP forwarding cache has an age timer. If the entry remains unused for ten minutes, the software removes the entry. The age timer is not configurable.

Here is an example of an entry in the IP forwarding cache.

IP Address	Next Hop	MAC	Type	Port	Vlan	Pri
1 192.168.1.11	DIRECT	0000.0000.0000	PU	n/a	0	

Each IP forwarding cache entry contains the IP address of the destination, and the IP address and MAC address of the next-hop router interface to the destination. If the destination is actually an interface configured on the Layer 3 switch itself, as shown here, then next-hop information indicates this. The port through which the destination is reached is also listed, as well as the VLAN and Layer 4 QoS priority associated with the destination if applicable.

NOTE

You cannot add static entries to the IP forwarding cache, although you can increase the number of entries the cache can contain. Refer to the section "Displaying and modifying system parameter default settings" in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*.

Layer 4 session table

The Layer 4 session provides a fast path for forwarding packets. A session is an entry that contains complete Layer 3 and Layer 4 information for a flow of traffic. Layer 3 information includes the source and destination IP addresses. Layer 4 information includes the source and destination TCP and UDP ports. For comparison, the IP forwarding cache contains the Layer 3 destination address but does not contain the other source and destination address information of a Layer 4 session table entry.

The Layer 2 switch or Layer 3 switch selects the session table instead of the IP forwarding table for fast-path forwarding for the following features:

- Layer 4 Quality-of-Service (QoS) policies
- IP access policies

To increase the size of the session table, refer to the section "Displaying and modifying system parameter default settings" in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*. The ip-qos-session parameter controls the size of the session table.

IP route exchange protocols

Ruckus Layer 3 switches support the following IP route exchange protocols:

- Routing Information Protocol (RIP)
- Open Shortest Path First (OSPF)
- Border Gateway Protocol version 4 (BGP4)

All these protocols provide routes to the IP route table. You can use one or more of these protocols, in any combination. The protocols are disabled by default.

IP multicast protocols

Ruckus Layer 3 switches also support the following Internet Group Membership Protocol (IGMP) based IP multicast protocols:

- Protocol Independent Multicast - Dense mode (PIM-DM)
- Protocol Independent Multicast - Sparse mode (PIM-SM)

For configuration information, refer to "IP Multicast Protocols" in the *FastIron Ethernet Switch IP Multicast Configuration Guide*.

NOTE

Ruckus Layer 3 switches support IGMP and can forward IP multicast packets. Refer to the "IP Multicast Traffic Reduction" chapter in the *FastIron Ethernet Switch IP Multicast Configuration Guide*.

IP interface redundancy protocols

You can configure a Ruckus Layer 3 switch to back up an IP interface configured on another Ruckus Layer 3 switch. If the link for the backed up interface becomes unavailable, the other Layer 3 switch can continue service for the interface. This feature is especially useful for providing a backup to a network default gateway.

Ruckus Layer 3 switches support the following IP interface redundancy protocols:

- Virtual Router Redundancy Protocol (VRRP) - A standard router redundancy protocol based on RFC 2338. You can use VRRP to configure Ruckus Layer 3 switches and third-party routers to back up IP interfaces on other Ruckus Layer 3 switches or third-party routers.
- Virtual Router Redundancy Protocol Extended (VRRP-E) - A Ruckus extension to standard VRRP that adds additional features and overcomes limitations in standard VRRP. You can use VRRP-E only on Ruckus Layer 3 switches.

ACLs and IP access policies

Ruckus Layer 3 switches provide two mechanisms for filtering IP traffic:

- Access Control Lists (ACLs)
- IP access policies

Both methods allow you to filter packets based on Layer 3 and Layer 4 source and destination information.

ACLs also provide great flexibility by providing the input to various other filtering mechanisms such as route maps, which are used by BGP4.

IP access policies allow you to configure QoS based on sessions (Layer 4 traffic flows).

Only one of these filtering mechanisms can be enabled on a Ruckus device at a time. Ruckus devices can store forwarding information for both methods of filtering in the session table.

For configuration information, refer to the chapter "Rule-Based IP ACLs" in the *FastIron Ethernet Switch Security Configuration Guide*.

IP Configuration

Basic IP parameters and defaults - Layer 3 switches

Basic IP parameters and defaults - Layer 3 switches

IP is enabled by default. The following IP-based protocols are all disabled by default:

- Routing protocols:
 - Routing Information Protocol (RIP)
 - Open Shortest Path First (OSPF)
 - Border Gateway Protocol version 4 (BGP4)
- Multicast protocols:
 - Internet Group Membership Protocol (IGMP)
 - Protocol Independent Multicast Dense (PIM-DM)
 - Protocol Independent Multicast Sparse (PIM-SM)
- Router redundancy protocols:
 - Virtual Router Redundancy Protocol Extended (VRRP-E)
 - Virtual Router Redundancy Protocol (VRRP)

When parameter changes take effect

Most IP parameters described in this chapter are dynamic. They take effect immediately, as soon as you enter the CLI command or select the Web Management Interface option. You can verify that a dynamic change has taken effect by displaying the running-config. To display the running-config, enter the **show running-config** or **write terminal** command at any CLI prompt. (You cannot display the running-config from the Web Management Interface.)

To save a configuration change permanently so that the change remains in effect following a system reset or software reload, save the change to the startup-config file:

- To save configuration changes to the startup-config file, enter the **write memory** command from the Privileged EXEC level of any configuration level of the CLI.
- To save the configuration changes using the Web Management Interface, select the Save link at the bottom of the dialog. Select Yes when prompted to save the configuration change to the startup-config file on the device flash memory. You also can access the dialog for saving configuration changes by clicking on Command in the tree view, then clicking on Save to Flash.

Changes to memory allocation require you to reload the software after you save the changes to the startup-config file. When reloading the software is required to complete a configuration change described in this chapter, the procedure that describes the configuration change includes a step for reloading the software.

IP global parameters - Layer 3 switches

TABLE 3 IP global parameters - Layer 3 switches

Parameter	Description	Default
IP state	The Internet Protocol, version 4	Enabled NOTE You cannot disable IP.

TABLE 3 IP global parameters - Layer 3 switches (continued)

Parameter	Description	Default
IP address and mask notation	<p>Format for displaying an IP address and its network mask information. You can enable one of the following:</p> <ul style="list-style-type: none"> • Class-based format; example: 192.168.1.1 255.255.255.0 • Classless Interdomain Routing (CIDR) format; example: 192.168.1.1/24 	<p>Class-based</p> <p>NOTE Changing this parameter affects the display of IP addresses, but you can enter addresses in either format regardless of the display setting.</p>
Router ID	The value that routers use to identify themselves to other routers when exchanging route information. OSPF and BGP4 use router IDs to identify routers. RIP does not use the router ID.	<p>The IP address configured on the lowest-numbered loopback interface.</p> <p>If no loopback interface is configured, then the lowest-numbered IP address configured on the device.</p>
Maximum Transmission Unit (MTU)	The maximum length an Ethernet packet can be without being fragmented.	<p>1500 bytes for Ethernet II encapsulation</p> <p>1492 bytes for SNAP encapsulation</p>
Address Resolution Protocol (ARP)	A standard IP mechanism that routers use to learn the Media Access Control (MAC) address of a device on the network. The router sends the IP address of a device in the ARP request and receives the device MAC address in an ARP reply.	Enabled
ARP rate limiting	You can specify a maximum number of ARP packets the device will accept each second. If the device receives more ARP packets than you specify, the device drops additional ARP packets for the remainder of the one-second interval.	Disabled
ARP age	<p>The amount of time the device keeps a MAC address learned through ARP in the device ARP cache. The device resets the timer to zero each time the ARP entry is refreshed and removes the entry if the timer reaches the ARP age.</p> <p>NOTE You also can change the ARP age on an individual interface basis.</p>	10 minutes
Proxy ARP	An IP mechanism a router can use to answer an ARP request on behalf of a host by replying with the router's own MAC address instead of the host.	Disabled
Static ARP entries	An ARP entry you place in the static ARP table. Static entries do not age out.	No entries
Time to Live (TTL)	The maximum number of routers (hops) through which a packet can pass before being discarded. Each router decreases a packet TTL by 1 before forwarding the packet. If decreasing the TTL causes the TTL to be 0, the router drops the packet instead of forwarding it.	64 hops
Directed broadcast forwarding	A directed broadcast is a packet containing all ones (or in some cases, all zeros) in the host portion of the destination IP address. When a	Disabled

IP Configuration

Basic IP parameters and defaults - Layer 3 switches

TABLE 3 IP global parameters - Layer 3 switches (continued)

Parameter	Description	Default
	<p>router forwards such a broadcast, it sends a copy of the packet out each of its enabled IP interfaces.</p> <p>NOTE You also can enable or disable this parameter on an individual interface basis.</p>	
Directed broadcast mode	<p>The packet format the router treats as a directed broadcast. The following formats can be directed broadcasts:</p> <ul style="list-style-type: none"> • All ones in the host portion of the packet destination address. • All zeroes in the host portion of the packet destination address. 	<p>All ones</p> <p>NOTE If you enable all-zeroes directed broadcasts, all-ones directed broadcasts remain enabled.</p>
Source-routed packet forwarding	A source-routed packet contains a list of IP addresses through which the packet must pass to reach its destination.	Enabled
Internet Control Message Protocol (ICMP) messages	The Ruckus Layer 3 switch can send the following types of ICMP messages:	Enabled
ICMP Router Discovery Protocol (IRDP)	<p>An IP protocol a router can use to advertise the IP addresses of its router interfaces to directly attached hosts. You can enable or disable the protocol, and change the following protocol parameters:</p> <ul style="list-style-type: none"> • Forwarding method (broadcast or multicast) • Hold time • Maximum advertisement interval • Minimum advertisement interval • Router preference level <p>NOTE You also can enable or disable IRDP and configure the parameters on an individual interface basis.</p>	Disabled
Reverse ARP (RARP)	An IP mechanism a host can use to request an IP address from a directly attached router when the host boots.	Enabled
Static RARP entries	An IP address you place in the RARP table for RARP requests from hosts.	No entries
	<p>NOTE You must enter the RARP entries manually. The Layer 3 switch does not have a mechanism for learning or dynamically generating RARP entries.</p>	
Maximum BootP relay hops	The maximum number of hops away a BootP server can be located from a router and still	Four

TABLE 3 IP global parameters - Layer 3 switches (continued)

Parameter	Description	Default
	be used by the router clients for network booting.	
Domain name for Domain Name Server (DNS) resolver	A domain name (for example, brocade.router.com) you can use in place of an IP address for certain operations such as IP pings, trace routes, and Telnet management connections to the router.	None configured
DNS default gateway addresses	A list of gateways attached to the router through which clients attached to the router can reach DNSs.	None configured
IP load sharing	<p>A Ruckus feature that enables the router to balance traffic to a specific destination across multiple equal-cost paths.</p> <p>IP load sharing uses a hashing algorithm based on the source IP address, destination IP address, protocol field in the IP header, TCP, and UDP information.</p> <p>You can specify the number of load-sharing paths depending on the device you are configuring. The maximum number of paths the device supports is a value from 2 through 8. The default value is 4. On the Brocade ICX 7750, the value range for the maximum number of load-sharing paths is from 2 through 32 which is controlled by the system-max max-ecmp command.</p> <p>NOTE Load sharing is sometimes called equal-cost multi-path (ECMP).</p>	Enabled
Maximum IP load sharing paths	The maximum number of equal-cost paths across which the Layer 3 switch is allowed to distribute traffic.	Four
Origination of default routes	You can enable a router to originate default routes for the following route exchange protocols, on an individual protocol basis:	Disabled
• OSPF • BGP4		
Default network route	The router uses the default network route if the IP route table does not contain a route to the destination and also does not contain an explicit default route (0.0.0.0 0.0.0.0 or 0.0.0.0/0).	None configured
Static route	An IP route you place in the IP route table.	No entries
Source interface	<p>The IP address the router uses as the source address for Telnet, RADIUS, or TACACS/TACACS+ packets originated by the router.</p> <p>The router can select the source address based on either of the following:</p> <ul style="list-style-type: none"> • The lowest-numbered IP address on the interface the packet is sent on. • The lowest-numbered IP address on a specific interface. The address is 	The lowest-numbered IP address on the interface the packet is sent on.

IP Configuration

Basic IP parameters and defaults - Layer 3 switches

TABLE 3 IP global parameters - Layer 3 switches (continued)

Parameter	Description	Default
	used as the source for all packets of the specified type regardless of interface the packet is sent on.	

IP interface parameters - Layer 3 switches

TABLE 4 IP interface parameters - Layer 3 switches

Parameter	Description	Default
IP state	The Internet Protocol, version 4	Enabled NOTE You cannot disable IP.
IP address	A Layer 3 network interface address NOTE Layer 2 switches have a single IP address used for management access to the entire device. Layer 3 switches have separate IP addresses on individual interfaces.	None configured NOTE Some devices have a factory default, such as 10.157.22.154, used for troubleshooting during installation. For Layer 3 switches, the address is on unit 1/slot 1/port 1 (or 1/1/1).
Encapsulation type	The format of the packets in which the router encapsulates IP datagrams. The encapsulation format can be one of the following: <ul style="list-style-type: none">• Ethernet II• SNAP	Ethernet II
Maximum Transmission Unit (MTU)	The maximum length (number of bytes) of an encapsulated IP datagram the router can forward.	1500 for Ethernet II encapsulated packets 1492 for SNAP encapsulated packets
Delay L3 notifications	When all ports in the VLAN go into the non-forwarding state, the device waits for the configured time before notifying the Layer 3 protocols of the VE down event. NOTE Available on the VE interface only.	Delay time is not configured
ARP age	Locally overrides the global setting.	Ten minutes
Directed broadcast forwarding	Locally overrides the global setting.	Disabled
ICMP Router Discovery Protocol (IRDP)	Locally overrides the global IRDP settings.	Disabled
DHCP gateway stamp	The router can assist DHCP/BootP Discovery packets from one subnet to reach DHCP/BootP servers on a different subnet by placing the IP address of the router interface that receives the request in the request packet Gateway field. You can override the default and specify the IP address to use for the Gateway field in the packets.	The lowest-numbered IP address on the interface that receives the request

TABLE 4 IP interface parameters - Layer 3 switches (continued)

Parameter	Description	Default
	<p>NOTE UDP broadcast forwarding for client DHCP/BootP requests (bootps) must be enabled (this is enabled by default) and you must configure an IP helper address (the server IP address or a directed broadcast to the server subnet) on the port connected to the client.</p>	
DHCP Client-Based Auto-Configuration	Allows the switch to obtain IP addresses from a DHCP host automatically, for either a specified (leased) or infinite period of time.	Enabled
DHCP Server	All FastIron devices can be configured to function as DHCP servers.	Disabled
UDP broadcast forwarding	<p>The router can forward UDP broadcast packets for UDP applications such as BootP. By forwarding the UDP broadcasts, the router enables clients on one subnet to find servers attached to other subnets.</p> <p>NOTE To completely enable a client UDP application request to find a server on another subnet, you must configure an IP helper address consisting of the server IP address or the directed broadcast address for the subnet that contains the server. Refer to the next row.</p>	The router helps forward broadcasts for the following UDP application protocols: <ul style="list-style-type: none"> • bootps • dns • netbios-dgm • netbios-ns • tacacs • tftp • time
IP helper address	The IP address of a UDP application server (such as a BootP or DHCP server) or a directed broadcast address. IP helper addresses allow the router to forward requests for certain UDP applications from a client on one subnet to a server on another subnet.	None configured

Basic IP parameters and defaults - Layer 2 switches

IP is enabled by default. The following tables list the Layer 2 switch IP parameters, their default values, and where to find configuration information.

NOTE

Ruckus Layer 2 switches also provide IP multicast forwarding, which is enabled by default. For information about this feature, refer to "IP Multicast Traffic Reduction" in the *FastIron Ethernet Switch IP Multicast Configuration Guide*.

IP Configuration

Basic IP parameters and defaults - Layer 2 switches

IP global parameters - Layer 2 switches

TABLE 5 IP global parameters - Layer 2 switches

Parameter	Description	Default
IP address and mask notation	<p>Format for displaying an IP address and its network mask information. You can enable one of the following:</p> <ul style="list-style-type: none"> • Class-based format; example: 192.168.1.1 255.255.255.0 • Classless Interdomain Routing (CIDR) format; example: 192.168.1.1/24 	<p>Class-based</p> <p>NOTE Changing this parameter affects the display of IP addresses, but you can enter addresses in either format regardless of the display setting.</p>
IP address	<p>A Layer 3 network interface address</p> <p>NOTE Layer 2 switches have a single IP address used for management access to the entire device. Layer 3 switches have separate IP addresses on individual interfaces.</p>	<p>None configured</p> <p>NOTE Some devices have a factory default, such as 10.157.22.154, used for troubleshooting during installation. For Layer 3 switches, the address is on port 1 (or 1/1/1).</p>
Default gateway	The IP address of a locally attached router (or a router attached to the Layer 2 switch by bridges or other Layer 2 switches). The Layer 2 switch and clients attached to it use the default gateway to communicate with devices on other subnets.	None configured
Address Resolution Protocol (ARP)	A standard IP mechanism that networking devices use to learn the Media Access Control (MAC) address of another device on the network. The Layer 2 switch sends the IP address of a device in the ARP request and receives the device MAC address in an ARP reply.	<p>Enabled</p> <p>NOTE You cannot disable ARP.</p>
ARP age	The amount of time the device keeps a MAC address learned through ARP in the device ARP cache. The device resets the timer to zero each time the ARP entry is refreshed and removes the entry if the timer reaches the ARP age.	<p>Ten minutes</p> <p>NOTE You cannot change the ARP age on Layer 2 switches.</p>
Time to Live (TTL)	The maximum number of routers (hops) through which a packet can pass before being discarded. Each router decreases a packet TTL by 1 before forwarding the packet. If decreasing the TTL causes the TTL to be 0, the router drops the packet instead of forwarding it.	64 hops
Domain name for Domain Name Server (DNS) resolver	A domain name (example: brocade.router.com) you can use in place of an IP address for certain operations such as IP pings, trace routes, and Telnet management connections to the router.	None configured
DNS default gateway addresses	A list of gateways attached to the router through which clients attached to the router can reach DNSs.	None configured
Source interface	The IP address the Layer 2 switch uses as the source address for Telnet, RADIUS, or	The management IP address of the Layer 2 switch.

TABLE 5 IP global parameters - Layer 2 switches (continued)

Parameter	Description	Default
	TACACS/TACACS+ packets originated by the router. The Layer 2 switch uses its management IP address as the source address for these packets.	NOTE This parameter is not configurable on Layer 2 switches.
DHCP gateway stamp	The device can assist DHCP/BootP Discovery packets from one subnet to reach DHCP/BootP servers on a different subnet by placing the IP address of the router interface that forwards the packet in the packet Gateway field. You can specify up to 32 gateway lists. A gateway list contains up to eight gateway IP addresses. You activate DHCP assistance by associating a gateway list with a port. When you configure multiple IP addresses in a gateway list, the Layer 2 switch inserts the addresses into the DHCP Discovery packets in a round robin fashion.	None configured
DHCP Client-Based Auto-Configuration	Allows the switch to obtain IP addresses from a DHCP host automatically, for either a specified (leased) or infinite period of time.	Enabled

Interface IP parameters - Layer 2 switches

TABLE 6 Interface IP parameters - Layer 2 switches

Parameter	Description	Default
DHCP gateway stamp	You can configure a list of DHCP stamp addresses for a port. When the port receives a DHCP/BootP Discovery packet from a client, the port places the IP addresses in the gateway list into the packet Gateway field.	None configured

Configuring IP parameters - Layer 3 switches

The following sections describe how to configure IP parameters. Some parameters can be configured globally while others can be configured on individual interfaces. Some parameters can be configured globally and overridden for individual interfaces.

Configuring IP addresses

You can configure an IP address on the following types of Layer 3 switch interfaces:

- Ethernet port
- Virtual routing interface (also called a Virtual Ethernet or "VE")
- Loopback interface
- GRE tunnels

By default, you can configure up to 24 IP addresses on each interface.

You can increase this amount to up to 128 IP subnet addresses per port by increasing the size of the ip-subnet-port table.

IP Configuration

Configuring IP parameters - Layer 3 switches

Refer to the section "Displaying system parameter default values" in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*.

NOTE

Once you configure a virtual routing interface on a VLAN, you cannot configure Layer 3 interface parameters on individual ports. Instead, you must configure the parameters on the virtual routing interface itself.

Ruckus devices support both classical IP network masks (Class A, B, and C subnet masks, and so on) and Classless Interdomain Routing (CIDR) network prefix masks:

- To enter a classical network mask, enter the mask in IP address format. For example, enter "10.157.22.99 255.255.255.0" for an IP address with a Class-C subnet mask.
- To enter a prefix network mask, enter a forward slash (/) and the number of bits in the mask immediately after the IP address. For example, enter "10.157.22.99/24" for an IP address that has a network mask with 24 significant bits (ones).

By default, the CLI displays network masks in classical IP address format (for example, 255.255.255.0). You can change the display to prefix format.

Assigning an IP address to an Ethernet port

To assign an IP address to port 1/1/1, enter the following commands.

```
device(config)# interface ethernet 1/1/1
device(config-if-1/1/1)# ip address 10.45.6.1 255.255.255.0
```

You also can enter the IP address and mask in CIDR format, as follows.

```
device(config-if-1/1/1)# ip address 10.45.6.1/24
```

Syntax: **no ip address ip-addr ip-mask [ospf-ignore | ospf-passive | secondary]**

or

Syntax: **no ip address ip-addr/mask-bits [ospf-ignore | ospf-passive | secondary]**

The **ospf-ignore** and **ospf-passive** parameters modify the Layer 3 switch defaults for adjacency formation and interface advertisement. Use one of these parameters if you are configuring multiple IP subnet addresses on the interface but you want to prevent OSPF from running on some of the subnets:

- **ospf-passive** - This option disables adjacency formation with OSPF neighbors. By default, when OSPF is enabled on an interface, the software forms OSPF router adjacencies between each primary IP address on the interface and the OSPF neighbor attached to the interface.
- **ospf-ignore** - This option disables OSPF adjacency formation and also disables advertisement of the interface into OSPF. The subnet is completely ignored by OSPF.

NOTE

The **ospf-passive** option disables adjacency formation but does not disable advertisement of the interface into OSPF. To disable advertisement in addition to disabling adjacency formation, you must use the **ospf-ignore** option.

Use the **secondary** parameter if you have already configured an IP address within the same subnet on the interface.

NOTE

When you configure more than one address in the same subnet, all but the first address are secondary addresses and do not form OSPF adjacencies.

NOTE

All physical IP interfaces on Ruckus FastIron Layer 3 devices share the same MAC address. For this reason, if more than one connection is made between two devices, one of which is a Ruckus FastIron Layer 3 device, Ruckus recommends the use of virtual interfaces. It is not recommended to connect two or more physical IP interfaces between two routers.

Assigning an IP address to a loopback interface

Loopback interfaces are always up, regardless of the states of physical interfaces. They can add stability to the network because they are not subject to route flap problems that can occur due to unstable links between a Layer 3 switch and other devices. You can configure up to eight loopback interfaces on a chassis Layer 3 switch devices. You can configure up to four loopback interfaces on a compact Layer 3 switch.

You can add up to 24 IP addresses to each loopback interface.

NOTE

If you configure the Ruckus Layer 3 switch to use a loopback interface to communicate with a BGP4 neighbor, you also must configure a loopback interface on the neighbor and configure the neighbor to use that loopback interface to communicate with the Ruckus Layer 3 switch. Refer to [Assigning an IP address to a loopback interface](#).

To add a loopback interface, enter commands such as those shown in the following example.

```
device(config-bgp-router) # exit
device(config) # interface loopback 1
device(config-lbif-1) # ip address 10.0.0.1/24
```

Syntax: interface loopback num

The *num* parameter specifies the virtual interface number. You can specify from 1 to the maximum number of virtual interfaces supported on the device. To display the maximum number of virtual interfaces supported on the device, enter the **show default values** command. The maximum is listed in the System Parameters section, in the Current column of the virtual-interface row.

Assigning an IP address to a virtual interface

A virtual interface is a logical port associated with a Layer 3 Virtual LAN (VLAN) configured on a Layer 3 switch. You can configure routing parameters on the virtual interface to enable the Layer 3 switch to route protocol traffic from one Layer 3 VLAN to the other, without using an external router.

You can configure IP routing interface parameters on a virtual interface. This section describes how to configure an IP address on a virtual interface. Other sections in this chapter that describe how to configure interface parameters also apply to virtual interfaces.

NOTE

The Layer 3 switch uses the lowest MAC address on the device (the MAC address of port 1 or 1/1/1) as the MAC address for all ports within all virtual interfaces you configure on the device.

To add a virtual interface to a VLAN and configure an IP address on the interface, enter commands such as the following.

```
device(config) # vlan 2 name IP-Subnet_10.1.2.0/24
device(config-vlan-2) # untag ethernet 1 to 4
device(config-vlan-2) # router-interface ve 1
device(config-vlan-2) # interface ve 1
device(config-vif-1) # ip address 10.1.2.1/24
```

The first two commands in this example create a Layer 3 protocol-based VLAN name "IP-Subnet_10.1.2.0/24" and add a range of untagged ports to the VLAN. The **router-interface** command creates virtual interface 1 as the routing interface for the VLAN.

IP Configuration

Configuring IP parameters - Layer 3 switches

Syntax: **router-interface ve num**

The *num* variable specifies the virtual interface number. You can enter a number from 1 through 4095.

When configuring virtual routing interfaces on a device, you can specify a number from 1 through 4095. However, the total number of virtual routing interfaces that are configured must not exceed the system-max limit of 512 (or 255 for the ICX 6450 and ICX 7250). For more information on the number of virtual routing interfaces supported, refer to "Allocating memory for more VLANs or virtual routing interfaces" in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*.

The last two commands change to the interface configuration level for the virtual interface and assign an IP address to the interface.

Syntax: **interface ve num**

Configuring IP follow on a virtual routing interface

IP Follow allows multiple virtual routing interfaces to share the same IP address. With this feature, one virtual routing interface is configured with an IP address, while the other virtual routing interfaces are configured to use that IP address, thus, they "follow" the virtual routing interface that has the IP address. This feature is helpful in conserving IP address space.

Configuration limitations and feature limitations for IP Follow on a virtual routing interface

- When configuring IP Follow, the primary virtual routing interface should not have ACL or DoS Protection configured. It is recommended that you create a dummy virtual routing interface as the primary and use the IP-follow virtual routing interface for the network.
- Global Policy Based Routing is not supported when IP Follow is configured.
- IPv6 is not supported with IP Follow.
- FastIron devices support IP Follow with OSPF and VRRP protocols only.

Configuration syntax for IP Follow on a virtual routing interface

Configure IP Follow by entering commands such as the following.

```
device(config)# vlan 2 name IP-Subnet_10.1.2.0/24
device(config-vlan-2)# untag ethernet 1 to 4
device(config-vlan-2)# router-interface ve 1
device(config-vlan-2)# interface ve 1
device(config-vif-1)# ip address 10.10.2.1/24
device(config-vif-1)# interface ve 2
device(config-vif-2)# ip follow ve 1
device(config-vif-2)# interface ve 3
device(config-vif-3)# ip follow ve 1
```

Syntax:[no] ip follow ve *number*

For *number*, enter the ID of the virtual routing interface.

Use the **no** form of the command to disable the configuration.

Virtual routing interface 2 and 3 do not have their own IP subnet addresses, but share the IP address of virtual routing interface 1.

Deleting an IP address

To delete an IP address, enter the **no ip address** command.

```
device(config-if-e1000-1)# no ip address 10.1.2.1
```

This command deletes IP address 10.1.2.1. You do not need to enter the subnet mask.

To delete all IP addresses from an interface, enter the **no ip address *** command.

```
device(config-if-e1000-1)# no ip address *
```

Syntax: [no] ip address *ip-addr* | *

Configuring 31-bit subnet masks on point-to-point networks

NOTE

31-bit subnet masks are supported on FSX, FCX, ICX 6450, ICX 6610, ICX 7250, ICX 7450, and ICX 7750 devices running the full Layer 3 image.

To conserve IPv4 address space, a 31-bit subnet mask can be assigned to point-to-point networks. Support for an IPv4 address with a 31-bit subnet mask is described in RFC 3021.

With IPv4, four IP addresses with a 30-bit subnet mask are allocated on point-to-point networks. In contrast, a 31-bit subnet mask uses only two IP addresses: all zero bits and all one bits in the host portion of the IP address. The two IP addresses are interpreted as host addresses, and do not require broadcast support because any packet that is transmitted by one host is always received by the other host at the receiving end. Therefore, directed broadcast on a point-to-point interface is eliminated.

IP-directed broadcast CLI configuration at the global level, or the per interface level, is not applicable on interfaces configured with a 31-bit subnet mask IP address.

When the 31-bit subnet mask address is configured on a point-to-point link, using network addresses for broadcast purposes is not allowed. For example, in an IPv4 broadcast scheme, the following subnets can be configured:

- 10.10.10.1 - Subnet for directed broadcast: {*Network-number* , -1}
- 10.10.10.0 - Subnet for network address: {*Network-number* , 0}

In a point-to-point link with a 31-bit subnet mask, the previous two addresses are interpreted as host addresses and packets are not rebroadcast.

Configuring an IPv4 address with a 31-bit subnet mask

To configure an IPv4 address with a 31-bit subnet mask, enter the following commands.

You can configure an IPv4 address with a 31-bit subnet mask on any interface (for example, Ethernet, loopback, VE, or tunnel interfaces).

```
device(config)# interface ethernet 1/1/5
device(config-if-e1000-1/1/5)# ip address 10.9.9.9 255.255.255.254
```

You can also enter the IP address and mask in the Classless Inter-domain Routing (CIDR) format, as follows.

```
device(config-if-e1000-1/1/5)# ip address 10.9.9.9/31
```

Syntax: [no] ip address *ip-address* *ip-mask*

Syntax: [no] ip address *ip-address*/*subnet-mask-bits*

The *ip-address* variable specifies the host address. The *ip-mask* variable specifies the IP network mask. The *subnet-mask-bits* variable specifies the network prefix mask.

To disable configuration for an IPv4 address with a 31-bit subnet mask on any interface, use the **no** form of the command.

IP Configuration

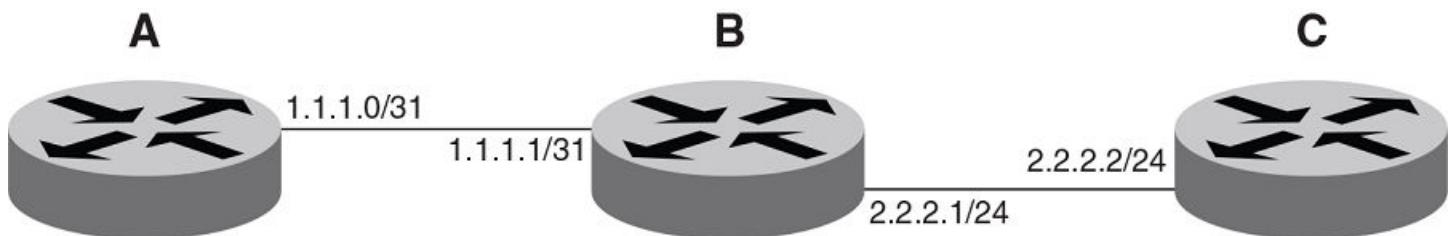
Configuring IP parameters - Layer 3 switches

You cannot configure a secondary IPv4 address with a 31-bit subnet mask on any interface. The following error message is displayed when a secondary IPv4 address with a 31-bit subnet mask is configured.

Error: Cannot assign /31 subnet address as secondary

Configuration example

FIGURE 2 Configured 31-bit and 24-bit subnet masks



Router A is connected to Router B as a point-to-point link with 10.1.1.0/31 subnet. There are only two available addresses in this subnet, 10.1.1.0 on Router A and 10.1.1.1 on Router B,

Routers B and C are connected by a regular 24-bit subnet. Router C can either be a switch with many hosts belonging to the 10.2.2.2/24 subnet connected to it, or it can be a router.

Router A

```
RouterA(config)# interface ethernet 1/1/1
RouterA(config-if-e1000-1/1/1)# ip address 10.1.1.0/31
```

Router B

```
RouterB(config)# interface ethernet 1/1/1
RouterB(config-if-e1000-1/1/1)# ip address 10.1.1.1/31
RouterB(config-if-e1000-1/1/1)# exit
RouterB(config)# interface ethernet 1/3/1
RouterB(config-if-e1000-1/3/1)# ip address 10.2.2.1/24
```

Router C

```
RouterC(config)# interface ethernet 1/3/1
RouterC(config-if-e1000-1/3/1)# ip address 10.2.2.2/24
```

Displaying information for a 31-bit subnet mask

Use the following commands to display information for the 31-bit subnet mask:

- **show run interface**
- **show ip route**
- **show ip cache**

Configuring DNS resolver

The Domain Name System (DNS) resolver is a feature in a Layer 2 or Layer 3 switch that sends and receives queries to and from the DNS server on behalf of a client.

You can create a list of domain names that can be used to resolve host names. This list can have more than one domain name. When a client sends a DNS query, all hosts within the domains in the list can be recognized and queries can be sent to any domain on the list.

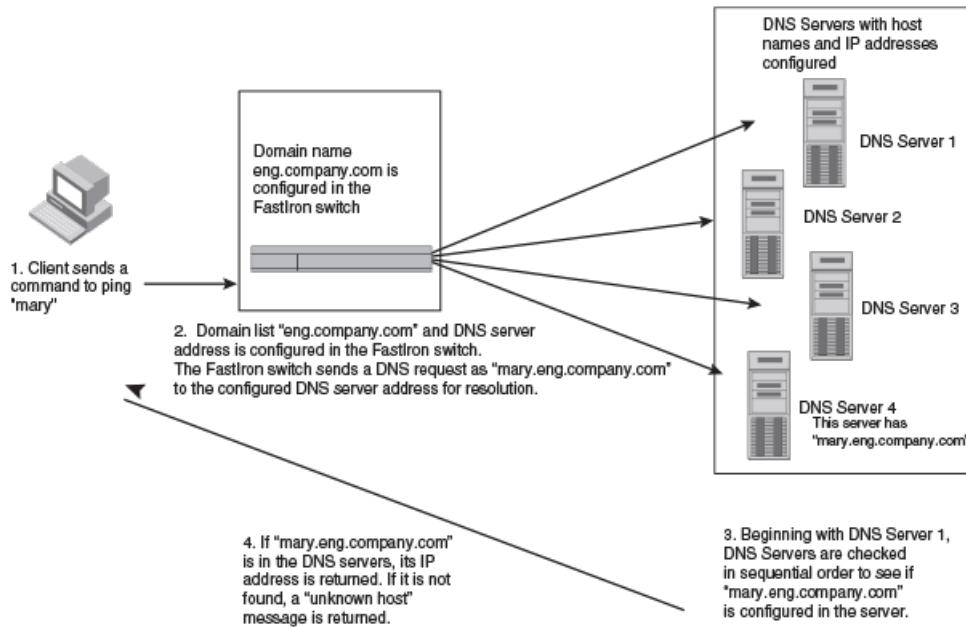
After you define a domain name, the Brocade device automatically appends the appropriate domain to a host and forwards it to the DNS servers for resolution.

For example, if the domain "ds.company.com" is defined on a Layer 2 or Layer 3 switch and you want to initiate a ping to "mary", you must reference only the host name instead of the host name and its domain name. For example, you could use the following command to initiate the ping.

```
Brocade:> ping mary
```

The Layer 2 or Layer 3 switch qualifies the host name by appending a domain name (for example, mary.ds1.company.com). This qualified name is sent to the DNS server for resolution. If there are four DNS servers configured, it is sent to the first DNS server. If the host name is not resolved, it is sent to the second DNS server. If a match is found, a response is sent back to the client with the host IP address. If no match is found, an "unknown host" message is returned.

FIGURE 3 DNS resolution with one domain name



Configuring DNS server addresses in a Brocade device

You can configure the Brocade device to recognize up to four DNS servers. The first entry serves as the primary default address. If a query to the primary address fails to be resolved after three attempts, the next DNS address is queried (also up to three times). This process continues for each defined DNS address until the query is resolved. The order in which the default DNS addresses are polled is the same as the order in which you enter them.

IP Configuration

Configuring IP parameters - Layer 3 switches

Use the **ip dns server-address** command to configure DNS servers.

```
device(config)# ip dns server-address 10.157.22.199 10.96.7.15 10.95.7.25 10.98.7.15
```

Alternatively, you can configure DNS servers one after the other.

```
device(config)# ip dns server-address 10.157.22.199
device(config)# ip dns server-address 10.96.7.15
device(config)# ip dns server-address 10.95.7.25
device(config)# ip dns server-address 10.98.7.15
```

In this example, the first IP address entered becomes the primary DNS address and all others are secondary addresses. Because IP address 10.98.7.15 is the last address listed, it is also the last address consulted to resolve a query.

Configuring DNS domain list on a Brocade device

If you want to use more than one domain name to resolve host names, you can create a list of domain names. Use the **ip dns domain-list** command to create a domain list.

```
device(config)# ip dns domain-list mycompany.com
device(config)# ip dns domain-list ds.company.com
device(config)# ip dns domain-list hw_company.com
device(config)# ip dns domain-list qa_company.com
```

The domain names are tried in the order you enter them.

Using a DNS name to initiate a trace route

Suppose you want to trace the route from a Brocade Layer 3 switch to a remote server identified as NYC02 on domain newyork.com. Because the NYC02@ds1.newyork.com domain is already defined on the Layer 3 switch, you need to enter only the host name, NYC02, as noted in the following example.

```
device# traceroute nyc02
```

The only required parameter is the IP address of the host at the other end of the route.

After you enter the **traceroute** command, a message indicating that the DNS query is in process and the current gateway address (IP address of the domain name server) being queried appear on the screen. When traceroute fails, an error occurs as shown in the last two lines in the following example.

```
Type Control-c to abort
Sending DNS Query to 10.157.22.199
Tracing Route to IP node 10.157.22.80
To ABORT Trace Route, Please use stop-traceroute command.
Traced route to target IP node 10.157.22.80:
  IP Address      Round Trip Time1      Round Trip Time2
  10.95.6.30      93 msec              121 msec
Trace route to target IP node 10.157.22.80 failed.
IP: Errno(9) No response from target or intermediate node
```

NOTE

In the example, 10.157.22.199 is the IP address of the domain name server (default DNS gateway address), and 10.157.22.80 represents the IP address of the NYC02 host.

Displaying DNS configuration

Use the following show commands to display the DNS configuration-related information.

1. Use the **show running-configuration** command to display the configured DNS server address and domain list in running configuration.

```
device# show running-configuration
ip dns domain-list 2222
ip dns server-address 10.157.22.199 10.96.7.15 10.95.7.25 10.98.7.15
```

2. Use the **show ip dns-server server-address** command to display the list of DNS server address configured on the device.

```
device# show ip dns-server server-address
IPV4 DNS server address:
1. 10.157.22.199
2. 10.96.7.15
3. 10.95.7.25
4. 10.98.7.15
```

3. Use the **show ip dns-server domain-list** command to display the domain list.

```
device# show ip dns-server domain-list
DNS Domain-list
1 mycompany.com
```

4. Use the **show ip dns-server** command to display the DNS server information.

```
switch(mode) # show ip dns-server
dns-server      Show DNS Server info
DNS Server information
DNS Domain-list
1 mycompany.com
IPV4 DNS server address:
1. 10.157.22.199
2. 10.96.7.15
3. 10.95.7.25
4. 10.98.7.15
IPV6 DNS server address:
NO ipv6 DNS server address is not configured
```

Configuring packet parameters

You can configure the following packet parameters on Layer 3 switches. These parameters control how the Layer 3 switch sends IP packets to other devices on an Ethernet network. The Layer 3 switch always places IP packets into Ethernet packets to forward them on an Ethernet port.

- Encapsulation type - The format for the Layer 2 packets within which the Layer 3 switch sends IP packets.
- Maximum Transmission Unit (MTU) - The maximum length of IP packet that a Layer 2 packet can contain. IP packets that are longer than the MTU are fragmented and sent in multiple Layer 2 packets. You can change the MTU globally or an individual ports:
 - Global MTU - The default MTU value depends on the encapsulation type on a port and is 1500 bytes for Ethernet II encapsulation and 1492 bytes for SNAP encapsulation.
 - Port MTU - A port default MTU depends on the encapsulation type enabled on the port.

IP Configuration

Configuring IP parameters - Layer 3 switches

Changing the encapsulation type

The Layer 3 switch encapsulates IP packets into Layer 2 packets, to send the IP packets on the network. (A Layer 2 packet is also called a MAC layer packet or an Ethernet frame.) The source address of a Layer 2 packet is the MAC address of the Layer 3 switch interface sending the packet. The destination address can be one of the following:

- The MAC address of the IP packet destination. In this case, the destination device is directly connected to the Layer 3 switch.
- The MAC address of the next-hop gateway toward the packet destination.
- An Ethernet broadcast address.

The entire IP packet, including the source and destination address and other control information and the data, is placed in the data portion of the Layer 2 packet. Typically, an Ethernet network uses one of two different formats of Layer 2 packet:

- Ethernet II
- Ethernet SNAP (also called IEEE 802.3)

The control portions of these packets differ slightly. All IP devices on an Ethernet network must use the same format. Ruckus Layer 3 switches use Ethernet II by default. You can change the IP encapsulation to Ethernet SNAP on individual ports if needed.

NOTE

All devices connected to the Layer 3 switch port must use the same encapsulation type.

To change the IP encapsulation type on interface 5 to Ethernet SNAP, enter the following commands.

```
device(config)# interface ethernet 5
device(config-if-e1000-5)# ip encapsulation snap
```

Syntax: **ip encapsulation { snap | ethernet_ii }**

Changing the MTU

The Maximum Transmission Unit (MTU) is the maximum length of IP packet that a Layer 2 packet can contain. IP packets that are longer than the MTU are fragmented and sent in multiple Layer 2 packets. You can change the MTU globally or on individual ports.

The default MTU is 1500 bytes for Ethernet II packets and 1492 for Ethernet SNAP packets.

MTU enhancements

Ruckus devices contain the following enhancements to jumbo packet support:

- Hardware forwarding of Layer 3 jumbo packets - Layer 3 IP unicast jumbo packets received on a port that supports the frame MTU size and forwarded to another port that also supports the frame MTU size are forwarded in hardware. Previous releases support hardware forwarding of Layer 2 jumbo frames only.
- ICMP unreachable message if a frame is too large to be forwarded - If a jumbo packet has the Do not Fragment (DF) bit set, and the outbound interface does not support the packet MTU size, the Ruckus device sends an ICMP unreachable message to the device that sent the packet.

NOTE

These enhancements apply only to transit traffic forwarded through the Ruckus device.

Configuration considerations for increasing the MTU

- The MTU command is applicable to VEs and physical IP interfaces. It applies to traffic routed between networks.

- For ICX 7250, ICX 7450, and ICX 7750 devices, the IPv4 and IPv6 MTU values are the same. Modifying one also changes the value of the other.
- For ICX 7250, ICX 7450, and ICX 7750 devices, the minimum IPv4 and IPv6 MTU values for both physical and virtual interfaces are 1280.
- You cannot use this command to set Layer 2 maximum frame sizes per interface. The global **jumbo** command causes all interfaces to accept Layer 2 frames.
- When you increase the MTU size of a port, the increase uses system resources. Increase the MTU size only on the ports that need it. For example, if you have one port connected to a server that uses jumbo frames and two other ports connected to clients that can support the jumbo frames, increase the MTU only on those three ports. Leave the MTU size on the other ports at the default value (1500 bytes). Globally increase the MTU size only if needed.

Forwarding traffic to a port with a smaller MTU size

NOTE

Forwarding traffic to a port with a smaller MTU size is not supported on the FastIron X Series.

In order to forward traffic from a port with 1500 MTU configured to a port that has a smaller MTU (for example, 750) size, you must apply the **mtu-exceed forward** global command. To remove this setting, enter the **mtu-exceed hard-drop** command. The **hard-drop** option is enabled by default on the router.

Syntax: **mtu-exceed { forward | hard-drop }**

- **forward** - Fragments and forwards a packet from a port with a larger MTU to a port with a smaller MTU.
- **hard-drop** - Resets to default and removes the forward function.

Globally changing the Maximum Transmission Unit

The Maximum Transmission Unit (MTU) is the maximum size an IP packet can be when encapsulated in a Layer 2 packet. If an IP packet is larger than the MTU allowed by the Layer 2 packet, the Layer 3 switch fragments the IP packet into multiple parts that will fit into the Layer 2 packets, and sends the parts of the fragmented IP packet separately, in different Layer 2 packets. The device that receives the multiple fragments of the IP packet reassembles the fragments into the original packet.

You can increase the MTU size to accommodate jumbo packet sizes up to 10,200 bytes.

To globally enable jumbo support on all ports of a FastIron device, enter commands such as the following.

```
device(config)# jumbo
device(config)# write memory
device(config)# end
device# reload
```

Syntax: **[no] jumbo**

NOTE

You must save the configuration change and then reload the software to enable jumbo support.

Changing the MTU on an individual port

By default, the maximum Ethernet MTU sizes are as follows:

- 1500 bytes - The maximum for Ethernet II encapsulation
- 1492 bytes - The maximum for SNAP encapsulation

IP Configuration

Configuring IP parameters - Layer 3 switches

When jumbo mode is enabled, the maximum Ethernet MTU sizes are as follows:

- For ICX 6610 devices
 - 10,200 bytes - The maximum for Ethernet II encapsulation (Default MTU: 9216)
 - 10,174 bytes - The maximum for SNAP encapsulation (Default MTU: 9216)
- For ICX 6430, ICX 6430-C12, and ICX 6450 devices
 - 10,178 bytes - The maximum for Ethernet II encapsulation (Default MTU: 9216)
 - 10,174 bytes - The maximum for SNAP encapsulation (Default MTU: 9216)
- For other devices
 - 10,218 bytes - The maximum for Ethernet II encapsulation (Default MTU: 9216)
 - 10,214 bytes - The maximum for SNAP encapsulation (Default MTU: 9216)

NOTE

If you set the MTU of a port to a value lower than the global MTU and from 576 through 1499, the port fragments the packets. However, if the port MTU is exactly 1500 and this is larger than the global MTU, the port drops the packets. For ICX 7250, ICX 7450, and ICX 7750 devices, the minimum IPv4 and IPv6 MTU values for both physical and virtual interfaces are 1280.

NOTE

You must save the configuration change and then reload the software to enable jumbo support.

To change the MTU for interface 1/1/5 to 1000, enter the following commands.

```
device(config)# interface ethernet 1/1/5
device(config-if-1/1/5)# ip mtu 1000
device(config-if-1/1/5)# write memory
device(config-if-1/1/5)# end
device# reload
```

Syntax: [no] ip mtu num

The *num* variable specifies the MTU. Ethernet II packets can hold IP packets from 576 through 1500 bytes long. If jumbo mode is enabled, Ethernet II packets can hold IP packets up to 10,218 bytes long. Ethernet SNAP packets can hold IP packets from 576 through 1492 bytes long. If jumbo mode is enabled, SNAP packets can hold IP packets up to 10,214 bytes long. The default MTU for Ethernet II packets is 1500. The default MTU for SNAP packets is 1492.

Path MTU discovery (RFC 1191) support

FastIron X Series devices support the path MTU discovery method described in RFC 1191. When the Ruckus device receives an IP packet that has its Do not Fragment (DF) bit set, and the packet size is greater than the MTU value of the outbound interface, then the Ruckus device returns an ICMP Destination Unreachable message to the source of the packet, with the Code indicating "fragmentation needed and DF set". The ICMP Destination Unreachable message includes the MTU of the outbound interface. The source host can use this information to help determine the maximum MTU of a path to a destination.

RFC 1191 is supported on all interfaces.

Changing the router ID

In most configurations, a Layer 3 switch has multiple IP addresses, usually configured on different interfaces. As a result, a Layer 3 switch identity to other devices varies depending on the interface to which the other device is attached. Some routing protocols, including Open Shortest Path First (OSPF) and Border Gateway Protocol version 4 (BGP4), identify a Layer 3 switch by just one of the IP addresses configured on the Layer 3 switch, regardless of the interfaces that connect the Layer 3 switches. This IP address is the router ID.

NOTE

Routing Information Protocol (RIP) does not use the router ID.

NOTE

If you change the router ID, all current BGP4 sessions are cleared.

By default, the router ID on a Ruckus Layer 3 switch is one of the following:

- If the router has loopback interfaces, the default router ID is the IP address configured on the lowest numbered loopback interface configured on the Layer 3 switch. For example, if you configure loopback interfaces 1, 2, and 3 as follows, the default router ID is 10.9.9.9/24:
 - Loopback interface 1, 10.9.9.9/24
 - Loopback interface 2, 10.4.4.4/24
 - Loopback interface 3, 10.1.1.1/24
- If the device does not have any loopback interfaces, the default router ID is the lowest numbered IP interface configured on the device.

If you prefer, you can explicitly set the router ID to any valid IP address. The IP address cannot be in use on another device in the network.

NOTE

Ruckus Layer 3 switches use the same router ID for both OSPF and BGP4. If the router is already configured for OSPF, you may want to use the router ID that is already in use on the router rather than set a new one. To display the router ID, enter the **show ip** command at any CLI level or select the IP->General links from the Configure tree in the Web Management Interface.

To change the router ID, enter a command such as the following.

```
device(config)# ip router-id 10.157.22.26
```

Syntax: ip router-id ip-addr

The *ip-addr* variable can be any valid, unique IP address.

NOTE

You can specify an IP address used for an interface on the Ruckus Layer 3 switch, but do not specify an IP address in use by another device.

Specifying a single source interface for specified packet types

NOTE

This feature is supported on Brocade FCX Series switches, FastIron X Series Layer 3 switches, ICX 6610, ICX 6430, and ICX 6450 switches.

IP Configuration

Configuring IP parameters - Layer 3 switches

When the Layer 3 switch originates a packet of one of the following types, the source address of the packet is the lowest-numbered IP address on the interface that sends the packet:

- Telnet
- TACACS/TACACS+
- TFTP
- RADIUS
- Syslog
- SNTP
- SNMP traps

You can configure the Layer 3 switch to always use the lowest-numbered IP address on a specific Ethernet, loopback, or virtual interface as the source addresses for these packets. When configured, the Layer 3 switch uses the same IP address as the source for all packets of the specified type, regardless of the ports that actually sends the packets.

Identifying a single source IP address for specified packets provides the following benefits:

- If your server is configured to accept packets only from specific IP addresses, you can use this feature to simplify configuration of the server by configuring the Ruckus device to always send the packets from the same link or source address.
- If you specify a loopback interface as the single source for specified packets, servers can receive the packets regardless of the states of individual links. Thus, if a link to the server becomes unavailable but the client or server can be reached through another link, the client or server still receives the packets, and the packets still have the source IP address of the loopback interface.

The software contains separate CLI commands for specifying the source interface for specific packets. You can configure a source interface for one or more of these types of packets separately.

The following sections show the syntax for specifying a single source IP address for specific packet types.

Telnet packets

To specify the lowest-numbered IP address configured on a virtual interface as the device source for all Telnet packets, enter commands such as the following.

```
device(config)# interface loopback 2
device(config-lbif-2)# ip address 10.0.0.2/24
device(config-lbif-2)# exit
device(config)# ip telnet source-interface loopback 2
```

The commands in this example configure loopback interface 2, assign IP address 10.0.0.2/24 to the interface, then designate the interface as the source for all Telnet packets from the Layer 3 switch.

The following commands configure an IP interface on an Ethernet port and designate the address port as the source for all Telnet packets from the Layer 3 switch.

```
device(config)# interface ethernet 1/1/4
device(config-if-1/1/4)# ip address 10.157.22.110/24
device(config-if-1/1/4)# exit
device(config)# ip telnet source-interface ethernet 1/1/4
```

Syntax: [no] ip telnet source-interface { ethernet unit / slot / port | loopback num | management num | venum }

TACACS/TACACS+ packets

To specify the lowest-numbered IP address configured on a virtual interface as the device source for all TACACS/TACACS+ packets, enter commands such as the following.

```
device(config)# interface ve 1
device(config-vif-1)# ip address 10.0.0.3/24
device(config-vif-1)# exit
device(config)# ip tacacs source-interface ve 1
```

The commands in this example configure virtual interface 1, assign IP address 10.0.0.3/24 to the interface, then designate the interface as the source for all TACACS/TACACS+ packets from the Layer 3 switch.

Syntax: [no] **ip tacacs source-interface { ethernet unit / slot / port | loopback num | management num | venum }**

RADIUS packets

To specify the lowest-numbered IP address configured on a virtual interface as the device source for all RADIUS packets, enter commands such as the following.

```
device(config)# interface ve 1
device(config-vif-1)# ip address 10.0.0.3/24
device(config-vif-1)# exit
device(config)# ip radius source-interface ve 1
```

The commands in this example configure virtual interface 1, assign IP address 10.0.0.3/24 to the interface, then designate the interface as the source for all RADIUS packets from the Layer 3 switch.

Syntax: [no] **ip radius source-interface { ethernet unit / slot / port | loopback num | management num | venum }**

TFTP packets

To specify the lowest-numbered IP address configured on a virtual interface as the device source for all TFTP packets, enter commands such as the following.

```
device(config)# interface ve 1
device(config-vif-1)# ip address 10.0.0.3/24
device(config-vif-1)# exit
device(config)# ip tftp source-interface ve 1
```

The commands in this example configure virtual interface 1, assign IP address 10.0.0.3/24 to the interface, then designate the interface's address as the source address for all TFTP packets.

Syntax: [no] **ip tftp source-interface { ethernet unit / slot / port | loopback num | management num | venum }**

The default is the lowest-numbered IP address configured on the port through which the packet is sent. The address therefore changes, by default, depending on the port.

Syslog packets

To specify the lowest-numbered IP address configured on a virtual interface as the device source for all Syslog packets, enter commands such as the following.

```
device(config)# interface ve 1
device(config-vif-1)# ip address 10.0.0.4/24
device(config-vif-1)# exit
device(config)# ip syslog source-interface ve 1
```

The commands in this example configure virtual interface 1, assign IP address 10.0.0.4/24 to the interface, then designate the interface's address as the source address for all Syslog packets.

IP Configuration

Configuring IP parameters - Layer 3 switches

Syntax: [no] ip syslog source-interface { ethernet unit / slot / port | loopback num | management num | venum }

The default is the lowest-numbered IP or IPv6 address configured on the port through which the packet is sent. The address therefore changes, by default, depending on the port.

SNTP packets

To specify the lowest-numbered IP address configured on a virtual interface as the device source for all SNTP packets, enter commands such as the following.

```
device(config)# interface ve 1
device(config-vif-1)# ip address 10.0.0.5/24
device(config-vif-1)# exit
device(config)# ip sntp source-interface ve 1
```

The commands in this example configure virtual interface 1, assign IP address 10.0.0.5/24 to the interface, then designate the interface's address as the source address for all SNTP packets.

Syntax: [no] ip sntp source-interface { ethernet unit / slot / port | loopback num | management num | venum }

The default is the lowest-numbered IP or IPv6 address configured on the port through which the packet is sent. The address therefore changes, by default, depending on the port.

SNMP packets

To specify a loopback interface as the SNMP single source trap, enter commands such as the following.

```
device(config)# interface loopback 1
device(config-lbif-1)# ip address 10.0.0.1/24
device(config-lbif-1)# exit
device(config)# snmp-server trap-source loopback 1
```

The commands in this example configure loopback interface 1, assign IP address 10.0.0.1/24 to the loopback interface, then designate the interface as the SNMP trap source for this device. Regardless of the port the Ruckus device uses to send traps to the receiver, the traps always arrive from the same source IP address.

Syntax: [no] snmp-server trap-source { ethernet unit / slot / port | loopback num | venum }

Configuring delay time for notifying VE down event

When all the ports in the VLAN go into an inactive state (for example, the non-forwarding state), the device notifies the Layer 3 protocols of the VE down event only after the configured timer expires. Once the timer expires, the device checks if any of the ports is in the forwarding state. If no ports are in the forwarding state, the device notifies the Layer 3 protocols of the VE down event. If any of the ports is in the forwarding state, the device ignores the down event.

While the timer is running, if any of the ports comes into forwarding state, the device cancels the timer and does not notify the VE down event to the protocols.

NOTE

In the case of multiple flaps, if any of the ports comes into forwarding state before the delay notification timer expiry then the device cancels the timer and a fresh timer is started during port down event. Incase of continuous flaps where flap time is less than delay notification timer, the flaps can be detected by other methods like port statistics or drop in traffic or by the convergence logs of layer2 loop detection protocols.

Suppressing the link status notification allows a quick port status change and recovery to occur without triggering any of the changes that are necessary when a port stays down.

By default, the delay time is not configured.

NOTE

Configuring delayed Layer 3 notifications on the VE feature is supported on ICX 7250, ICX 7450, and ICX 7750 product families from Brocade.

Configuring VE down time notification

Perform the following steps to configure the delay time for notifying the Layer 3 protocols of the VE down event.

1. From global configuration mode, enter VE interface configuration mode.

```
device(config)# interface ve 50
```

2. Configure the delay notifications time value.

```
device(config-vif-50)# delay-notifications 20
```

3. Use the **show ip interface ve** command to confirm the configuration.

The following example shows how to configure the delay time for notifying the Layer 3 protocols of the VE down event.

```
device(config)# interface ve 50
device(config-vif-50)# delay-notifications 20
```

ARP parameter configuration

Address Resolution Protocol (ARP) is a standard IP protocol that enables an IP Layer 3 switch to obtain the MAC address of another device interface when the Layer 3 switch knows the IP address of the interface. ARP is enabled by default and cannot be disabled.

NOTE

Ruckus Layer 2 switches also support ARP. However, the configuration options described later in this section apply only to Layer 3 switches, not to Layer 2 switches.

How ARP works

A Layer 3 switch needs to know a destination MAC address when forwarding traffic, because the Layer 3 switch encapsulates the IP packet in a Layer 2 packet (MAC layer packet) and sends the Layer 2 packet to a MAC interface on a device directly attached to the Layer 3 switch. The device can be the packet final destination or the next-hop router toward the destination.

The Layer 3 switch encapsulates IP packets in Layer 2 packets regardless of whether the ultimate destination is locally attached or is multiple router hops away. Because the Layer 3 switch IP route table and IP forwarding cache contain IP address information but not MAC address information, the Layer 3 switch cannot forward IP packets based solely on the information in the route table or forwarding cache. The Layer 3 switch needs to know the MAC address that corresponds with the IP address of either the packet locally attached destination or the next-hop router that leads to the destination.

For example, to forward a packet whose destination is multiple router hops away, the Layer 3 switch must send the packet to the next-hop router toward its destination, or to a default route or default network route if the IP route table does not contain a route to the packet destination. In each case, the Layer 3 switch must encapsulate the packet and address it to the MAC address of a locally attached device, the next-hop router toward the IP packet destination.

To obtain the MAC address required for forwarding a datagram, the Layer 3 switch first looks in the ARP cache (not the static ARP table) for an entry that lists the MAC address for the IP address. The ARP cache maps IP addresses to MAC addresses. The cache also lists the port attached to the device and, if the entry is dynamic, the age of the entry. A dynamic ARP entry enters the cache

IP Configuration

Configuring IP parameters - Layer 3 switches

when the Layer 3 switch receives an ARP reply or receives an ARP request (which contains the sender IP address and MAC address). A static entry enters the ARP cache from the separate static ARP table when the interface for the entry comes up.

To ensure the accuracy of the ARP cache, each dynamic entry has its own age timer. The timer is reset to zero each time the Layer 3 switch receives an ARP reply or ARP request containing the IP address and MAC address of the entry. If a dynamic entry reaches its maximum allowable age, the entry times out and the software removes the entry from the table. Static entries do not age out and can be removed only by you.

If the ARP cache does not contain an entry for the destination IP address, the Layer 3 switch broadcasts an ARP request out all its IP interfaces. The ARP request contains the IP address of the destination. If the device with the IP address is directly attached to the Layer 3 switch, the device sends an ARP response containing its MAC address. The response is a unicast packet addressed directly to the Layer 3 switch. The Layer 3 switch places the information from the ARP response into the ARP cache.

ARP requests contain the IP address and MAC address of the sender, so all devices that receive the request learn the MAC address and IP address of the sender and can update their own ARP caches accordingly.

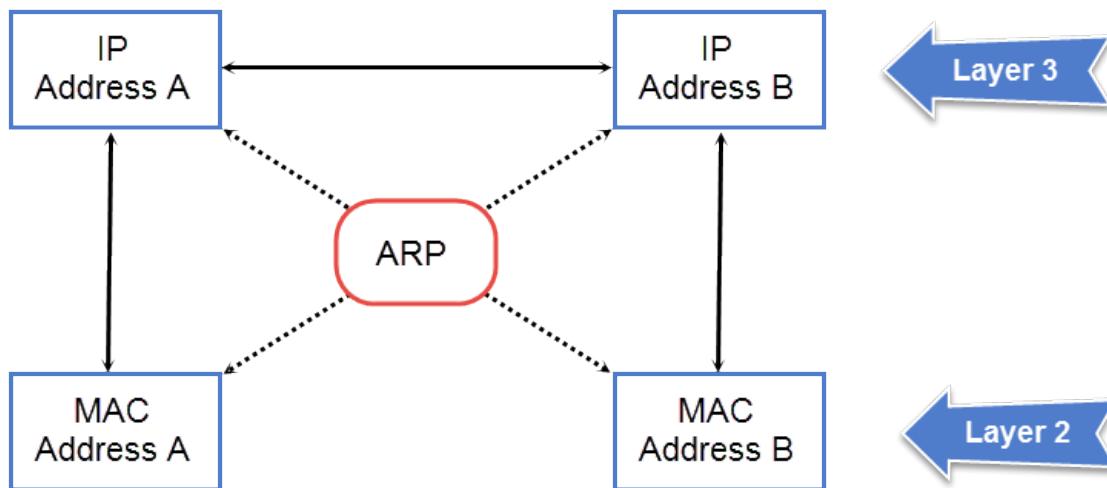
NOTE

The ARP request broadcast is a MAC broadcast, which means the broadcast goes only to devices that are directly attached to the Layer 3 switch. A MAC broadcast is not routed to other networks. However, some routers, including Ruckus Layer 3 switches, can be configured to reply to ARP requests from one network on behalf of devices on another network.

NOTE

If the router receives an ARP request packet that it is unable to deliver to the final destination because of the ARP timeout and no ARP response is received (the Layer 3 switch knows of no route to the destination address), the router sends an ICMP Host Unreachable message to the source.

FIGURE 4 ARP supplies the MAC address corresponding to an IP address



If Device A wants to communicate with Device B, knowing the IP address of Device B is not sufficient; the MAC address is also required. ARP supplies the MAC address.

Rate limiting ARP packets

You can limit the number of ARP packets the Ruckus device accepts during each second. By default, the software does not limit the number of ARP packets the device can receive. Since the device sends ARP packets to the CPU for processing, if a device in a busy network receives a high number of ARP packets in a short period of time, some CPU processing might be deferred while the CPU processes the ARP packets.

To prevent the CPU from becoming flooded by ARP packets in a busy network, you can restrict the number of ARP packets the device will accept each second. When you configure an ARP rate limit, the device accepts up to the maximum number of packets you specify, but drops additional ARP packets received during the one-second interval. When a new one-second interval starts, the counter restarts at zero, so the device again accepts up to the maximum number of ARP packets you specified, but drops additional packets received within the interval.

To limit the number of ARP packets the device will accept each second, enter the **rate-limit-arp** command at the global CONFIG level of the CLI.

```
device(config)# rate-limit-arp 100
```

This command configures the device to accept up to 100 ARP packets each second. If the device receives more than 100 ARP packets during a one-second interval, the device drops the additional ARP packets during the remainder of that one-second interval.

Syntax:[no] **rate-limit-arp** num

The *num* variable specifies the number of ARP packets and can be from 0 through 100. If you specify 0, the device will not accept any ARP packets.

NOTE

If you want to change a previously configured the ARP rate limiting policy, you must remove the previously configured policy using the **no rate-limit-arp** command before entering the new policy.

Changing the ARP aging period

When the Layer 3 switch places an entry in the ARP cache, the Layer 3 switch also starts an aging timer for the entry. The aging timer ensures that the ARP cache does not retain learned entries that are no longer valid. An entry can become invalid when the device with the MAC address of the entry is no longer on the network.

The ARP age affects dynamic (learned) entries only, not static entries. The default ARP age is ten minutes. On Layer 3 switches, you can change the ARP age to a value from 0 through 240 minutes. You cannot change the ARP age on Layer 2 switches. If you set the ARP age to zero, aging is disabled and entries do not age out.

NOTE

Host devices connected to an ICX 7750 that also have a valid IP address and reply periodically to the arp request are not timed out, even if no traffic is destined for the device. This behavior is restricted to only ICX 7750 devices.

To globally change the ARP aging parameter to 20 minutes, enter the **ip arp-age** command.

```
device(config)# ip arp-age 20
```

Syntax: [no] **ip arp-age** num

The *num* parameter specifies the number of minutes, which can be from 0 through 240. The default is 10. If you specify 0, aging is disabled.

IP Configuration

Configuring IP parameters - Layer 3 switches

To override the globally configured IP ARP age on an individual interface, enter the **ip arp-age** command followed by the new value at the interface configuration level.

```
device(config-if-e1000-1/1/1)# ip arp-age 30
```

Enabling proxy ARP

Proxy ARP allows a Layer 3 switch to answer ARP requests from devices on one network on behalf of devices in another network. Because ARP requests are MAC-layer broadcasts, they reach only the devices that are directly connected to the sender of the ARP request. Thus, ARP requests do not cross routers.

For example, if Proxy ARP is enabled on a Layer 3 switch connected to two subnets, 10.10.10.0/24 and 10.20.20.0/24, the Layer 3 switch can respond to an ARP request from 10.10.10.69 for the MAC address of the device with IP address 10.20.20.69. In standard ARP, a request from a device in the 10.10.10.0/24 subnet cannot reach a device in the 10.20.20.0 subnet if the subnets are on different network cables, and thus is not answered.

NOTE

An ARP request from one subnet can reach another subnet when both subnets are on the same physical segment (Ethernet cable), because MAC-layer broadcasts reach all the devices on the segment.

Proxy ARP is disabled by default on Ruckus Layer 3 switches. This feature is not supported on Ruckus Layer 2 switches.

You can enable proxy ARP at the Interface level, as well as at the Global CONFIG level, of the CLI.

NOTE

Configuring proxy ARP at the Interface level overrides the global configuration.

Enabling proxy ARP globally

To enable IP proxy ARP on a global basis, enter the **ip proxy-arp** command.

```
device(config)# ip proxy-arp
```

To again disable IP proxy ARP on a global basis, enter the **no ip proxy-arp** command.

```
device(config)# no ip proxy-arp
```

Syntax: **[no] ip proxy-arp**

Enabling IP ARP on an interface

NOTE

Configuring proxy ARP at the Interface level overrides the global configuration.

To enable IP proxy ARP on an interface, enter the following commands.

```
device(config)# interface ethernet 5
device(config-if-e1000-5)# ip proxy-arp enable
```

To again disable IP proxy ARP on an interface, enter the following command.

```
device(config)# interface ethernet 5
device(config-if-e1000-5)# ip proxy-arp disable
```

Syntax: **[no] ip proxy-arp { enable | disable }**

NOTE

By default, gratuitous ARP is disabled for local proxy ARP.

Creating static ARP entries

Ruckus Layer 3 switches have a static ARP table, in addition to the regular ARP cache. The static ARP table contains entries that you configure.

Static entries are useful in cases where you want to pre-configure an entry for a device that is not connected to the Layer 3 switch, or you want to prevent a particular entry from aging out. The software removes a dynamic entry from the ARP cache if the ARP aging interval expires before the entry is refreshed. Static entries do not age out, regardless of whether the Ruckus device receives an ARP request from the device that has the entry address.

NOTE

You cannot create static ARP entries on a Layer 2 switch.

The maximum number of static ARP entries you can configure depends on the software version running on the device.

To create a static ARP entry, enter a command such as the following.

```
device(config)# arp 1 10.53.4.2 0000.0054.2348 ethernet 1/1/2
```

Syntax: arp num ip-addr mac-addr ethernet port

The *num* variable specifies the entry number. You can specify a number from 1 up to the maximum number of static entries allowed on the device.

The *ip-addr* variable specifies the IP address of the device that has the MAC address of the entry.

The *mac-addr* variable specifies the MAC address of the entry.

Changing the maximum number of entries the static ARP table can hold

NOTE

The basic procedure for changing the static ARP table size is the same as the procedure for changing other configurable cache or table sizes. Refer to the section "Displaying system parameter default values" in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*.

To increase the maximum number of static ARP table entries you can configure on a Ruckus Layer 3 switch, enter commands such as the following at the global CONFIG level of the CLI.

```
device(config)# system-max ip-static-arp 1000
device(config)# write memory
device(config)# end
device# reload
```

NOTE

You must save the configuration to the startup-config file and reload the software after changing the static ARP table size to place the change into effect.

Syntax: system-max ip-static-arp num

The *num* variable indicates the maximum number of static ARP entries and can be within one of these ranges, depending on the software version running on the device.

TABLE 7 Static ARP entry support

Default maximum	Configurable minimum	Configurable maximum
FastIron X Series and Brocade FCX Series devices		

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Configuring IP parameters - Layer 3 switches

TABLE 7 Static ARP entry support (continued)

Default maximum	Configurable minimum	Configurable maximum
512	512	6000
ICX 6430 and ICX 6450 devices		
256	64	1024
ICX 6610		
512	512	6000

Enabling learning gratuitous ARP

Learning gratuitous ARP enables Brocade Layer 3 devices to learn ARP entries from incoming gratuitous ARP packets from the hosts which are directly connected. This helps achieve faster convergence for the hosts when they are ready to send traffic.

A new ARP entry is created when a gratuitous ARP packet is received. If the ARP is already existing, it will be updated with the new content.

To enable learning gratuitous ARP, enter the following command at the device configuration level.

```
Brocade (config)# ip arp learn-gratuitous-arp
```

Syntax: [no] ip arp learn-gratuitous-arp

The **no** form of the command disables learning gratuitous ARP from the device.

Use the **show run** command to see whether ARP is enabled or disabled. Use the **show arp** command to see the newly learned ARP entries.

ARP Packet Validation

Validates ARP packets to avoid traffic interruption or loss.

To avoid traffic interruption or loss, ARP Packet Validation allows the user to detect and drop ARP packets that do not pass the ARP validation process. ARP Packet Validation is disabled by default and can be enabled at the global configuration level. This functionality can be configured for the destination MAC address, the IP address and the source MAC address or with a combination of these parameters. The Ethernet header contains the destination MAC address and source MAC address, while the ARP packet contains the sender hardware address and target hardware address.

Follow these steps to perform checks on the incoming ARP packets.

1. Enter the global configuration mode.

- Run the **ip arp inspection validate [dst-mac | ip | src-mac]** command to perform a check on any incoming ARP packets. Use one of the following parameters to run the validation check:

- dst-mac**

The destination MAC address in the Ethernet header must be the same as the target hardware address in the ARP body. This validation is performed for the ARP response packet. When the destination MAC address validation is enabled, the packets with different MAC addresses are classified as invalid and are dropped.

- src-mac**

The source MAC address in the Ethernet header and the sender hardware address in the ARP body must be the same. This validation is performed for the ARP request and response packets. When the source MAC validation is enabled, the packets with different MAC addresses are classified as invalid and are dropped.

- ip**

Each ARP packet has a sender IP address and target IP address. The target IP address cannot be invalid or an unexpected IP address in the ARP response packet. The sender IP address cannot be an invalid or an unexpected IP address in the ARP request and response packets. Addresses include 0.0.0.0, 255.255.255.255, and all IP multicast addresses. When the IP address validation is enabled, the packets with invalid and unexpected IP addresses are classified as invalid and are dropped.

The following example shows ARP packets being validated for the destination MAC address.

```
device(config)# configuration terminal
device(config)#ip arp inspection validate dst-mac
```

Ingress ARP packet priority

You can configure the priority of the ingress ARP packets to an optimum value that depends on your network configuration and traffic volume. Ingress ARP packets have a default priority value of 4. At the default priority value, ingress ARP packets may get dropped because of high traffic volume or non-ARP packets with higher priority values. This can cause devices to become unreachable. If the ingress ARP packets have higher priority values than the default priority value, a high volume of ARP traffic may lead to drops in control traffic. This may cause traffic loops in the network.

NOTE

You cannot change the priority of the ingress ARP packets on the management port.

Configuring the priority of ingress ARP packets

To configure the priority of ingress ARP packets, use the **arp-internal-priority priority-value** command in global configuration mode.

The following example shows the priority of ingress ARP packets set to level 7.

```
Brocade(config)# arp-internal-priority 7
```

Configuring forwarding parameters

The following configurable parameters control the forwarding behavior of Ruckus Layer 3 switches:

- Time-To-Live (TTL) threshold
- Forwarding of directed broadcasts
- Forwarding of source-routed packets
- Ones-based and zero-based broadcasts

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Configuring IP parameters - Layer 3 switches

All these parameters are global and thus affect all IP interfaces configured on the Layer 3 switch.

Changing the TTL threshold

The time to live (TTL) threshold prevents routing loops by specifying the maximum number of router hops an IP packet originated by the Layer 3 switch can travel through. Each device capable of forwarding IP that receives the packet decrements (decreases) the packet TTL by one. If a device receives a packet with a TTL of 1 and reduces the TTL to zero, the device drops the packet.

The default value for the TTL threshold is 64. You can change the TTL threshold to a value from 1 through 255.

To modify the TTL threshold to 25, enter the **ip ttl** command.

```
device(config)# ip ttl 25
```

Syntax: **ip ttl ttl-threshold**

Enabling forwarding of directed broadcasts

A directed broadcast is an IP broadcast to all devices within a single directly-attached network or subnet. A net-directed broadcast goes to all devices on a given network. A subnet-directed broadcast goes to all devices within a given subnet.

NOTE

A less common type, the all-subnets broadcast, goes to all directly-attached subnets. Forwarding for this broadcast type also is supported, but most networks use IP multicasting instead of all-subnet broadcasting.

Forwarding for all types of IP directed broadcasts is disabled by default. You can enable forwarding for all types if needed. You cannot enable forwarding for specific broadcast types.

To enable forwarding of IP directed broadcasts, enter the **ip directed-broadcast** command in device configuration mode.

```
device # configure terminal  
device(config)# ip directed-broadcast
```

Syntax: **[no] ip directed-broadcast**

Ruckus software makes the forwarding decision based on the router's knowledge of the destination network prefix. Routers cannot determine that a message is unicast or directed broadcast apart from the destination network prefix. The decision to forward or not forward the message is by definition only possible in the last hop router.

To disable the directed broadcasts, enter the **no ip directed-broadcast** command in device configuration mode.

```
device # configure terminal  
device(config)# no ip directed-broadcast
```

To enable directed broadcasts on an individual interface instead of globally for all interfaces, enter the **ip directed-broadcast** command at the interface configuration level as shown in the following example.

```
device # configure terminal  
device(config)# interface ethernet 1/1/1  
device(config-if-1/1/1) # ip directed-broadcast
```

Disabling forwarding of IP source-routed packets

A source-routed packet specifies the exact router path for the packet. The packet specifies the path by listing the IP addresses of the router interfaces through which the packet must pass on its way to the destination. The Layer 3 switch supports both types of IP source routing:

- Strict source routing - Requires the packet to pass through only the listed routers. If the Layer 3 switch receives a strict source-routed packet but cannot reach the next hop interface specified by the packet, the Layer 3 switch discards the packet and sends an ICMP Source-Route-Failure message to the sender.

NOTE

The Layer 3 switch allows you to disable sending of the Source-Route-Failure messages.

- Loose source routing - Requires that the packet pass through all of the listed routers but also allows the packet to travel through other routers, which are not listed in the packet.

The Layer 3 switch forwards both types of source-routed packets by default. To disable the feature, use either of the following methods. You cannot enable or disable strict or loose source routing separately.

To disable forwarding of IP source-routed packets, enter the **no ip source-route** command.

```
device # configure terminal
device(config)# no ip source-route
```

Syntax: [no] ip source-route

To re-enable forwarding of source-routed packets, enter the **ip source-route** command.

```
device # configure terminal
device(config)# ip source-route
```

Enabling support for zero-based IP subnet broadcasts

By default, the Layer 3 switch treats IP packets with all ones in the host portion of the address as IP broadcast packets. For example, the Layer 3 switch treats IP packets with 10.157.22.255/24 as the destination IP address as IP broadcast packets and forwards the packets to all IP hosts within the 10.157.22.x subnet (except the host that sent the broadcast packet to the Layer 3 switch).

Most IP hosts are configured to receive IP subnet broadcast packets with all ones in the host portion of the address. However, some older IP hosts instead expect IP subnet broadcast packets that have all zeros instead of all ones in the host portion of the address. To accommodate this type of host, you can enable the Layer 3 switch to treat IP packets with all zeros in the host portion of the destination IP address as broadcast packets.

NOTE

When you enable the Layer 3 switch for zero-based subnet broadcasts, the Layer 3 switch still treats IP packets with all ones in the host portion as IP subnet broadcasts too. Thus, the Layer 3 switch can be configured to support all ones only (the default) or all ones and all zeroes.

NOTE

This feature applies only to IP subnet broadcasts, not to local network broadcasts. The local network broadcast address is still expected to be all ones.

To enable the Layer 3 switch for zero-based IP subnet broadcasts in addition to ones-based IP subnet broadcasts, enter the following command.

```
device(config)# ip broadcast-zero
device(config)# write memory
```

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```
device(config)# end  
device# reload
```

NOTE

You must save the configuration and reload the software to place this configuration change into effect.

Syntax: [no] ip broadcast-zero

Disabling ICMP messages

Ruckus devices are enabled to reply to ICMP echo messages and send ICMP Destination Unreachable messages by default.

You can selectively disable the following types of Internet Control Message Protocol (ICMP) messages:

- Echo messages (ping messages) - The Layer 3 switch replies to IP pings from other IP devices.
- Destination Unreachable messages - If the Layer 3 switch receives an IP packet that it cannot deliver to its destination, the Layer 3 switch discards the packet and sends a message back to the device that sent the packet to the Layer 3 switch. The message informs the device that the destination cannot be reached by the Layer 3 switch.

Disabling replies to broadcast ping requests

By default, Ruckus devices are enabled to respond to broadcast ICMP echo packets, which are ping requests.

To disable response to broadcast ICMP echo packets (ping requests), enter the following command.

```
device(config)# no ip icmp echo broadcast-request
```

Syntax: [no] ip icmp echo broadcast-request

If you need to re-enable response to ping requests, enter the following command.

```
device(config)# ip icmp echo broadcast-request
```

Disabling ICMP destination unreachable messages

By default, when a Ruckus device receives an IP packet that the device cannot deliver, the device sends an ICMP Unreachable message back to the host that sent the packet. You can selectively disable a Ruckus device response to the following types of ICMP Unreachable messages:

- **Host** - The destination network or subnet of the packet is directly connected to the Ruckus device, but the host specified in the destination IP address of the packet is not on the network.
- **Protocol** - The TCP or UDP protocol on the destination host is not running. This message is different from the Port Unreachable message, which indicates that the protocol is running on the host but the requested protocol port is unavailable.
- **Administration** - The packet was dropped by the Ruckus device due to a filter or ACL configured on the device.
- **Fragmentation-needed** - The packet has the Do not Fragment bit set in the IP Flag field, but the Ruckus device cannot forward the packet without fragmenting it.
- **Port** - The destination host does not have the destination TCP or UDP port specified in the packet. In this case, the host sends the ICMP Port Unreachable message to the Ruckus device, which in turn sends the message to the host that sent the packet.
- **Source-route-fail** - The device received a source-routed packet but cannot locate the next-hop IP address indicated in the packet Source-Route option.

You can disable the Ruckus device from sending these types of ICMP messages on an individual basis. To do so, use the following CLI method.

NOTE

Disabling an ICMP Unreachable message type does not change the Ruckus device ability to forward packets. Disabling ICMP Unreachable messages prevents the device from generating or forwarding the Unreachable messages.

To disable all ICMP Unreachable messages, enter the **no ip icmp unreachable** command.

```
device(config)# no ip icmp unreachable
```

Syntax: [no] ip icmp unreachable { host | protocol | administration | fragmentation-needed | port | source-route-fail }

- If you enter the command without specifying a message type (as in the example above), all types of ICMP Unreachable messages listed above are disabled. If you want to disable only specific types of ICMP Unreachable messages, you can specify the message type. To disable more than one type of ICMP message, enter the **no ip icmp unreachable** command for each messages type.
- The **host** parameter disables ICMP Host Unreachable messages.
- The **protocol** parameter disables ICMP Protocol Unreachable messages.
- The **administration** parameter disables ICMP Unreachable (caused by Administration action) messages.
- The **fragmentation-needed** parameter disables ICMP Fragmentation-Needed But Do not-Fragment Bit Set messages.
- The **port** parameter disables ICMP Port Unreachable messages.
- The **source-route-fail** parameter disables ICMP Unreachable (caused by Source-Route-Failure) messages.

To disable ICMP Host Unreachable messages but leave the other types of ICMP Unreachable messages enabled, enter the following commands instead of the command shown above.

```
device(config)# no ip icmp unreachable host
```

If you have disabled all ICMP Unreachable message types but you want to re-enable certain types, for example ICMP Host Unreachable messages, you can do so by entering the following command.

```
device(config)# ip icmp unreachable host
```

Enabling ICMP redirect messages

You can enable and disable IPv4 ICMP redirect messages globally or on individual Virtual Ethernet (VE) interfaces but not on individual physical interfaces.

NOTE

Some FSX devices do not generate ICMP redirect and network unreachable messages.

NOTE

The device forwards misdirected traffic to the appropriate router, even if you disable the redirect messages.

By default, IP ICMP redirect over global level is disabled and a Brocade Layer 3 switch does not send an ICMP redirect message to the source of a misdirected packet in addition to forwarding the packet to the appropriate router. To enable ICMP redirect messages globally, enter the following command at the global CONFIG level of the CLI:

```
device(config)# ip icmp redirect
```

Syntax: [no] ip icmp redirect

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To disable ICMP redirect messages on a specific virtual interface, enter the following command at the configuration level for the virtual interface:

```
Brocade(config-vlan-10)# interface ve 10
Brocade(config-vif-10)# no ip redirect
```

Syntax: [no] ip redirect

Static routes configuration

The IP route table can receive routes from the following sources:

- **Directly-connected networks** - When you add an IP interface, the Layer 3 switch automatically creates a route for the network the interface is in.
- **RIP** - If RIP is enabled, the Layer 3 switch can learn about routes from the advertisements other RIP routers send to the Layer 3 switch. If the route has a lower administrative distance than any other routes from different sources to the same destination, the Layer 3 switch places the route in the IP route table.
- **OSPF** - Refer to RIP, but substitute "OSPF" for "RIP".
- **BGP4** - Refer to RIP, but substitute "BGP4" for "RIP".
- **Default network route** - A statically configured default route that the Layer 3 switch uses if other default routes to the destination are not available.
- **Statically configured route** - You can add routes directly to the route table. When you add a route to the IP route table, you are creating a static IP route. This section describes how to add static routes to the IP route table.

Static route types

You can configure the following types of static IP routes:

- **Standard** - The static route consists of the destination network address and network mask, and the IP address of the next-hop gateway. You can configure multiple standard static routes with the same metric for load sharing or with different metrics to provide a primary route and backup routes.
- **Interface-based** - The static route consists of the destination network address and network mask, and the Layer 3 switch interface through which you want the Layer 3 switch to send traffic for the route. Typically, this type of static route is for directly attached destination networks.
- **Null** - The static route consists of the destination network address and network mask, and the "null0" parameter. Typically, the null route is configured as a backup route for discarding traffic if the primary route is unavailable.

Static IP route parameters

When you configure a static IP route, you must specify the following parameters:

- The IP address and network mask for the route destination network.
- The route path, which can be one of the following:
 - The IP address of a next-hop gateway
 - An Ethernet port
 - A virtual interface (a routing interface used by VLANs for routing Layer 3 protocol traffic among one another)
 - A "null" interface. The Layer 3 switch drops traffic forwarded to the null interface.

You also can specify the following optional parameters:

- The metric for the route - The value the Layer 3 switch uses when comparing this route to other routes in the IP route table to the same destination. The metric applies only to routes that the Layer 3 switch has already placed in the IP route table. The default metric for static IP routes is 1.
- The administrative distance for the route - The value that the Layer 3 switch uses to compare this route with routes from other route sources to the same destination before placing a route in the IP route table. This parameter does not apply to routes that are already in the IP route table. The default administrative distance for static IP routes is 1.

The default metric and administrative distance values ensure that the Layer 3 switch always prefers static IP routes over routes from other sources to the same destination.

Multiple static routes to the same destination provide load sharing and redundancy

You can add multiple static routes for the same destination network to provide one or more of the following benefits:

- **IP load balancing** - When you add multiple IP static routes for the same destination to different next-hop gateways, and the routes each have the same metric and administrative distance, the Layer 3 switch can load balance traffic to the routes' destination.
- **Path redundancy** - When you add multiple static IP routes for the same destination, but give the routes different metrics or administrative distances, the Layer 3 switch uses the route with the lowest administrative distance by default, but uses another route to the same destination if the first route becomes unavailable.

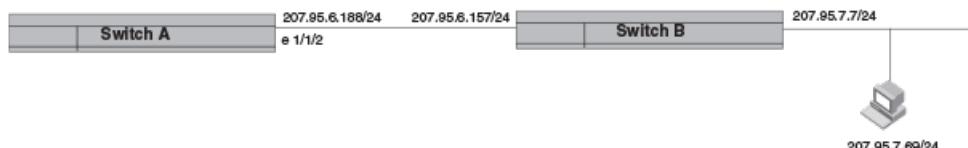
Static route states follow port states

IP static routes remain in the IP route table only so long as the port or virtual interface used by the route is available. If the port or virtual routing interface becomes unavailable, the software removes the static route from the IP route table. If the port or virtual routing interface becomes available again later, the software adds the route back to the route table.

This feature allows the Layer 3 switch to adjust to changes in network topology. The Layer 3 switch does not continue trying to use routes on unavailable paths but instead uses routes only when their paths are available.

The static route is configured on Switch A, as shown in the CLI example following the figure.

FIGURE 5 Example of a static route



The following command configures a static route to 10.95.7.0, using 10.95.6.157 as the next-hop gateway.

```
device(config)# ip route 10.95.7.0/24 10.95.6.157
```

When you configure a static IP route, you specify the destination address for the route and the next-hop gateway or Layer 3 switch interface through which the Layer 3 switch can reach the route. The Layer 3 switch adds the route to the IP route table. In this case, Switch A knows that 10.95.6.157 is reachable through port 1/1/2, and also assumes that local interfaces within that subnet are on the same port. Switch A deduces that IP interface 10.95.7.188 is also on port 1/1/2.

The software automatically removes a static IP route from the IP route table if the port used by that route becomes unavailable. When the port becomes available again, the software automatically re-adds the route to the IP route table.

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Configuring a static IP route

To configure an IP static route with a destination address of 10.0.0.0 255.0.0.0 and a next-hop router IP address of 10.1.1.1, enter a command such as the following.

```
device(config)# ip route 10.0.0.0 255.0.0.0 10.1.1.1
```

To configure a static IP route with an Ethernet port instead of a next-hop address, enter a command such as the following.

```
device(config)# ip route 10.128.2.69 255.255.255.0 ethernet 1/4/1
```

The command in the previous example configures a static IP route for destination network 10.128.2.69/24. Since an Ethernet port is specified instead of a gateway IP address as the next hop, the Layer 3 switch always forwards traffic for the 10.128.2.69/24 network to port 1/4/1. The command in the following example configures an IP static route that uses virtual interface 3 as its next hop.

```
device(config)# ip route 10.128.2.71 255.255.255.0 ve 3
```

Syntax: **ip route** *dest-ip-addr dest-mask { next-hop-ip-addr | ethernet unit / slot / port | ve num } [metric] [distance num] [name static-route-name] [tag tag-num]*

or

Syntax: **ip route** *dest-ip-addr / mask-bits { next-hop-ip-addr | ethernet unit / slot / port | ve num } [metric] [distance num] [name static-route-name] [tag tag-num]*

The *dest-ip-addr* variable is the route destination. The *dest-mask* variable is the network mask for the route destination IP address. Alternatively, you can specify the network mask information by entering a forward slash followed by the number of bits in the network mask. For example, you can enter 10.0.0.0 255.255.255.0 as 10.0.0.0/24.

The *next-hop-ip-addr* variable is the IP address of the next-hop router (gateway) for the route.

If you do not want to specify a next-hop IP address, you can instead specify a port or interface number. The *num* variable is a virtual interface number. You can instead specify an Ethernet port. In this case, a Layer 3 switch forwards packets destined for the static route destination network to the specified Layer 3 switch interface. Conceptually, this feature makes the destination network like a directly connected network, associated with a specific Layer 3 switch interface.

NOTE

The port or virtual interface you use for the static route next hop must have at least one IP address configured on it. The address does not need to be in the same subnet as the destination network.

The *metric* variable can be a number from 1 through 16. The default is 1.

NOTE

If you specify 16, RIP considers the metric to be infinite and thus also considers the route to be unreachable.

The **distance num** variable specifies the administrative distance of the route. When comparing otherwise equal routes to a destination, the Layer 3 switch prefers lower administrative distances over higher ones, so make sure you use a low value for your default route. The default is 1.

NOTE

The Layer 3 switch will replace the static route if it receives a route with a lower administrative distance.

NOTE

You can also assign the default router as the destination by entering 0.0.0.0 0.0.0.0 xxx.xxx.xxx.xxx.

Configuring a "Null" route

You can configure the Layer 3 switch to drop IP packets to a specific network or host address by configuring a "null" (sometimes called "null0") static route for the address. When the Layer 3 switch receives a packet destined for the address, the Layer 3 switch drops the packet instead of forwarding it.

To configure a null static route, use the following CLI method.

To configure a null static route to drop packets destined for network 10.157.22.x, enter the following commands.

```
device(config)# ip route 10.157.22.0 255.255.255.0 null0
device(config)# write memory
```

Syntax: **ip route** *ip-addr* *ip-mask* **null0** [*metric*] [**distance num**]

or

Syntax: **ip route** *ip-addr* /*mask-bits* **null0** [*metric*] [**distance num**]

To display the maximum value for your device, enter the **show default values** command. The maximum number of static IP routes the system can hold is listed in the ip-static-route row in the System Parameters section of the display. To change the maximum value, use the **system-max ip-static-route** command at the global CONFIG level.

The *ip-addr* variable specifies the network or host address. The Layer 3 switch will drop packets that contain this address in the destination field instead of forwarding them.

The *ip-mask* variable specifies the network mask. Ones are significant bits and zeros allow any value. For example, the mask 255.255.255.0 matches on all hosts within the Class C subnet address specified by *ip-addr*. Alternatively, you can specify the number of bits in the network mask. For example, you can enter 10.157.22.0/24 instead of 10.157.22.0 255.255.255.0.

The **null0** variable indicates that this is a null route. You must specify this parameter to make this a null route.

The *metric* variable adds a cost to the route. You can specify from 1 through 16. The default is 1.

The **distance num** variable configures the administrative distance for the route. You can specify a value from 1 through 255. The default is 1. The value 255 makes the route unusable.

NOTE

The last two variables are optional and do not affect the null route, unless you configure the administrative distance to be 255. In this case, the route is not used and the traffic might be forwarded instead of dropped.

Naming a static IP route

You can assign a name to a static IP route. A static IP route name serves as a description of the route. The name can be used to more readily reference or identify the associated static route.

NOTE

The static route name is an optional feature. It does not affect the selection of static routes.

The Ruckus device does not check for the uniqueness of names assigned to static routes. Static routes that have the same or different next hops can have the same or different names. Due to this, the same name can be assigned to multiple static routes to group them. The name is then used to reference or identify a group of static routes.

The option to assign a name to a static route is displayed after you select either an outgoing interface type or configure the next hop address.

To assign a name to a static route, enter commands such as the following.

```
device(config)# ip route 10.22.22.22 255.255.255.255 eth 1/1/1 name abc
```

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OR

```
device(config)# ip route 10.22.22.22 255.255.255.255 10.1.1.1 name abc
```

Syntax: [no] **ip route** dest-ip-addr dest-mask { next-hop-ip-addr | **ethernet** unit / slot / port | **ve** num } [metric] [**distance** num] [**name** static-route-name] [**tag** tag-num]

Enter the static route name for **name** string. The maximum length of the name is 128 bytes.

The output of the **show** commands displays the name of a static IP route if there is one assigned.

The **show run** command displays the entire name of the static IP route. The **show ip static route** command displays an asterisk (*) after the first twelve characters if the assigned name is thirteen characters or more. The **show ipv6 static route** command displays an asterisk after the first two characters if the assigned name is three characters or more.

When displayed in **show run**, a static route name with a space in the name will appear within quotation marks (for example, "brcd route").

Changing the name of a static IP route

To change the name of a static IP route, enter the static route as configured. Proceed to enter the new name instead of the previous name. Refer to the following example.

Static IP route with the original name "abc":

```
device(config)# ip route 10.22.22.22 255.255.255.255 10.1.1.1 name abc
```

Change the name of "abc" to "xyz":

```
device(config)# ip route 10.22.22.22 255.255.255.255 10.1.1.1 name xyz
```

In this example, "xyz" is set as the new name of the static IP route.

Deleting the name of a static IP route

To delete the name of a static IP route, use the **no** command. See the example below.

Static IP route with the name "xyz":

```
device(config)# ip route 10.22.22.22 255.255.255.255 10.1.1.1 name xyz
```

To remove the name "xyz" from the static IP route, specify both "name" and the string, in this case "xyz".

```
device(config)#no ip route 10.22.22.22 255.255.255.255 10.1.1.1 name xyz
```

The static route no longer has a name assigned to it.

Configuring load balancing and redundancy using multiple static routes to the same destination

You can configure multiple static IP routes to the same destination, for the following benefits:

- **IP load sharing** - If you configure more than one static route to the same destination, and the routes have different next-hop gateways but have the same metrics, the Layer 3 switch load balances among the routes using basic round-robin. For example, if you configure two static routes with the same metrics but to different gateways, the Layer 3 switch alternates between the two routes.

- **Backup Routes** - If you configure multiple static IP routes to the same destination, but give the routes different next-hop gateways and different metrics, the Layer 3 switch will always use the route with the lowest metric. If this route becomes unavailable, the Layer 3 switch will fail over to the static route with the next-lowest metric, and so on.

NOTE

You also can bias the Layer 3 switch to select one of the routes by configuring them with different administrative distances. However, make sure you do not give a static route a higher administrative distance than other types of routes, unless you want those other types to be preferred over the static route.

The steps for configuring the static routes are the same as described in the previous section. The following sections provide examples.

To configure multiple static IP routes, enter commands such as the following.

```
device(config)# ip route 10.128.2.69 255.255.255.0 10.157.22.1
device(config)# ip route 10.128.2.69 255.255.255.0 10.111.10.1
```

The commands in the previous example configure two static IP routes. The routes go to different next-hop gateways but have the same metrics. These commands use the default metric value (1), so the metric is not specified. These static routes are used for load sharing among the next-hop gateways.

The following commands configure static IP routes to the same destination, but with different metrics. The route with the lowest metric is used by default. The other routes are backups in case the first route becomes unavailable. The Layer 3 switch uses the route with the lowest metric if the route is available.

```
device(config)# ip route 10.128.2.69 255.255.255.0 10.157.22.1
device(config)# ip route 10.128.2.69 255.255.255.0 10.111.10.1 2
device(config)# ip route 10.128.2.69 255.255.255.0 10.1.1.1 3
```

In this example, each static route has a different metric. The metric is not specified for the first route, so the default (1) is used. A metric is specified for the second and third static IP routes. The second route has a metric of two and the third route has a metric of 3. Thus, the second route is used only if the first route (which has a metric of 1) becomes unavailable. Likewise, the third route is used only if the first and second routes (which have lower metrics) are both unavailable.

Configuring standard static IP routes and interface or null static routes to the same destination

You can configure a null0 or interface-based static route to a destination and also configure a normal static route to the same destination, so long as the route metrics are different.

When the Layer 3 switch has multiple routes to the same destination, the Layer 3 switch always prefers the route with the lowest metric. Generally, when you configure a static route to a destination network, you assign the route a low metric so that the Layer 3 switch prefers the static route over other routes to the destination.

This feature is especially useful for the following configurations. These are not the only allowed configurations but they are typical uses of this enhancement:

- When you want to ensure that if a given destination network is unavailable, the Layer 3 switch drops (forwards to the null interface) traffic for that network instead of using alternate paths to route the traffic. In this case, assign the normal static route to the destination network a lower metric than the null route.
- When you want to use a specific interface by default to route traffic to a given destination network, but want to allow the Layer 3 switch to use other interfaces to reach the destination network if the path that uses the default interface becomes unavailable. In this case, give the interface route a lower metric than the normal static route.

IP Configuration

Configuring IP parameters - Layer 3 switches

NOTE

You cannot add a null or interface-based static route to a network if there is already a static route of any type with the same metric you specify for the null or interface-based route.

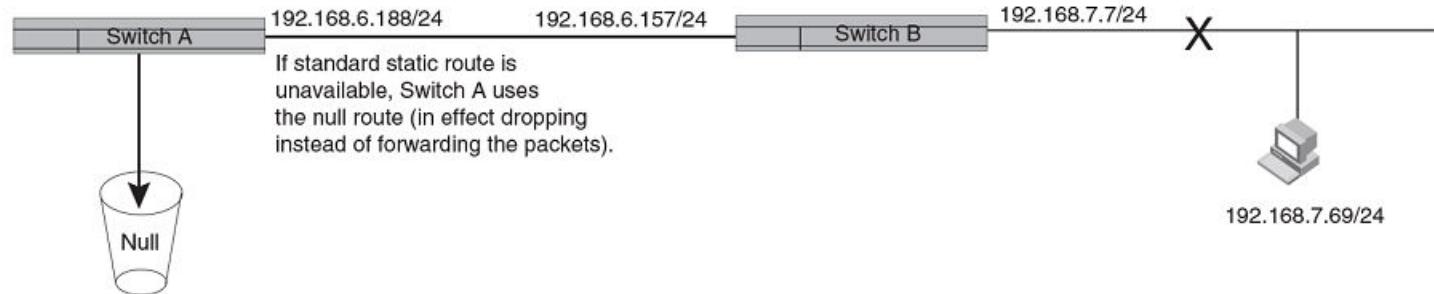
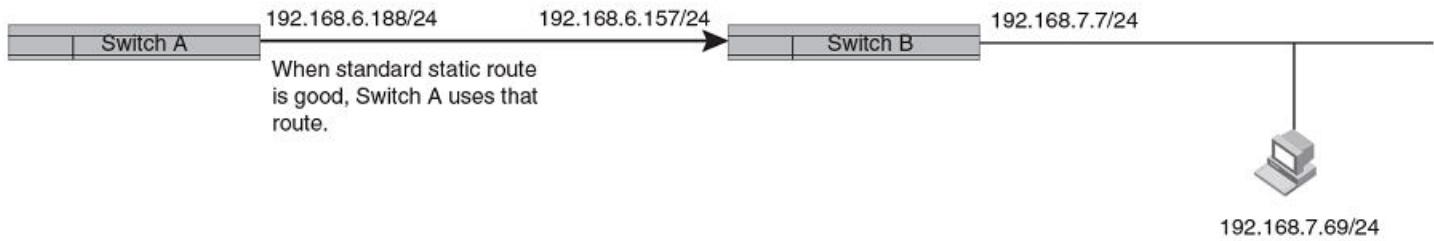
In the example, two static routes configured for the same destination network. One of the routes is a standard static route and has a metric of 1. The other static route is a null route and has a higher metric than the standard static route. The Layer 3 switch always prefers the static route with the lower metric. In this example, the Layer 3 switch always uses the standard static route for traffic to destination network 192.168.7.0/24, unless that route becomes unavailable, in which case the Layer 3 switch sends traffic to the null route instead.

FIGURE 6 Standard and null static routes to the same destination network

Two static routes to 192.168.7.0/24:

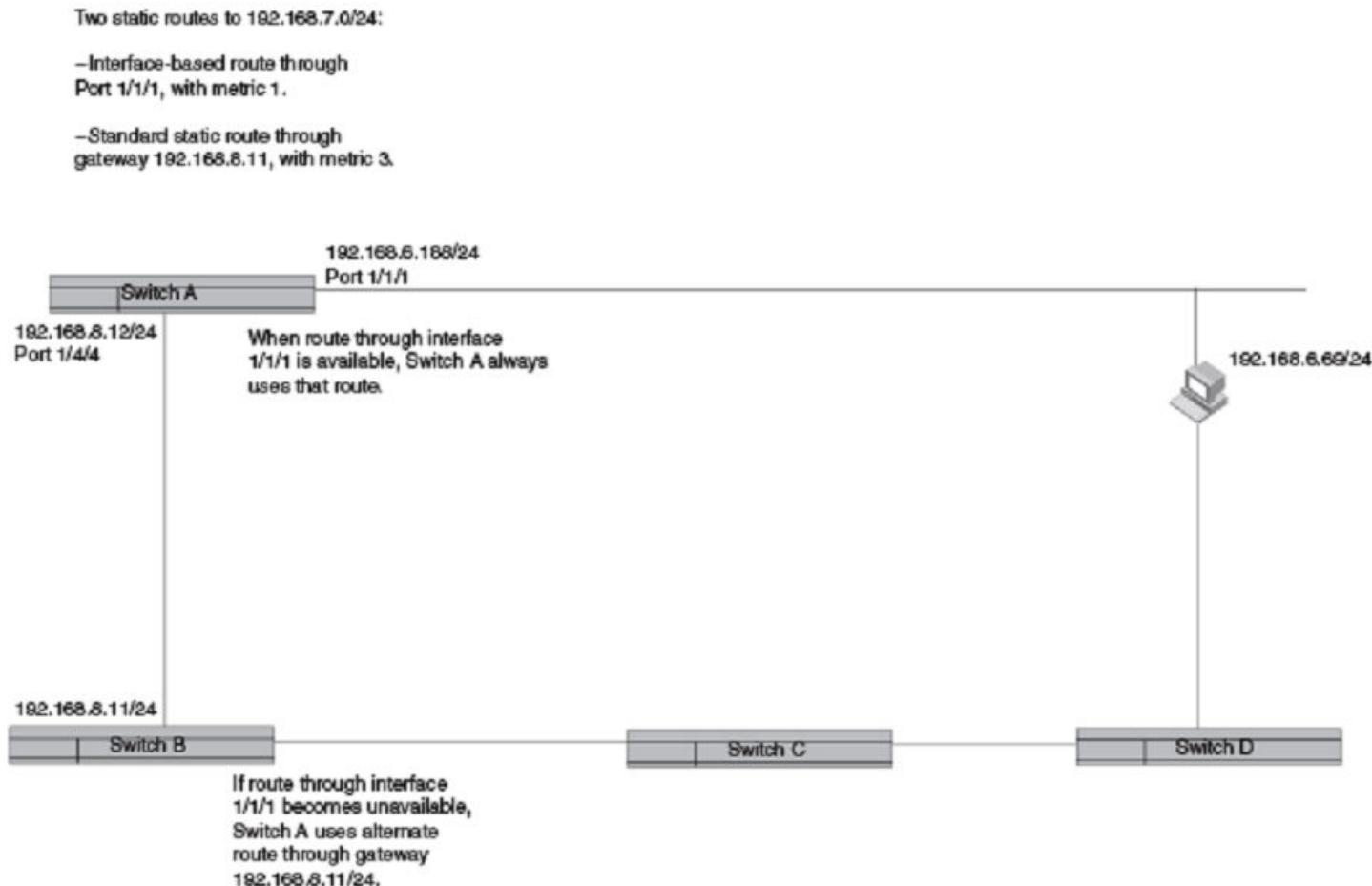
--Standard static route through gateway 192.168.6.157, with metric 1

--Null route, with metric 2



The next example shows another example of two static routes. In this example, a standard static route and an interface-based static route are configured for destination network 192.168.6.0/24. The interface-based static route has a lower metric than the standard static route. As a result, the Layer 3 switch always prefers the interface-based route when the route is available. However, if the interface-based route becomes unavailable, the Layer 3 switch still forwards the traffic toward the destination using an alternate route through gateway 192.168.8.11/24.

FIGURE 7 Standard and interface routes to the same destination network



To configure a standard static IP route and a null route to the same network, enter commands such as the following.

```
device(config)# ip route 192.168.7.0/24 192.168.6.157/24 1
device(config)# ip route 192.168.7.0/24 null0 3
```

The first command configures a standard static route, which includes specification of the next-hop gateway. The command also gives the standard static route a metric of 1, which causes the Layer 3 switch to always prefer this route when the route is available.

The second command configures another static route for the same destination network, but the second route is a null route. The metric for the null route is 3, which is higher than the metric for the standard static route. If the standard static route is unavailable, the software uses the null route.

To configure a standard static route and an interface-based route to the same destination, enter commands such as the following.

```
device(config)# ip route 192.168.6.0/24 ethernet 1/1/1 1
device(config)# ip route 192.168.6.0/24 192.168.8.11/24 3
```

The first command configured an interface-based static route through Ethernet port 1/1/1. The command assigns a metric of 1 to this route, causing the Layer 3 switch to always prefer this route when it is available. If the route becomes unavailable, the Layer 3 switch uses an alternate route through the next-hop gateway 192.168.8.11/24.

IP Configuration

Configuring IP parameters - Layer 3 switches

Configuring a default network route

The Layer 3 switch enables you to specify a candidate default route without the need to specify the next hop gateway. If the IP route table does not contain an explicit default route (for example, 0.0.0.0/0) or propagate an explicit default route through routing protocols, the software can use the default network route as a default route instead.

When the software uses the default network route, it also uses the default network route's next hop gateway as the gateway of last resort.

This feature is especially useful in environments where network topology changes can make the next hop gateway unreachable. This feature allows the Layer 3 switch to perform default routing even if the default network route's default gateway changes.

The feature thus differs from standard default routes. When you configure a standard default route, you also specify the next hop gateway. If a topology change makes the gateway unreachable, the default route becomes unusable.

For example, if you configure 10.10.10.0/24 as a candidate default network route, if the IP route table does not contain an explicit default route (0.0.0.0/0), the software uses the default network route and automatically uses that route's next hop gateway as the default gateway. If a topology change occurs and as a result the default network route's next hop gateway changes, the software can still use the default network route. To configure a default network route, use the following CLI method.

If you configure more than one default network route, the Layer 3 switch uses the following algorithm to select one of the routes.

1. Use the route with the lowest administrative distance.
2. If the administrative distances are equal:
 - Are the routes from different routing protocols (RIP, OSPF, or BGP4)? If so, use the route with the lowest IP address.
 - If the routes are from the same routing protocol, use the route with the best metric. The meaning of "best" metric depends on the routing protocol:
 - **RIP** - The metric is the number of hops (additional routers) to the destination. The best route is the route with the fewest hops.
 - **OSPF** - The metric is the path cost associated with the route. The path cost does not indicate the number of hops but is instead a numeric value associated with each route. The best route is the route with the lowest path cost.
 - **BGP4** - The metric is the Multi-exit Discriminator (MED) associated with the route. The MED applies to routes that have multiple paths through the same Autonomous System. The best route is the route with the lowest MED.

Example of configuring a default network route

You can configure up to four default network routes.

To configure a default network route, enter commands such as the following.

```
device(config)# ip default-network 10.157.22.0
device(config)# write memory
```

Syntax: ip default-network *ip-addr*

The *ip-addr* variable specifies the network address.

To verify that the route is in the route table, enter the following command at any level of the CLI.

```
device# show ip route
Total number of IP routes: 2
Start index: 1 B:BGP D:Connected R:RIP S:Static O:OSPF *:Candidate default
      Destination      NetMask      Gateway      Port      Cost      Type
1          10.157.20.0    255.255.255.0    0.0.0.0      1b1       1          D
2          10.157.22.0    255.255.255.0    0.0.0.0     1/4/11     1      *D
```

This example shows two routes. Both of the routes are directly attached, as indicated in the Type column. However, one of the routes is shown as type "*D", with an asterisk (*). The asterisk indicates that this route is a candidate for the default network route.

Configuring IP load sharing

The IP route table can contain more than one path to a given destination. When this occurs, the Layer 3 switch selects the path with the lowest cost as the path for forwarding traffic to the destination. If the IP route table contains more than one path to a destination and the paths each have the lowest cost, then the Layer 3 switch uses IP load sharing to select a path to the destination.

IP load sharing uses a hashing algorithm based on the source IP address, destination IP address, and protocol field in the IP header, TCP, and UDP information.

NOTE

IP load sharing is also called "Equal-Cost Multi-Path (ECMP) load sharing or just ECMP.

NOTE

IP load sharing is based on next-hop routing, and not on source routing.

NOTE

The term "path" refers to the next-hop router to a destination, not to the entire route to a destination. Thus, when the software compares multiple equal-cost paths, the software is comparing paths that use different next-hop routers, with equal costs, to the same destination. In many contexts, the terms "route" and "path" mean the same thing. The term "path" is used in this section to refer to an individual next-hop router to a destination, while the term "route" refers collectively to the multiple paths to the destination. Load sharing applies when the IP route table contains multiple, equal-cost paths to a destination.

NOTE

Ruckus devices also perform load sharing among the ports in aggregate links. Refer to "Trunk group load sharing" in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*.

How multiple equal-cost paths enter the IP route table

IP load sharing applies to equal-cost paths in the IP route table. Routes that are eligible for load sharing can enter the routing table from any of the following routing protocols:

- IP static routes
- Routes learned through OSPF
- Routes learned through BGP4

Administrative distance for each IP route

The administrative distance is a unique value associated with each type (source) of IP route. Each path has an administrative distance. The administrative distance is not used when performing IP load sharing, but the administrative distance is used when evaluating multiple equal-cost paths to the same destination from different sources, such as between static IP routes, OSPF, and BGP4.

The value of the administrative distance is determined by the source of the route. The Layer 3 switch is configured with a unique administrative distance value for each IP route source.

IP Configuration

Configuring IP parameters - Layer 3 switches

When the software receives multiple paths to the same destination and the paths are from different sources, the software compares the administrative distances of the paths and selects the path with the lowest administrative distance. The software then places the path with the lowest administrative distance in the IP route table. For example, if the Layer 3 switch has a path learned from OSPF and a path learned from IBGP for a given destination, only the path with the lower administrative distance enters the IP route table.

Here are the default administrative distances on the Ruckus Layer 3 switch:

- Directly connected - 0 (this value is not configurable)
- Static IP route - 1 (applies to all static routes, including default routes and default network routes)
- Exterior Border Gateway Protocol (EBGP) - 20
- OSPF - 110
- Interior Gateway Protocol (IBGP) - 200
- Local BGP - 200
- Unknown - 255 (the router will not use this route)

Lower administrative distances are preferred over higher distances. For example, if the router receives routes for the same network from OSPF and from IBGP, the router will prefer the OSPF route by default.

NOTE

You can change the administrative distances individually. Refer to the configuration chapter for the route source for information.

Since the software selects only the path with the lowest administrative distance, and the administrative distance is determined by the path source. IP load sharing applies only when the IP route table contains multiple paths to the same destination, from the same IP route source.

IP load sharing does not apply to paths that come from different sources.

Path cost

The cost parameter provides a common basis of comparison for selecting from among multiple paths to a given destination. Each path in the IP route table has a cost. When the IP route table contains multiple paths to a destination, the Layer 3 switch chooses the path with the lowest cost. When the IP route table contains more than one path with the lowest cost to a destination, the Layer 3 switch uses IP load sharing to select one of the lowest-cost paths.

The source of a path cost value depends on the source of the path:

- **IP static route** - The value you assign to the metric parameter when you configure the route. The default metric is 1.
- **OSPF** - The Path Cost associated with the path. The paths can come from any combination of inter-area, intra-area, and external Link State Advertisements (LSAs).
- **BGP4** - The path Multi-Exit Discriminator (MED) value.

NOTE

If the path is redistributed between two or more of the above sources before entering the IP route table, the cost can increase during the redistribution due to settings in redistribution filters.

Static route, OSPF, and BGP4 load sharing

IP load sharing and load sharing for BGP4 routes are individually configured. Multiple equal-cost paths for a destination can enter the IP route table only if the source of the paths is configured to support multiple equal-cost paths. For example, if BGP4

allows only one path with a given cost for a given destination, the BGP4 route table cannot contain equal-cost paths to the destination. Consequently, the IP route table will not receive multiple equal-cost paths from BGP4.

The load sharing state for all the route sources is based on the state of IP load sharing. Since IP load sharing is enabled by default on all Ruckus Layer 3 switches, load sharing for static IP routes, OSPF routes, and BGP4 routes also is enabled by default.

TABLE 8 Default load sharing parameters for route sources

Route source	Default maximum number of paths	Maximum number of paths		
		FSX	FCX / ICX 6450 / ICX 6610 / ICX 6650 / ICX 7450 / ICX 7250	ICX 7750
Static IP route	4^3	6^3	8^3	32^3
OSPF	4^3	6^3	8^3	32^3
BGP4 ⁴	1	4	4	32

How IP load sharing works

When ECMP is enabled, multiple equal-cost paths for the destination IP is installed in the hardware Layer 3 routing table. When an ingress Layer 3 IP traffic matches with the entry in the hardware for Layer 3 routing, one of the paths is selected based on the internal Hardware hashing logic and the packet gets forwarded on that path.

Disabling IP load sharing

To disable IP load sharing, enter the following commands.

```
device(config)# no ip load-sharing
```

Syntax: no ip load-sharing

Changing the maximum number of ECMP (load sharing) paths

You can change the maximum number of paths the Layer 3 switch supports to a value from 2 through 8. On the Brocade ICX 7750, the value range for the maximum number of load-sharing paths is from 2 through 32.

TABLE 9 Maximum number of ECMP load sharing paths per device

FSX 800 / FSX 1600	FCX	ICX 6450 / ICX 6610 / ICX 6650 / ICX 7250 / ICX 7450	ICX 7750
6	8	8	32

For optimal results, set the maximum number of paths to a value at least as high as the maximum number of equal-cost paths your network typically contains. For example, if the Layer 3 switch you are configuring for IP load sharing has six next-hop routers, set the maximum paths value to six.

To change the number of IP load sharing paths, enter a command such as the following.

```
device(config)# ip load-sharing 6
```

³ This value depends on the value for IP load sharing, and is not separately configurable.

⁴ Not applicable for Brocade ICX 6450 and Brocade ICX 7250.

IP Configuration

Configuring IP parameters - Layer 3 switches

Syntax: [no] ip load-sharing [num]

The *num* variable specifies the number of paths and can be from 2 through 8, depending on the device you are configuring. On the Brocade ICX 7750, the value of the *num* variable can be from 2 through 32.

The configuration of the maximum number of IP load sharing paths to a value more than 8 is determined by the maximum number of ECMP paths defined at the system level using the **system-max max-ecmp** command. You cannot configure the maximum number of IP load sharing paths higher than the value defined at the system level. Also, you cannot configure the maximum number of ECMP paths at the system level to a value less than the configured IP load sharing value.

To define the maximum number of ECMP paths at the system level, enter a command such as the following.

```
device(config)# system-max max-ecmp 20
device(config)# write memory
device(config)# exit
device# reload
```

Syntax: [no] system-max max-ecmp [num]

The *num* variable specifies the maximum number of ECMP paths and the value range can be from 8 through 32. This command is supported only on the Brocade ICX 7750.

You must save the configuration and reload the device for the maximum ECMP value change to take effect.

ECMP load sharing for IPv6

The IPv6 route table selects the best route to a given destination from among the routes in the tables maintained by the configured routing protocols (BGP4, OSPF, static, and so on). The IPv6 route table can contain more than one path to a given destination. When this occurs, the Ruckus device selects the path with the lowest cost for insertion into the routing table. If more than one path with the lowest cost exists, all of these paths are inserted into the routing table, subject to the configured maximum number of load sharing paths (by default 4). The device uses Equal-Cost Multi-Path (ECMP) load sharing to select a path to a destination.

When a route is installed by routing protocols or configured static route for the first time, and the IPv6 route table contains multiple, equal-cost paths to that route, the device checks the IPv6 neighbor for each next hop. Every next hop where the link layer address has been resolved will be stored in hardware. The device will initiate neighbor discovery for the next hops whose link layer addresses are not resolved. The hardware will hash the packet and choose one of the paths. The number of paths would be updated in hardware as the link layer gets resolved for a next hop.

If the path selected by the device becomes unavailable, the IPv6 neighbor should change state and trigger the update of the destination path in the hardware.

Ruckus FastIron devices support network-based ECMP load-sharing methods for IPv6 traffic. The Ruckus device distributes traffic across equal-cost paths based on a XOR of some bits from the MAC source address, MAC destination address, IPv6 source address, IPv6 destination address, IPv6 flow label, IPv6 next header. The software selects a path based on a calculation involving the maximum number of load-sharing paths allowed and the actual number of paths to the destination network. This is the default ECMP load-sharing method for IPv6.

You can manually disable or enable ECMP load sharing for IPv6 and specify the number of equal-cost paths the device can distribute traffic across. In addition, you can display information about the status of ECMP load-sharing on the device.

Disabling or re-enabling ECMP load sharing for IPv6

ECMP load sharing for IPv6 is enabled by default. To disable the feature, enter the following command.

```
device(config)# no ipv6 load-sharing
```

If you want to re-enable the feature after disabling it, you must specify the number of load-sharing paths. By entering a command such as the following, IPv6 load-sharing will be re-enabled.

```
device(config)#ipv6 load-sharing 4
```

Syntax: [no] ipv6 load-sharing num

The *num* variable specifies the number of paths and can be from 2-8. The default is 4. On the ICX 7750 device, the value of the *num* variable can be from 2 through 32.

The configuration of the maximum number of IP load sharing paths to a value more than 8 is determined by the maximum number of ECMP paths defined at the system level using the **system-max max-ecmp** command. You cannot configure the maximum number of IP load sharing paths higher than the value defined at the system level.

To define the maximum number of ECMP paths at the system level, enter a command such as the following.

```
device(config)# system-max max-ecmp 20
device(config)# write memory
device(config)# exit
device# reload
```

Syntax: [no] system-max max-ecmp [num]

The *num* variable specifies the maximum number of ECMP paths and the value range can be from 8 through 32. This is supported only on the ICX 7750 device.

Changing the maximum load sharing paths for IPv6

By default, IPv6 ECMP load sharing allows traffic to be balanced across up to four equal paths.

To change the number of ECMP load sharing paths for IPv6, enter a command such as the following.

```
device(config)#ipv6 load-sharing 6
```

Syntax: [no] ipv6 load-sharing [num]

The *num* variable specifies the number of paths and can be from 2 through 8, depending on the device you are configuring. On the Brocade ICX 7750, the value of the *num* variable can be from 2 through 32.

The configuration of the maximum number of IP load sharing paths to a value more than 8 is determined by the maximum number of ECMP paths defined at the system level using the **system-max max-ecmp** command. You cannot configure the maximum number of IP load sharing paths higher than the value defined at the system level. Also, you cannot configure the maximum number of ECMP paths at the system level to a value less than the configured IP load sharing value.

To define the maximum number of ECMP paths at the system level, enter a command such as the following.

```
device(config)# system-max max-ecmp 20
device(config)# write memory
device(config)# exit
device# reload
```

Syntax: [no] system-max max-ecmp [num]

The *num* variable specifies the maximum number of ECMP paths and the value range can be from 8 through 32. This command is supported only on the Brocade ICX 7750.

You must save the configuration and reload the device for the maximum ECMP value change to take effect.

IP Configuration

Configuring IP parameters - Layer 3 switches

Displaying ECMP load-sharing information for IPv6

To display the status of ECMP load sharing for IPv6, enter the following command.

```
device#show ipv6
Global Settings
  unicast-routing enabled, hop-limit 64
  No IPv6 Domain Name Set
  No IPv6 DNS Server Address set
  Prefix-based IPv6 Load-sharing is Enabled, Number of load share paths: 4
```

Syntax: `show ipv6`

ICMP Router Discovery Protocol configuration

The ICMP Router Discovery Protocol (IRDP) is used by Ruckus Layer 3 switches to advertise the IP addresses of its router interfaces to directly attached hosts. IRDP is disabled by default. You can enable the feature on a global basis or on an individual port basis:

- If you enable the feature globally, all ports use the default values for the IRDP parameters.
- If you leave the feature disabled globally but enable it on individual ports, you also can configure the IRDP parameters on an individual port basis.

NOTE

You can configure IRDP parameters only on individual port basis. To do so, IRDP must be disabled globally and enabled only on individual ports. You cannot configure IRDP parameters if the feature is globally enabled.

When IRDP is enabled, the Layer 3 switch periodically sends Router Advertisement messages out the IP interfaces on which the feature is enabled. The messages advertise the Layer 3 switch IP addresses to directly attached hosts who listen for the messages. In addition, hosts can be configured to query the Layer 3 switch for the information by sending Router Solicitation messages.

Some types of hosts use the Router Solicitation messages to discover their default gateway. When IRDP is enabled on the Ruckus Layer 3 switch, the Layer 3 switch responds to the Router Solicitation messages. Some clients interpret this response to mean that the Layer 3 switch is the default gateway. If another router is actually the default gateway for these clients, leave IRDP disabled on the Ruckus Layer 3 switch.

IRDP parameters

IRDP uses the following parameters. If you enable IRDP on individual ports instead of enabling the feature globally, you can configure these parameters on an individual port basis:

- **Packet type** - The Layer 3 switch can send Router Advertisement messages as IP broadcasts or as IP multicasts addressed to IP multicast group 224.0.0.1. The packet type is IP broadcast.
- **Maximum message interval and minimum message interval** - When IRDP is enabled, the Layer 3 switch sends the Router Advertisement messages every 450 - 600 seconds by default. The time within this interval that the Layer 3 switch selects is random for each message and is not affected by traffic loads or other network factors. The random interval minimizes the probability that a host will receive Router Advertisement messages from other routers at the same time. The interval on each IRDP-enabled Layer 3 switch interface is independent of the interval on other IRDP-enabled interfaces. The default maximum message interval is 600 seconds. The default minimum message interval is 450 seconds.
- **Hold time** - Each Router Advertisement message contains a hold time value. This value specifies the maximum amount of time the host should consider an advertisement to be valid until a newer advertisement arrives. When a new

advertisement arrives, the hold time is reset. The hold time is always longer than the maximum advertisement interval. Therefore, if the hold time for an advertisement expires, the host can reasonably conclude that the router interface that sent the advertisement is no longer available. The default hold time is three times the maximum message interval.

- **Preference** - If a host receives multiple Router Advertisement messages from different routers, the host selects the router that sent the message with the highest preference as the default gateway. The preference can be a number from 0-4294967296. The default is 0.

Enabling IRDP globally

To globally enable IRDP, enter the following command.

```
device(config)# ip irdp
```

This command enables IRDP on the IP interfaces on all ports. Each port uses the default values for the IRDP parameters. The parameters are not configurable when IRDP is globally enabled.

Enabling IRDP on an individual port

To enable IRDP on an individual interface and change IRDP parameters, enter commands such as the following.

```
device(config)# interface ethernet 1/1/3
device(config-if-1/1/3)# ip irdp maxadvertinterval 400
```

This example shows how to enable IRDP on a specific port and change the maximum advertisement interval for Router Advertisement messages to 400 seconds.

NOTE

To enable IRDP on individual ports, you must leave the feature globally disabled.

Syntax: [no] ip irdp { broadcast | multicast } [holdtime seconds] [maxadvertinterval seconds] [minadvertinterval seconds] [preference number]

The **broadcast** and **multicast** parameters specify the packet type the Layer 3 switch uses to send Router Advertisement:

- **broadcast** - The Layer 3 switch sends Router Advertisement as IP broadcasts. This is the default.
- **multicast** - The Layer 3 switch sends Router Advertisement as multicast packets addressed to IP multicast group 224.0.0.1.

The **holdtime** *seconds* parameter specifies how long a host that receives a Router Advertisement from the Layer 3 switch should consider the advertisement to be valid. When a host receives a new Router Advertisement message from the Layer 3 switch, the host resets the hold time for the Layer 3 switch to the hold time specified in the new advertisement. If the hold time of an advertisement expires, the host discards the advertisement, concluding that the router interface that sent the advertisement is no longer available. The value must be greater than the value of the **maxadvertinterval** parameter and cannot be greater than 9000. The default is three times the value of the **maxadvertinterval** parameter.

The **maxadvertinterval** parameter specifies the maximum amount of time the Layer 3 switch waits between sending Router Advertisements. You can specify a value from 1 to the current value of the **holdtime** parameter. The default is 600 seconds.

The **minadvertinterval** parameter specifies the minimum amount of time the Layer 3 switch can wait between sending Router Advertisements. The default is three-fourths (0.75) the value of the **maxadvertinterval** parameter. If you change the **maxadvertinterval** parameter, the software automatically adjusts the **minadvertinterval** parameter to be three-fourths the new value of the **maxadvertinterval** parameter. If you want to override the automatically configured value, you can specify an interval from 1 to the current value of the **maxadvertinterval** parameter.

IP Configuration

Configuring IP parameters - Layer 3 switches

The **preference number** parameter specifies the IRDP preference level of this Layer 3 switch. If a host receives Router Advertisements from multiple routers, the host selects the router interface that sent the message with the highest interval as the host default gateway. The valid range is from 0 to 4294967296. The default is 0.

Reverse Address Resolution Protocol configuration

The Reverse Address Resolution Protocol (RARP) provides a simple mechanism for directly-attached IP hosts to boot over the network. RARP allows an IP host that does not have a means of storing its IP address across power cycles or software reloads to query a directly-attached router for an IP address.

RARP is enabled by default. However, you must create a RARP entry for each host that will use the Layer 3 switch for booting. A RARP entry consists of the following information:

- The entry number - The entry sequence number in the RARP table.
- The MAC address of the boot client.
- The IP address you want the Layer 3 switch to give to the client.

When a client sends a RARP broadcast requesting an IP address, the Layer 3 switch responds to the request by looking in the RARP table for an entry that contains the client MAC address:

- If the RARP table contains an entry for the client, the Layer 3 switch sends a unicast response to the client that contains the IP address associated with the client MAC address in the RARP table.
- If the RARP table does not contain an entry for the client, the Layer 3 switch silently discards the RARP request and does not reply to the client.

How RARP Differs from BootP and DHCP

RARP and BootP and DHCP are different methods for providing IP addresses to IP hosts when they boot. These methods differ in the following ways:

- Location of configured host addresses:
 - RARP requires static configuration of the host IP addresses on the Layer 3 switch. The Layer 3 switch replies directly to a host request by sending an IP address you have configured in the RARP table.
 - The Layer 3 switch forwards BootP and DHCP requests to a third-party BootP/DHCP server that contains the IP addresses and other host configuration information.
- Connection of host to boot source (Layer 3 switch or BootP/DHCP server):
 - RARP requires the IP host to be directly attached to the Layer 3 switch.
 - An IP host and the BootP/DHCP server can be on different networks and on different routers, so long as the routers are configured to forward ("help") the host boot request to the boot server.
 - You can centrally configure other host parameters on the BootP/DHCP server, in addition to the IP address, and supply those parameters to the host along with its IP address.

To configure the Layer 3 switch to forward BootP/DHCP requests when boot clients and the boot servers are on different subnets on different Layer 3 switch interfaces, refer to [BootP and DHCP relay parameter configuration](#) on page 82.

Disabling RARP

RARP is enabled by default. To disable RARP, enter the following command at the global CONFIG level.

```
device(config)# no ip rarp
```

Syntax: [no] ip rarp

To re-enable RARP, enter the following command.

```
device(config)# ip rarp
```

Creating static RARP entries

You must configure the RARP entries for the RARP table. The Layer 3 switch can send an IP address in reply to a client RARP request only if create a RARP entry for that client.

To assign a static IP RARP entry for static routes on a Ruckus router, enter a command such as the following.

```
device(config)# rarp 1 0000.0054.2348 10.53.4.2
```

This command creates a RARP entry for a client with MAC address 0000.0054.2348. When the Layer 3 switch receives a RARP request from this client, the Layer 3 switch replies to the request by sending IP address 192.53.4.2 to the client.

Syntax: **rarp** *number mac-addr ip-addr*

The *number* parameter identifies the RARP entry number. You can specify an unused number from 1 to the maximum number of RARP entries supported on the device. To determine the maximum number of entries supported on the device, refer to the section "Displaying and modifying system parameter default settings" in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*.

The *mac-addr* parameter specifies the MAC address of the RARP client.

The *ip-addr* parameter specifies the IP address the Layer 3 switch will give the client in response to the client RARP request.

Changing the maximum number of static RARP entries supported

The number of RARP entries the Layer 3 switch supports depends on how much memory the Layer 3 switch has. To determine how many RARP entries your Layer 3 switch can have, display the system default information using the procedure in the section "Displaying system parameter default values" in the *FastIron Ethernet Switch Platform and Layer 2 Switching Configuration Guide*.

If your Layer 3 switch allows you to increase the maximum number of RARP entries, you can use a procedure in the same section to do so.

NOTE

You must save the configuration to the startup-config file and reload the software after changing the RARP cache size to place the change into effect.

Configuring UDP broadcast and IP helper parameters

Some applications rely on client requests sent as limited IP broadcasts addressed to the UDP application port. If a server for the application receives such a broadcast, the server can reply to the client. Routers do not forward subnet directed broadcasts, so the client and server must be on the same network for the broadcast to reach the server. If the client and server are on different networks (on opposite sides of a router), the client request cannot reach the server.

You can configure the Layer 3 switch to forward clients' requests to UDP application servers. To do so:

- Enable forwarding support for the UDP application port, if forwarding support is not already enabled.
- Configure a helper adders on the interface connected to the clients. Specify the helper address to be the IP address of the application server or the subnet directed broadcast address for the IP subnet the server is in. A helper address is associated with a specific interface and applies only to client requests received on that interface. The Layer 3 switch forwards client requests for any of the application ports the Layer 3 switch is enabled to forward to the helper address.

IP Configuration

Configuring IP parameters - Layer 3 switches

Forwarding support for the following application ports is enabled by default:

- dns (port 53)
- tftp (port 69)
- time (port 37)
- tacacs (port 65)

NOTE

The application names are the names for these applications that the Layer 3 switch software recognizes, and might not match the names for these applications on some third-party devices. The numbers listed in parentheses are the UDP port numbers for the applications. The numbers come from RFC 1340.

NOTE

Forwarding support for BootP/DHCP is enabled by default.

You can enable forwarding for other applications by specifying the application port number.

You also can disable forwarding for an application.

NOTE

If you disable forwarding for a UDP application, forwarding of client requests received as broadcasts to helper addresses is disabled. Disabling forwarding of an application does not disable other support for the application. For example, if you disable forwarding of Telnet requests to helper addresses, other Telnet support on the Layer 3 switch is not also disabled.

Enabling forwarding for a UDP application

If you want the Layer 3 switch to forward client requests for UDP applications that the Layer 3 switch does not forward by default, you can enable forwarding support for the port. To enable forwarding support for a UDP application, use the following method. You also can disable forwarding for an application using this method.

NOTE

You also must configure a helper address on the interface that is connected to the clients for the application. The Layer 3 switch cannot forward the requests unless you configure the helper address.

To enable the forwarding of NTP broadcasts, enter the following command.

```
device(config)# ip forward-protocol udp ntp
```

Syntax: [no] ip forward-protocol {udp *udp-port-name* | *udp-port-num* }

The *udp-port-name* parameter can have one of the following values. For reference, the corresponding port numbers from RFC 1340 are shown in parentheses. If you specify an application name, enter the name only, not the parentheses or the port number shown here:

- bootpc (port 68)
- bootps (port 67)
- discard (port 9)
- dns (port 53)
- dnsix (port 90)
- echo (port 7)
- mobile-ip (port 434)

- netbios-dgm (port 138)
- netbios-ns (port 137)
- ntp (port 123)
- tacacs (port 65)
- talk (port 517)
- time (port 37)
- tftp (port 69)

In addition, you can specify any UDP application by using the application UDP port number.

The *udp-port-num* parameter specifies the UDP application port number. If the application you want to enable is not listed above, enter the application port number. You also can list the port number for any of the applications listed above.

To disable forwarding for an application, enter a command such as the following.

```
device(config)# no ip forward-protocol udp ntp
```

This command disables forwarding of SNMP requests to the helper addresses configured on Layer 3 switch interfaces.

Configuring an IP helper address

To forward a client broadcast request for a UDP application when the client and server are on different networks, you must configure a helper address on the interface connected to the client.

Specify the server IP address or the subnet directed broadcast address of the server's IP subnet as the helper address. You can configure up to 16 helper addresses on each interface. You can configure a helper address on an Ethernet port or a virtual interface.

1. Enter the global configuration mode by issuing the **configure terminal** command.

```
device# configure terminal
```

2. Enter the interface configuration mode.

```
device(config)# interface ethernet 1/1/2
```

3. Add a helper address for the server.

```
device(config-if-1/1/2)# ip helper-address 1 10.95.7.6
```

The commands in the example above add a helper address for server 10.95.7.6 to the port. If the port receives a client request for any of the applications that the Layer 3 switch is enabled to forward, the Layer 3 switch forwards the client request to the server.

4. By default, an IP helper does not forward client broadcast requests to a server within the network. To forward a client broadcast request when the client and server are on the same network, configure an IP helper with the unicast option on the interface connected to the client.

```
device(config-if-1/1/2)# ip helper-address 1 10.10.10.1 unicast
```

The previous example configures an IP helper unicast option on unit 1, slot 1, port 2. The IP helper with unicast parameter forwards the client request to the server 10.10.10.1, which is within the network.

IP Configuration

Configuring IP parameters - Layer 3 switches

Configuring the source IP address of a DHCP client packet on the DHCP relay agent

Enables the DHCP server to know the source subnet or network of a DHCP-client packet.

By default, a DHCP relay agent forwards a DHCP client packet with the source IP address set to the IP address of the outgoing interface to the DHCP server. You can configure ACLs on a DHCP server to provide or block DHCP services to particular subnets or networks. The **ip bootp-use-intf-ip** command configures a DHCP relay agent to set the source IP address of a DHCP client packet with the IP address of the incoming interface for the packet. This reveals the source subnet or network of a DHCP client packet to the DHCP server and enables the DHCP server to process or discard the DHCP traffic according to the configured ACLs.

Enter the **ip bootp-use-intf-ip** command in global configuration mode of the DHCP relay agent.

```
device(config)# ip bootp-use-intf-ip
```

BootP and DHCP relay parameter configuration

A host on an IP network can use BootP or DHCP to obtain its IP address from a BootP/DHCP server. To obtain the address, the client sends a BootP or DHCP request. The request is a subnet directed broadcast and is addressed to UDP port 67. A limited IP broadcast is addressed to IP address 255.255.255.255 and is not forwarded by the Ruckus Layer 3 switch or other IP routers.

When the BootP or DHCP client and server are on the same network, the server receives the broadcast request and replies to the client. However, when the client and server are on different networks, the server does not receive the client request, because the Layer 3 switch does not forward the request.

You can configure the Layer 3 switch to forward BootP/DHCP requests. To do so, configure a helper address on the interface that receives the client requests, and specify the BootP/DHCP server IP address as the address you are helping the BootP/DHCP requests to reach. Instead of the server IP address, you can specify the subnet directed broadcast address of the IP subnet the server is in.

BootP and DHCP relay parameters

The following parameters control the Layer 3 switch forwarding of BootP and DHCP requests:

- **Helper address** - The BootP/DHCP server IP address. You must configure the helper address on the interface that receives the BootP/DHCP requests from the client. The Layer 3 switch cannot forward a request to the server unless you configure a helper address for the server.
- **Gateway address** - The Layer 3 switch places the IP address of the interface that received the BootP/DHCP request in the request packet Gateway Address field (sometimes called the Router ID field). When the server responds to the request, the server sends the response as a unicast packet to the IP address in the Gateway Address field. (If the client and server are directly attached, the Gateway ID field is empty and the server replies to the client using a unicast or broadcast packet, depending on the server.)

By default, the Layer 3 switch uses the lowest-numbered IP address on the interface that receives the request as the Gateway address. You can override the default by specifying the IP address you want the Layer 3 switch to use.

- **Hop count** - Each router that forwards a BootP/DHCP packet increments the hop count by 1. Routers also discard a forwarded BootP/DHCP request instead of forwarding the request if the hop count is greater than the maximum number of BootP/DHCP hops allowed by the router. By default, a Ruckus Layer 3 switch forwards a BootP/DHCP request if its hop count is four or less, but discards the request if the hop count is greater than four. You can change the maximum number of hops the Layer 3 switch will allow to a value from 1 through 15.

NOTE

The BootP/DHCP hop count is not the TTL parameter.

Configuring an IP helper address

The procedure for configuring a helper address for BootP/DHCP requests is the same as the procedure for configuring a helper address for other types of UDP broadcasts. Refer to [Configuring an IP helper address](#) on page 81.

Configuring the BOOTP and DHCP reply source address

You can configure the Ruckus device so that a BOOTP/DHCP reply to a client contains the server IP address as the source address instead of the router IP address. To do so, enter the following command at the Global CONFIG level of the CLI.

```
device(config)# ip helper-use-responder-ip
```

Syntax: [no] ip helper-use-responder-ip

Changing the IP address used for stamping BootP and DHCP requests

When the Layer 3 switch forwards a BootP/DHCP request, the Layer 3 switch "stamps" the Gateway Address field. The default value the Layer 3 switch uses to stamp the packet is the lowest-numbered IP address configured on the interface that received the request. If you want the Layer 3 switch to use a different IP address to stamp requests received on the interface, use either of the following methods to specify the address.

The BootP/DHCP stamp address is an interface parameter. Change the parameter on the interface that is connected to the BootP/DHCP client.

To change the IP address used for stamping BootP/DHCP requests received on interface 1/1/1, enter commands such as the following.

```
device(config)# interface ethernet 1/1/1
device(config-if-1/1/1)# ip bootp-gateway 10.157.22.26
```

These commands change the CLI to the configuration level for port 1/1/1, then change the BootP/DHCP stamp address for requests received on port 1/1/1 to 10.157.22.26. The Layer 3 switch will place this IP address in the Gateway Address field of BootP/DHCP requests that the Layer 3 switch receives on port 1/1/1 and forwards to the BootP/DHCP server.

Syntax: ip bootp-gateway *ip-addr*

Changing the maximum number of hops to a BootP relay server

Each BootP or DHCP request includes a field Hop Count field. The Hop Count field indicates how many routers the request has passed through. When the Layer 3 switch receives a BootP/DHCP request, the Layer 3 switch looks at the value in the Hop Count field:

- If the hop count value is equal to or less than the maximum hop count the Layer 3 switch allows, the Layer 3 switch increments the hop count by one and forwards the request.
- If the hop count is greater than the maximum hop count the Layer 3 switch allows, the Layer 3 switch discards the request.

To change the maximum number of hops the Layer 3 switch allows for forwarded BootP/DHCP requests, use either of the following methods.

NOTE

The BootP and DHCP hop count is not the TTL parameter.

To modify the maximum number of BootP/DHCP hops, enter the following command.

```
device(config)# bootp-relay-max-hops 10
```

IP Configuration

Configuring IP parameters - Layer 3 switches

This command allows the Layer 3 switch to forward BootP/DHCP requests that have passed through ten previous hops before reaching the Layer 3 switch. Requests that have traversed 11 hops before reaching the switch are dropped. Since the hop count value initializes at zero, the hop count value of an ingressing DHCP Request packet is the number of Layer 3 routers that the packet has already traversed.

Syntax: **bootp-relay-max-hops** *max-hops*

The *max-hops* parameter value can be 1 through 15.

DHCP server

All FastIron devices can be configured to function as DHCP servers.

Dynamic Host Configuration Protocol (DHCP) is a computer networking protocol used by devices (DHCP clients) to obtain leased (or permanent) IP addresses. DHCP is an extension of the Bootstrap Protocol (BootP). The differences between DHCP and BootP are the address allocation and renewal process.

DHCP introduces the concept of a lease on an IP address. The DHCP server can allocate an IP address for a specified amount of time or can extend a lease for an indefinite amount of time. DHCP provides greater control of address distribution within a subnet. This feature is crucial if the subnet has more devices than available IP addresses. In contrast to BootP, which has two types of messages that can be used for leased negotiation, DHCP provides seven types of messages.

DHCP allocates temporary or permanent network IP addresses to clients. When a client requests the use of an address for a time interval, the DHCP server guarantees not to reallocate that address within the requested time and tries to return the same network address each time the client makes a request. The period of time for which a network address is allocated to a client is called a lease. The client may extend the lease through subsequent requests. When the client is done with the address, they can release the address back to the server. By asking for an indefinite lease, clients may receive a permanent assignment.

In some environments, it may be necessary to reassign network addresses due to exhaustion of the available address pool. In this case, the allocation mechanism reuses addresses with expired leases.

Configuration notes for DHCP servers

- The DHCP server is supported in the Layer 2 and Layer 3 software images.
- The management VLAN or the management port must be enabled for a device to receive IP addresses from a DHCP server.
- In the event of a controlled or forced switchover, a DHCP client will request from the DHCP server the same IP address and lease assignment that it had before the switchover. After the switchover, the DHCP Server will be automatically re-initialized on the new active controller or management module.
- For DHCP client hitless support in an IronStack, the **stack mac** command must be used to configure the IronStack MAC address, so that the MAC address does not change in the event of a switchover or failover. If **stack mac** is not configured, the MAC address/IP address pair assigned to a DHCP client will not match after a switchover or failover. Furthermore, in the Layer 3 router image, if the **stack mac** configuration is changed or removed and the management port has a dynamic IP address, when a DHCP client tries to renew its lease from the DHCP server, the DHCP server will assign a different IP address.
- If any address from the configured DHCP pool is used, for example by the DHCP server or TFTP server, you must exclude the address from the network pool. For configuration instructions, refer to [Specifying addresses to exclude from the address pool](#) on page 91.
- Ensure that DHCP clients do not send DHCP request packets with a Maximum Transmission Unit (MTU) larger than 1500 bytes. Brocade devices do not support DHCP packets with an MTU larger than 1500 bytes.

DHCP option 82 support

The DHCP relay agent information option (DHCP option 82) enables a DHCP relay agent to include information about itself when forwarding client-originated DHCP packets to a DHCP server. The DHCP server uses this information to implement IP address or other parameter-assignment policies.

In a metropolitan Ethernet-access environment, the DHCP server can centrally manage IP address assignments for a large number of subscribers. If DHCP option 82 is disabled, a DHCP policy can only be applied per subnet, rather than per physical port. When DHCP option 82 is enabled, a subscriber is identified by the physical port through which it connects to the network.

DHCP server options

A FastIron configured as a DHCP server can support up to 1000 DHCP clients, offering them the following options:

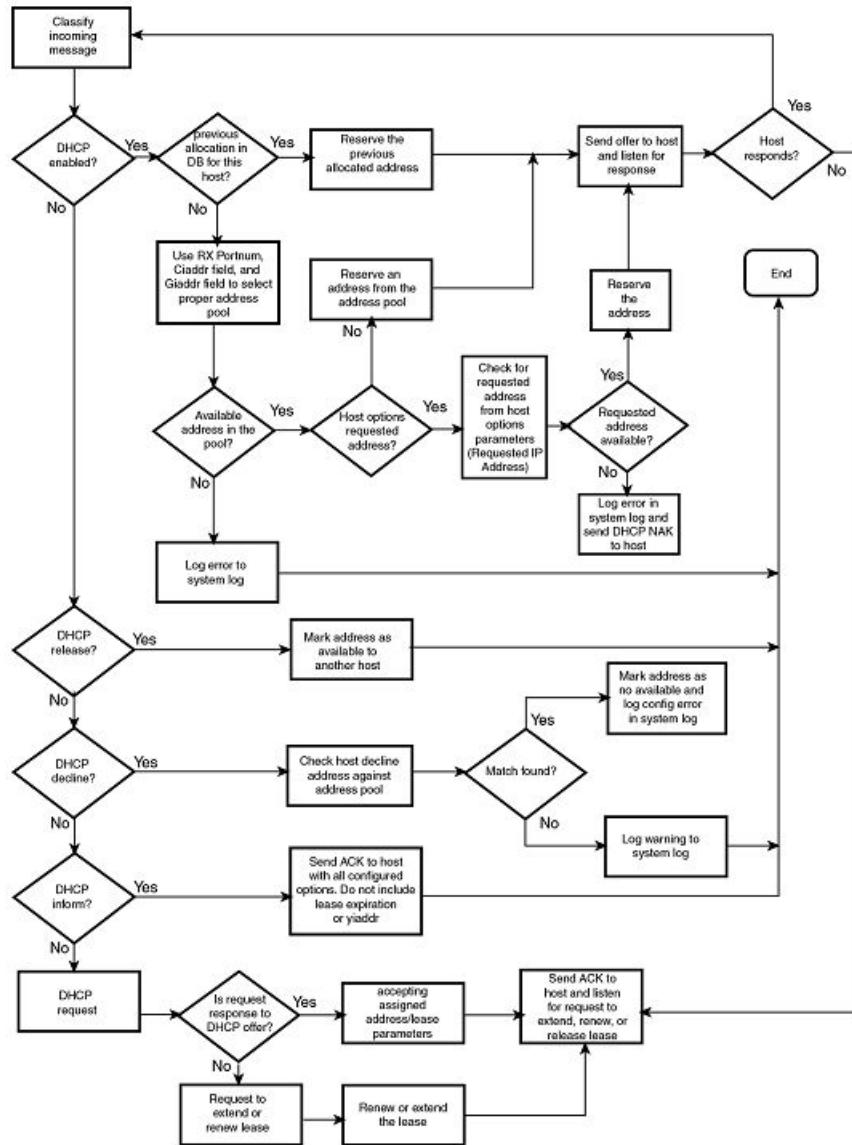
- **NetBIOS over TCP/IP Name Server** - Specifies a list of RFC1001/1002 NBNS name servers listed in order of preference.
- **Domain Name Server** - Specifies a list of Domain Name System (RFC 1035) name servers available to the client. Servers are listed in order of preference.
- **Domain Name** - Specifies the domain name the client should use when resolving host names using the Domain Name System.
- **Router Option** - specifies a list of IP addresses for routers on the client subnet. Routers are listed in order of preference.
- **Subnet Mask** - Specifies the client subnet mask (per RFC 950).
- **Vendor Specific Information** - Allows clients and servers to exchange vendor-specific information.
- **Boot File** - Specifies a boot image to be used by the client
- **Next Bootstrap Server** - Configures the IP address of the next server to be used for startup by the client.
- **TFTP Server** - Configures the address or name of the TFTP server available to the client.

A DHCP server assigns and manages IPv4 addresses from multiple address pools, using dynamic address allocation. The DHCP server also contains the relay agent to forward DHCP broadcast messages to network segments that do not support these types of messages.

IP Configuration

Configuring IP parameters - Layer 3 switches

FIGURE 8 DHCP server configuration flow chart



Configuring DHCP server on a device

Perform the following steps to configure the DHCP server feature on your FastIron device:

1. Enable DHCP server by entering a command similar to the following.

```
device(config)# ip dhcp-server enable
```

2. Create a DHCP server address pool by entering a command similar to the following.

```
device(config)# ip dhcp-server pool cab0
```

3. Configure the DHCP server address pool by entering commands similar to the following.

```
device(config-dhcp-cabo) # network 172.16.1.0/24
device(config-dhcp-cabo) # domain-name brocade.com
device(config-dhcp-cabo) # dns-server 172.16.1.2 172.16.1.3
device(config-dhcp-cabo) # netbios-name-server 172.16.1.2
device(config-dhcp-cabo) # lease 0 0 5
```

4. To disable DHCP, enter a command similar to the following.

```
device(config)# no ip dhcp-server enable
```

The following sections describe the default DHCP settings, CLI commands and the options you can configure for the DHCP server feature.

Default DHCP server settings

TABLE 10 DHCP server default settings

Parameter	Default Value
DHCP server	Disabled
Lease database expiration time	86400 seconds
The duration of the lease for an assigned IP address	43200 seconds (one day)
Maximum lease database expiration time	86400 seconds
DHCP server with option 82	Disabled
DHCP server unknown circuit-ID for option 82	Permit range lookup
IP distribution mechanism	Linear

DHCP server CLI commands

TABLE 11 DHCP server optional parameters

Command options	Description
<i>domain-name</i>	Specifies the domain name for the DHCP clients.
<i>domain-name-servers</i>	Specifies the Domain Name System (DNS) IP servers that are available to the DHCP clients.
<i>merit-dump</i>	Specifies the path name of a file into which the client's core image should be placed in the event that the client crashes (the DHCP application issues an exception in case of errors such as division by zero).
<i>root-path</i>	Specifies the name of the path that contains the client's root filesystem in NFS notation.
<i>router</i>	Adds the default router and gateway for the DHCP clients.
<i>subnet-mask</i>	Defines the subnet mask for the network.
<i>broadcast-address</i>	Defines a broadcast address for the network.
<i>wins-server</i>	Defines the NetBIOS Windows Internet Naming Service (WINS) name servers that are available to Microsoft DHCP clients.
<i>log-servers</i>	Defines a list of log servers available to the client.
<i>bootstrap-server</i>	Specifies the IP address of the bootstrap server (the command fills the "siaddr" field in the DHCP packet).

IP Configuration

Configuring IP parameters - Layer 3 switches

TABLE 12 DHCP server CLI commands

Command	Description
dbexpire command	Specifies how long, in seconds, the DHCP server should wait before aborting a database transfer.
ip dhcp-server arp-ping-timeout	Specifies the time (in seconds) the server will wait for a response to an arp-ping packet before deleting the client from the binding database. The minimum setting is 5 seconds and the maximum time is 30 seconds. NOTE Do not alter the default value unless it is necessary. Increasing the value of this timer may increase the time to get console access after a reboot.
clear ip dhcp-server binding	Deletes a specific, or all leases from the binding database.
ip dhcp-server enable	Enables the DHCP server feature.
no ip dhcp-server mgmt	Disables DHCP server on the management port.
ip dhcp-server pool	Switches to pool configuration mode (config-dhcp-name# prompt) and creates an address pool.
ip dhcp-server relay-agent-echo enable	Enables relay agent echo (Option 82).
ip dhcp-server	Specifies the IP address of the selected DHCP server.
show ip dhcp-server binding	Displays a specific lease entry, or all lease entries.
show ip dhcp-server	Displays a specific address pool or all address pools.
show ip dhcp-server flash	Displays the lease binding database that is stored in flash memory.
show ip dhcp-server summary	Displays a summary of active leases, deployed address pools, undeployed address pools, and server uptime.
bootfile	Specifies a boot image to be used by the client.
deploy	Deploys an address pool configuration to the server.
dhcp-default-router	Specifies the IP address of the default router or routers for a client.
dns-server	Specifies the IP addresses of a DNS server or servers available to the client.
domain-name	Configures the domain name for the client.
lease	Specifies the lease duration for an address pool. The default is a one-day lease.
excluded-address	Specifies an address or range of addresses to be excluded from the address pool.
netbios-name-server	Specifies the IP address of a NetBIOS WINS server or servers that are available to Microsoft DHCP clients.
network	Configures the subnet network and mask of the DHCP address pool.
next-bootstrap-server	Configures the IP address of the next server to be used for startup by the client.
tftp-server	Configures the address or name of the TFTP server available to the client.
vendor-class	Specifies the vendor type and configuration value for the DHCP client.

Removing DHCP leases

The **clear ip dhcp-server binding** command can be used to delete a specific lease, or all lease entries from the lease binding database.

```
device(config)# clear ip dhcp-server binding *
```

Syntax: **clear ip dhcp-server binding { address | * }**

- *address* - The IP address to be deleted
- The wildcard (*) clears all IP addresses.

Enabling DHCP server

The **ip dhcp-server enable** command enables DHCP server, which is disabled by default.

Syntax: **[no] ip dhcp-server enable**

The **no** version of this command disables DHCP server.

Disabling DHCP server on the management port

By default, when DHCP server is enabled, it responds to DHCP client requests received on the management port. If desired, you can prevent the response to DHCP client requests received on the management port, by disabling DHCP server support on the port. When disabled, DHCP client requests that are received on the management port are silently discarded.

To disable DHCP server on the management port, enter the following command at the global configuration level of the CLI.

```
device(config)# no ip dhcp-server mgmt
```

To re-enable DHCP server on the management port after it has been disabled, enter the **ip dhcp-server mgmt** command:

```
device(config)# ip dhcp-server mgmt
```

Syntax: **[no] ip dhcp-server mgmt**

Setting the wait time for ARP-ping response

At startup, the server reconciles the lease-binding database by sending an ARP-ping packet out to every client. If there is no response to the ARP-ping packet within a set amount of time (set in seconds), the server deletes the client from the lease-binding database. The minimum setting is 5 seconds and the maximum is 30 seconds.

Syntax: **ip dhcp-server arp-ping-timeout num**

- *num* - The number of seconds to wait for a response to an ARP-ping packet.

NOTE

Do not alter the default value unless it is necessary. Increasing the value of this timer may increase the time to get console access after a reboot.

Creating an address pool

The **ip dhcp-server pool** command puts you in pool configuration mode, and allows you to create an address pool.

```
device(config)# ip dhcp-server pool
device(config-dhcp-name)# ip dhcp-server pool monterey
device(config-dhcp-monterey) #
```

These commands create an address pool named "monterey".

Syntax: **ip dhcp-server pool name**

IP Configuration

Configuring IP parameters - Layer 3 switches

Configuration notes for creating an address pool

- If the DHCP server address is part of a configured DHCP address pool, you must exclude the DHCP server address from the network pool. Refer to [Specifying addresses to exclude from the address pool](#) on page 91.
- While in DHCP server pool configuration mode, the system will place the DHCP server pool in *pending* mode and the DHCP server will not use the address pool to distribute information to clients. To activate the pool, use the **deploy** command. Refer to [Deploying an address pool configuration to the server](#) on page 90.

Enabling relay agent echo (option 82)

The **ip dhcp-server relay-agent-echo enable** command activates DHCP option 82, and enables the DHCP server to echo relay agent information in all replies.

```
device(config)# ip dhcp-server relay-agent-echo enable
```

Syntax: **ip dhcp-server relay-agent-echo enable**

Configuring the IP address of the DHCP server

The **ip dhcp-server** command specifies the IP address of the selected DHCP server, as shown in this example:

```
device(config)# ip dhcp-server 10.1.1.144
```

Syntax: **ip dhcp-server server-identifier**

- *server-identifier* - The IP address of the DHCP server

This command assigns an IP address to the selected DHCP server.

Configuring the boot image

The **bootfile** command specifies a boot image name to be used by the DHCP client.

```
device(config-dhcp-cabo)# bootfile foxhound
```

In this example, the DHCP client should use the boot image called "foxhound".

Syntax: **bootfile name**

Deploying an address pool configuration to the server

The **deploy** command sends an address pool configuration to the DHCP server.

```
device(config-dhcp-cabo)# deploy
```

Syntax: **deploy**

Specifying default routers available to the client

The **dhcp-default-router** command specifies the IP addresses of the default routers for a client.

Syntax: **dhcp-default-router address [address, address]**

Specifying DNS servers available to the client

The **dns-server** command specifies DNS servers that are available to DHCP clients.

```
device(config-dhcp-cabo) # dns-server 10.2.1.143, 10.2.2.142
```

Syntax: **dns-server address [address, address]**

Configuring the domain name for the client

The **domain-name** command configures the domain name for the client.

```
device(config-dhcp-cabo) # domain-name sierra
```

Syntax: **domain-name domain**

Configuring the lease duration for the address pool

The **lease** command specifies the lease duration for the address pool. The default is a one-day lease.

```
device(config-dhcp-cabo) # lease 1 4 32
```

In this example, the lease duration has been set to one day, four hours, and 32 minutes. You can set a lease duration for just days, just hours, or just minutes, or any combination of the three.

Syntax: **lease days hours minutes**

Specifying addresses to exclude from the address pool

The **excluded-address** command specifies either a single address, or a range of addresses that are to be excluded from the address pool.

```
device(config-dhcp-cabo) # excluded-address 10.2.3.44
```

Syntax: **excluded-address { address | address-low address-high }**

- *address* - Specifies a single address
- *address-low address-high* - Specifies a range of addresses

Configuring the NetBIOS server for DHCP clients

The **netbios-name-server** command specifies the IP address of a NetBIOS WINS server or servers that are available to Microsoft DHCP clients.

```
device(config-dhcp-cabo) # netbios-name-server 192.168.1.55
```

Syntax: **netbios-name-server address [,address2,address3]**

Configuring the subnet and mask of a DHCP address pool

This **network** command configures the subnet network and mask of the DHCP address pool.

```
device(config-dhcp-cabo) # network 10.2.3.44/24
```

Syntax: **network subnet/mask**

IP Configuration

Configuring IP parameters - Layer 3 switches

Configuring a next-bootstrap server

The **next-bootstrap-server** command specifies the IP address of the next server the client should use for boot up.

```
device(config-dhcp-cabo) # next-bootstrap-server 10.2.5.44
```

Syntax: **next-bootstrap-server** *address*

Configuring the TFTP server

The **tftp-server** command specifies the address or name of the TFTP server to be used by the DHCP clients.

To configure a TFTP server by specifying its IP address, enter a command similar to the following.

```
device(config-dhcp-cabo) # tftp-server 10.7.5.48
```

To configure a TFTP server by specifying its server name, enter a command similar to the following.

```
device(config-dhcp-cabo) # tftp-server tftp.domain.com
```

Syntax: **tftp-server** { *address* | **name** *server-name* }

- *address* is the IP address of the TFTP server.
- **name** configures the TFTP server specified by *server-name*.

If DHCP options 66 (TFTP server name) and 150 (TFTP server IP address) are both configured, the DHCP client ignores option 150 and tries to resolve the TFTP server name (option 66) using DNS.

Configuring DHCP option 43 and option 60

Brocade devices running as DHCP servers can be configured with option 43 and option 60.

Configuring the DHCP option 60 helps in identifying the incoming DHCP client. If the vendor class identifier (VCI) advertised by the DHCP client matches with the DHCP server, the server makes a decision to exchange the vendor-specific information (VSI) configured as part of DHCP option 43.

The Brocade ICX DHCP server can recognize the DHCP client device using the VCI (option 60) and pass specific information to this device type only (using option 43). However, the DHCP server can be configured to always pass additional information using option 43 (regardless of the client).

1. Enter global configuration mode.

```
device# configure terminal  
device(config) #
```

2. Create a DHCP server pool.

```
device(config) # ip dhcp-server pool ruckus
```

NOTE

Save the configuration to retain the configuration through warm or cold reboots.

3. Add option 60 using the **vendor-class** command.

```
device(ip dhcp-server pool ruckus) # vendor-class ascii "Ruckus CPE"
```

NOTE

If the **ascii** option contains a space, you must enter it with double quotes as shown in the previous example.

4. Add the option 43 line using the **option** command.

```
device(ip dhcp-server pool ruckus)# option 43 ascii 192.168.10.1,192.168.20.01,192.168.30.1
```

or

```
device(ip dhcp-server pool ruckus)# option 43 hex 0108c0a80a01c0a81401
```

5. Deploy the configuration using the **deploy** command.

```
device(ip dhcp-server pool ruckus)# deploy
```

The following example configures option 60 and option 43 (hex) for a Ruckus Access Point (AP).

```
device# configure terminal
device(config)# ip dhcp-server pool ruckus
device(ip dhcp-server pool ruckus)# vendor-class ascii "Ruckus CPE"
device(ip dhcp-server pool ruckus)# option 43 hex 010cc0a80a01c0a81401c0a81e01
device(ip dhcp-server pool ruckus)# deploy
```

The following example configures option 60 and option 43 (ASCII) for a Ruckus AP.

```
device# configure terminal
device(config)# ip dhcp-server pool ruckus
device(ip dhcp-server pool ruckus)# vendor-class ascii "Ruckus CPE"
device(ip dhcp-server pool ruckus)# option 43 ascii 192.168.10.1,192.168.20.01,192.168.30.1
device(ip dhcp-server pool ruckus)# deploy
```

Configuring X Window System Display Manager IP addresses (Option 49)

Option 49 specifies a list of IP addresses of systems that are running the X Window System Display Manager and are available to the client.

Option 49 is described in RFC 2132. The X Window client is a DHCP client in a network that solicits configuration information by broadcasting a DHCP discovery packet on bootup or when the DHCP client is enabled. The DHCP server provides the IP addresses of systems running the X Window System Display Managers available in the network in their preferred order as part of the DHCP offer message.

On receipt of a discovery packet from the client, a DHCP offer must be sent back. Option 49 must be added with the IP addresses of systems running the X Window System Display Manager in the network, along with other mandatory options. You can configure a maximum of three IP addresses in a DHCP server pool.

NOTE

Option 49 is ignored if the client is a non-X Window client.

1. Enter global configuration mode.
2. Enter the DHCP server pool configuration mode.
3. Enter the **xwindow-manager** command along with the IP addresses of the X Window Display Manager separated by spaces.

The following example configures the IP addresses of systems running the X Window Display Manager in the DHCP configuration pool.

```
device# configure terminal
device# ip dhcp-server pool cabo
device(config-dhcp-cabo)# xwindow-manager 10.38.12.1 10.38.12.3 10.38.12.5
```

IP Configuration

Configuring IP parameters - Layer 3 switches

Enabling static IP to MAC address mapping

Based on the client MAC address, you can statically configure the IP address to the MAC address in the DHCP server.

This configuration is useful when you want to have selected clients assigned with particular IP addresses from the server. Whenever a DHCP discover message is received from these clients, based on the static configuration, the IP address will be assigned with the other required parameters.

1. Enter global configuration mode.

```
device# configure terminal  
device(config)#
```

2. Create a DHCP server pool.

```
device(config)# ip dhcp-server pool cabo
```

3. Enter the **static-mac-ip-mapping** command followed by the IP address and MAC address for mapping.

```
device(config-dhcp-cabo)# static-mac-ip-mapping 10.10.10.29 0010.9400.0005
```

The following example enables the static MAC address to IP address mapping.

```
device# configure terminal  
device(config)# ip dhcp-server pool cabo  
device(config-dhcp-cabo)# static-mac-ip-mapping 10.10.10.29 0010.9400.0005
```

Displaying DHCP server information

The following DHCP **show** commands can be entered from any level of the CLI.

Displaying active lease entries

The **show ip dhcp-server binding** command displays a specific active lease, or all active leases, as shown in the following example:

```
device# show ip dhcp-server binding
```

The following output is displayed:

```
device# show ip dhcp-server binding  
Bindings from all pools:  
      IP Address     Client-ID/  
                  Hardware address      Lease expiration Type  
          192.168.1.2    0000.005d.a440    0d:0h:29m:31s  Automatic  
          192.168.1.3    0000.00e1.26c0    0d:0h:29m:38s  Automatic
```

Syntax: **show ip dhcp-server binding [address]**

- *address* - Displays entries for this address only

TABLE 13 show ip dhcp-server binding output descriptions

Field	Description
IP address	The IP addresses currently in the binding database
Client ID/Hardware address	The hardware address for the client
Lease expiration	The time when this lease will expire
Type	The type of lease

Displaying address-pool information

This **show ip dhcp-server address-pool** command displays information about a specific address pool, or for all address pools.

```
device# show ip dhcp-server address-pools

Showing all address pool(s):
Pool Name: one
Time elapsed since last save: 0d:0h:6m:52s
Total number of active leases: 2
Address Pool State: active
IP Address Exclusions: 192.168.1.45
IP Address Exclusions: 192.168.1.99 192.168.1.103
Pool Configured Options:
bootfile: example.bin
    dhcp-default-router: 192.168.1.1
        dns-server: 192.168.1.100
        domain-name: example.com
        lease: 0 0 30
    netbios-name-server: 192.168.1.101
        network: 192.168.1.0 255.255.255.0
next-bootstrap-server: 192.168.1.102
tftp-server: 192.168.1.103
```

Syntax: **show ip dhcp-server [address-pool name | address-pools]**

- **address-pools** - If you enter address-pools, the display shows all address pools
- **address-pool name** - Displays information about a specific address pool

TABLE 14 show ip dhcp-server address-pools output descriptions

Field	Description
Pool name	The name of the address pool
Time elapsed since last save	The time that has elapsed since the last save.
Total number of active leases	The number of leases that are currently active.
Address pool state	The state of the address pool (active or inactive).
IP Address exclusions	IP addresses that are not included in the address pool
Pool configured options (as described below)	
bootfile	The name of the bootfile
dhcp-server-router	The address of the DHCP server router
dns-server	The address of the dns server
domain-name	The name of the domain
lease	The identifier for the lease
netbios-name server	The address of the netbios name server
network	The address of the network
next-bootstrap-server	The address of the next-bootstrap server
tftp-server	The address of the TFTP server

Displaying lease-binding information in flash memory

The **show ip dhcp-server flash** command displays the lease-binding database that is stored in flash memory.

```
device# show ip dhcp-server flash

device# show ip dhcp-server flash
Address Pool Binding:
      IP Address     Client-ID/
      Hardware address          Lease expiration Type
```

IP Configuration

Configuring IP parameters - Layer 2 switches

```
192.168.1.2      0000.005d.a440      0d:0h:18m:59s    Automatic  
192.168.1.3      0000.00e1.26c0      0d:0h:19m:8s    Automatic
```

Syntax: show ip dhcp-server flash

TABLE 15 show ip dhcp-server flash output descriptions

Field	Description
IP address	The IP address of the flash memory lease-binding database
Client-ID/Hardware address	The address of the client
Lease expiration	The time when the lease will expire
Type	The type of lease

Displaying summary DHCP server information

The **show ip dhcp-server summary** command displays information about active leases, deployed address-pools, undeployed address-pools, and server uptime.

```
device# show ip dhcp-server summary  
  
DHCP Server Summary:  
          Total number of active leases:  2  
          Total number of deployed address-pools: 1  
          Total number of undeployed address-pools: 0  
          Server uptime: 0d:0h:8m:27s
```

Syntax: show ip dhcp-server summary

TABLE 16 show ip dhcp-server summary output descriptions

Field	Description
Total number of active leases	Indicates the number of leases that are currently active
Total number of deployed address-pools	The number of address pools currently in use.
Total number of undeployed address-pools	The number of address-pools being held in reserve.
Server uptime	The amount of time that the server has been active.

Configuring IP parameters - Layer 2 switches

The following sections describe how to configure IP parameters on a Ruckus Layer 2 switch.

Configuring the management IP address and specifying the default gateway

To manage a Layer 2 switch using Telnet or Secure Shell (SSH) CLI connections or the Web Management Interface, you must configure an IP address for the Layer 2 switch. Optionally, you also can specify the default gateway.

Ruckus devices support both classical IP network masks (Class A, B, and C subnet masks, and so on) and Classless Interdomain Routing (CIDR) network prefix masks:

- To enter a classical network mask, enter the mask in IP address format. For example, enter "10.157.22.99 255.255.255.0" for an IP address with a Class-C subnet mask.

- To enter a prefix network mask, enter a forward slash (/) and the number of bits in the mask immediately after the IP address. For example, enter "10.157.22.99/24" for an IP address that has a network mask with 24 significant bits (ones).

By default, the CLI displays network masks in classical IP address format (example: 255.255.255.0). You can change the display to prefix format.

Assigning an IP address to a Brocade Layer 2 switch

To assign an IP address to a Ruckus Layer 2 switch, enter a command such as the following at the global CONFIG level.

```
device(config)# ip address 10.45.6.110 255.255.255.0
```

Syntax: **ip address** *ip-add rip-mask*

or

Syntax: **ip address** *ip-addr/mask-bits*

You also can enter the IP address and mask in CIDR format, as follows.

```
device(config)# ip address 10.45.6.1/24
```

To specify the Layer 2 switch default gateway, enter a command such as the following.

```
device(config)# ip default-gateway 10.45.6.1
```

Syntax: **ip default-gateway** *ip-addr*

NOTE

When configuring an IP address on a Layer 2 switch that has multiple VLANs, make sure the configuration includes a designated management VLAN that identifies the VLAN to which the global IP address belongs. Refer to "Designated VLAN for Telnet management sessions to a Layer 2 Switch" in the *FastIron Ethernet Switch Security Configuration Guide*.

Configuring Domain Name System resolver

The Domain Name System (DNS) resolver feature lets you use a host name to perform Telnet, ping, and traceroute commands. You can also define a DNS domain on a Ruckus Layer 2 switch or Layer 3 switch and thereby recognize all hosts within that domain. After you define a domain name, the Ruckus Layer 2 switch or Layer 3 switch automatically appends the appropriate domain to the host and forwards it to the domain name server.

For example, if the domain "newyork.com" is defined on a Ruckus Layer 2 switch or Layer 3 switch and you want to initiate a ping to host "NYC01" on that domain, you need to reference only the host name in the command instead of the host name and its domain name. For example, you could enter either of the following commands to initiate the ping.

```
device# ping nyc01
device# ping nyc01.newyork.com
```

Defining a DNS entry

You can define up to four DNS servers for each DNS entry. The first entry serves as the primary default address. If a query to the primary address fails to be resolved after three attempts, the next gateway address is queried (also up to three times). This process continues for each defined gateway address until the query is resolved. The order in which the default gateway addresses are polled is the same as the order in which you enter them.

To define four possible default DNS gateway addresses, enter command such as the following:

```
device(config)# ip dns server-address 10.157.22.199 10.96.7.15 10.95.7.25 10.98.7.15
```

IP Configuration

Configuring IP parameters - Layer 2 switches

Syntax: **ip dns server-address ip-addr [ip-addr] [ip-addr] [ip-addr]**

In this example, the first IP address in the **ip dns server-address** command becomes the primary gateway address and all others are secondary addresses. Because IP address 10.98.7.15 is the last address listed, it is also the last address consulted to resolve a query.

Using a DNS name to initiate a trace route

Suppose you want to trace the route from a Ruckus Layer 2 switch to a remote server identified as NYC02 on domain newyork.com. Because the newyork.com domain is already defined on the Layer 2 switch, you need to enter only the host name, NYC02, as noted in the following command.

```
device# traceroute nyc02
```

Syntax: **traceroute host-ip-addr [maxttl value] [minttl value] [numeric] [timeout value] [source-ip ip-addr]**

The only required parameter is the IP address of the host at the other end of the route.

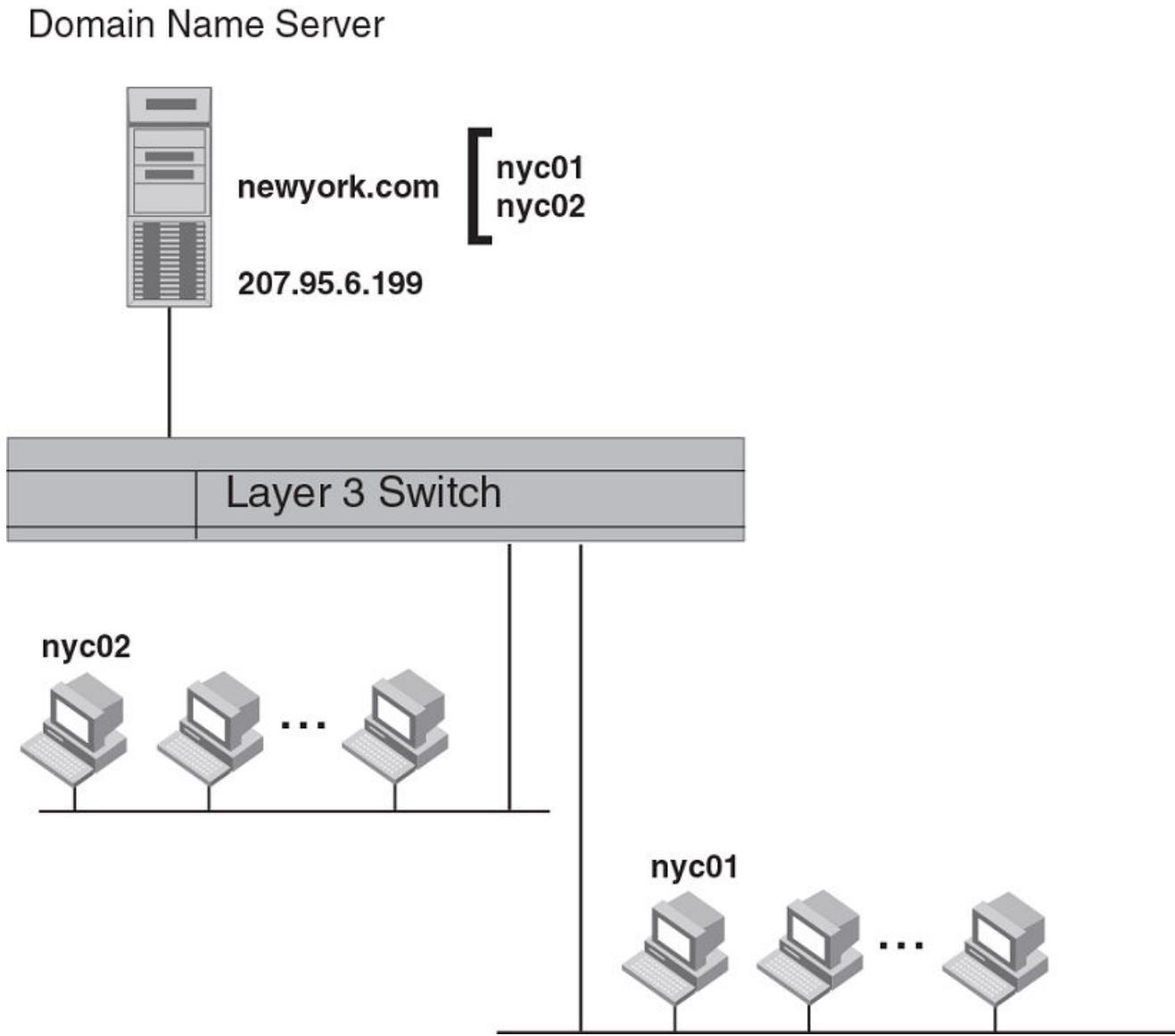
After you enter the command, a message indicating that the DNS query is in process and the current gateway address (IP address of the domain name server) being queried appear on the screen.

```
Type Control-c to abort
Sending DNS Query to 10.157.22.199
Tracing Route to IP node 10.157.22.80
To ABORT Trace Route, Please use stop-traceroute command.
Traced route to target IP node 10.157.22.80:
 IP Address          Round Trip Time1      Round Trip Time2
 10.95.6.30          93 msec                  121 msec
```

NOTE

In the previous example, 10.157.22.199 is the IP address of the domain name server (default DNS gateway address), and 10.157.22.80 represents the IP address of the NYC02 host.

FIGURE 9 Querying a host on the newyork.com domain



Changing the TTL threshold

The time to live (TTL) threshold prevents routing loops by specifying the maximum number of router hops an IP packet originated by the Layer 2 switch can travel through. Each device capable of forwarding IP that receives the packet decrements (decreases) the packet TTL by one. If a router receives a packet with a TTL of 1 and reduces the TTL to zero, the router drops the packet.

The default TTL is 64. You can change the *ttl-threshold* to a value from 1 through 255.

To modify the TTL threshold to 25, enter the following commands.

```
device(config)# ip ttl 25
device(config)# exit
```

IP Configuration

Configuring IP parameters - Layer 2 switches

Syntax: `ip ttl ttl-threshold`

DHCP Assist configuration

DHCP Assist allows a Ruckus Layer 2 switch to assist a router that is performing multi-netting on its interfaces as part of its DHCP relay function.

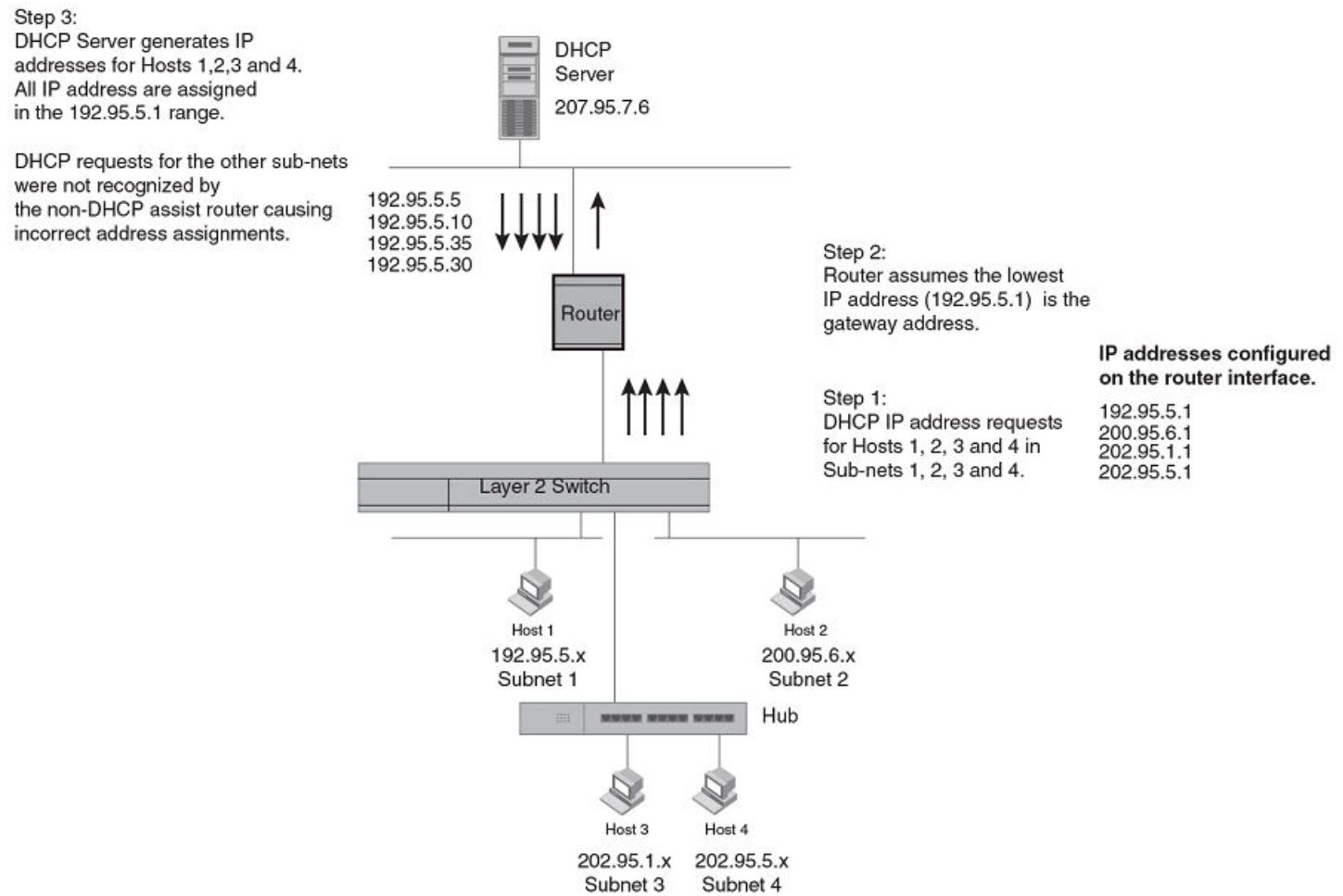
DHCP Assist ensures that a DHCP server that manages multiple IP subnets can readily recognize the requester IP subnet, even when that server is not on the client local LAN segment. The Ruckus Layer 2 switch does so by stamping each request with its IP gateway address in the DHCP discovery packet.

NOTE

Ruckus Layer 2 switches provide BootP/DHCP assistance by default on an individual port basis. Refer to [Changing the IP address used for stamping BootP and DHCP requests](#) on page 83.

By allowing multiple subnet DHCP requests to be sent on the same wire, you can reduce the number of router ports required to support secondary addressing as well as reduce the number of DHCP servers required, by allowing a server to manage multiple subnet address assignments.

FIGURE 10 DHCP requests in a network without DHCP Assist on the Layer 2 switch



In a network operating without DHCP Assist, hosts can be assigned IP addresses from the wrong subnet range because a router with multiple subnets configured on an interface cannot distinguish among DHCP discovery packets received from different subnets.

In the example depicted, a host from each of the four subnets supported on a Layer 2 switch requests an IP address from the DHCP server. These requests are sent transparently to the router. Because the router is unable to determine the origin of each packet by subnet, it assumes the lowest IP address or the "primary address" is the gateway for all ports on the Layer 2 switch and stamps the request with that address.

When the DHCP request is received at the server, it assigns all IP addresses within that range only.

With DHCP Assist enabled on a Ruckus Layer 2 switch, correct assignments are made because the Layer 2 switch provides the stamping service.

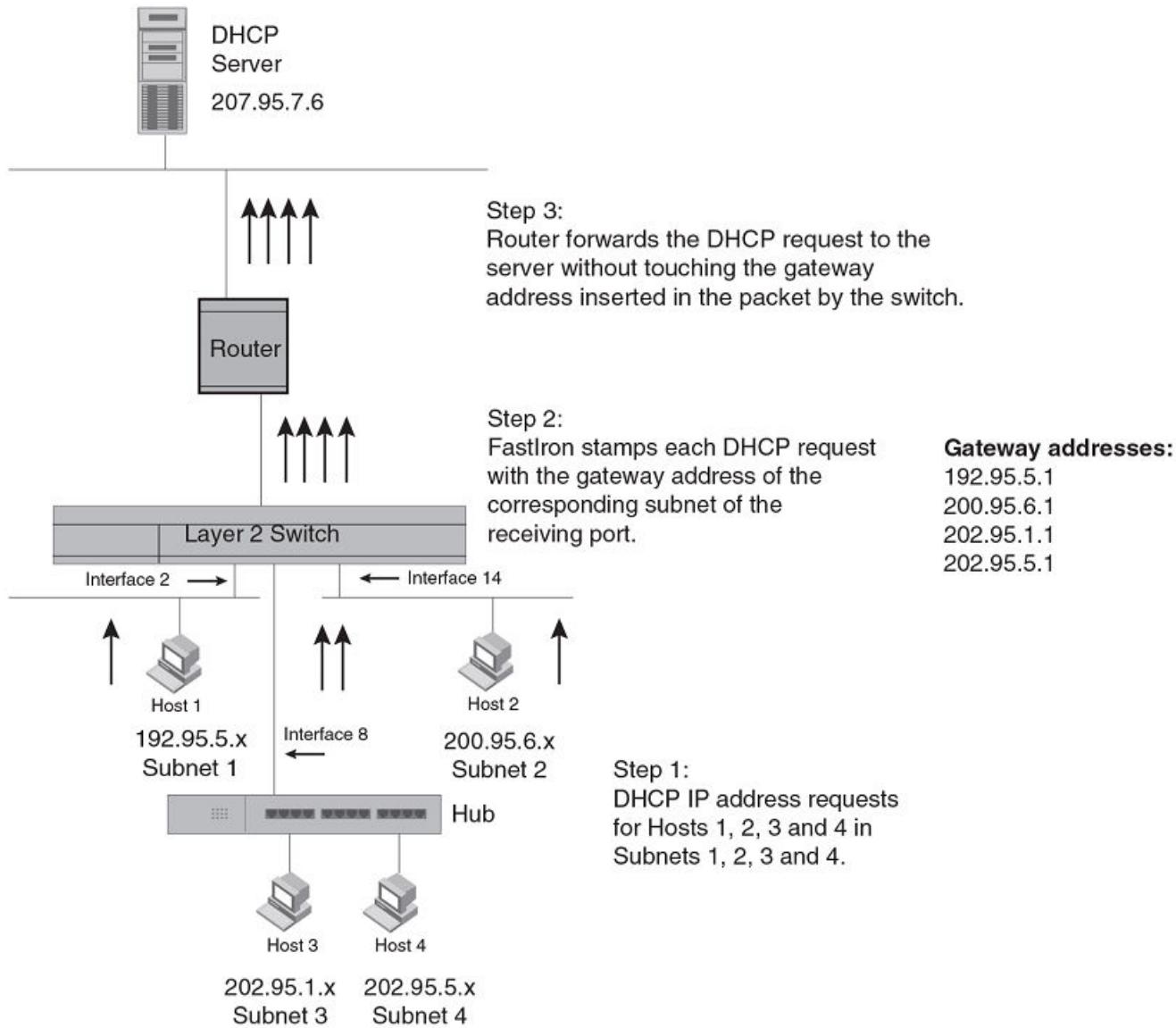
How DHCP Assist works

Upon initiation of a DHCP session, the client sends out a DHCP discovery packet for an address from the DHCP server. When the DHCP discovery packet is received at a Ruckus Layer 2 switch with the DHCP Assist feature enabled, the gateway address configured on the receiving interface is inserted into the packet. This address insertion is also referred to as stamping.

IP Configuration

Configuring IP parameters - Layer 2 switches

FIGURE 11 DHCP requests in a network with DHCP Assist operating on a FastIron switch



When the stamped DHCP discovery packet is then received at the router, it is forwarded to the DHCP server. The DHCP server then extracts the gateway address from each request and assigns an available IP address within the corresponding IP subnet. The IP address is then forwarded back to the workstation that originated the request.

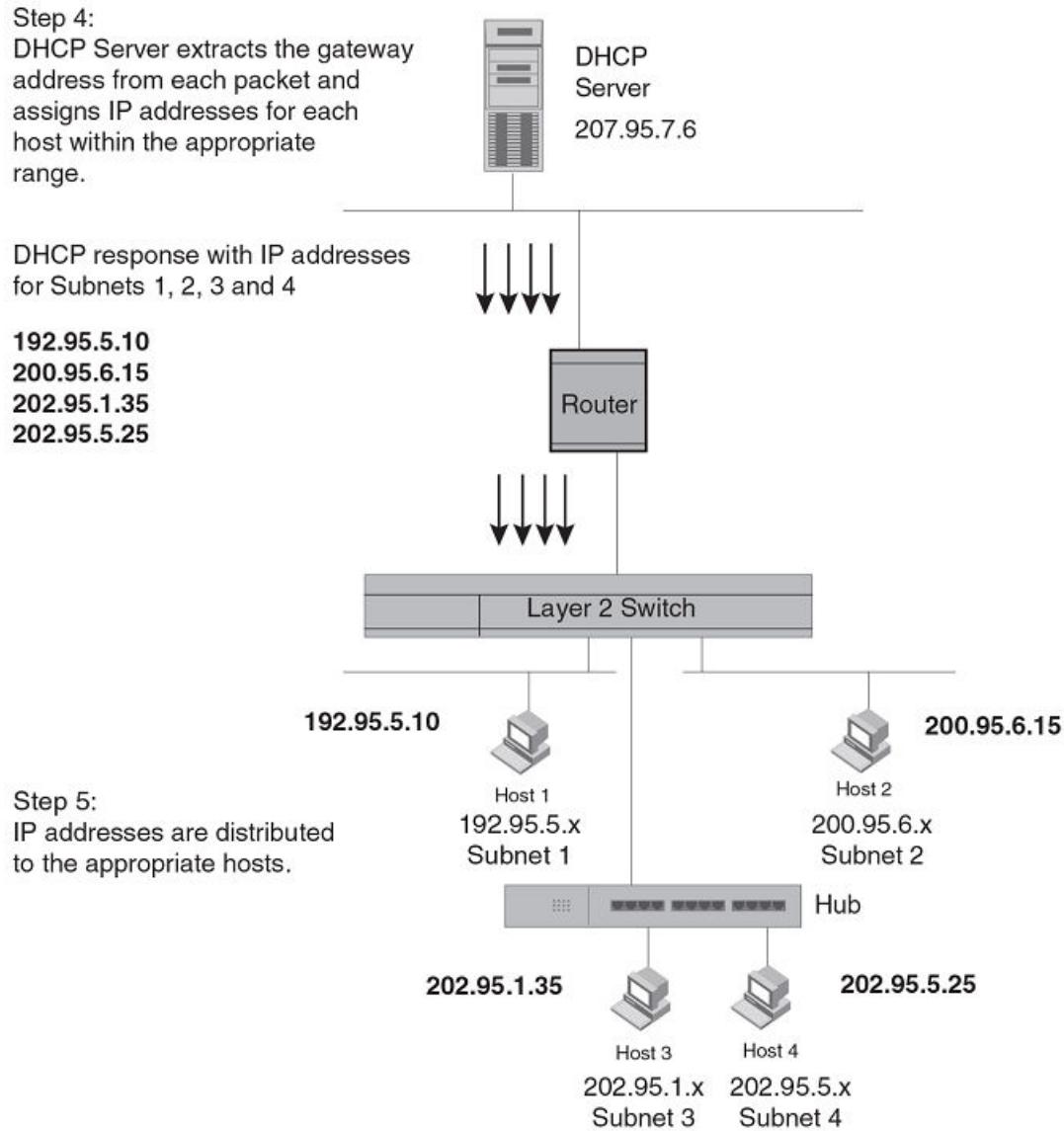
NOTE

When DHCP Assist is enabled on any port, Layer 2 broadcast packets are forwarded by the CPU. Unknown unicast and multicast packets are still forwarded in hardware, although selective packets such as IGMP, are sent to the CPU for analysis. When DHCP Assist is not enabled, Layer 2 broadcast packets are forwarded in hardware.

NOTE

The DHCP relay function of the connecting router must be turned on.

FIGURE 12 DHCP offers are forwarded back toward the requestors



NOTE

When DHCP Assist is enabled on any port, Layer 2 broadcast packets are forwarded by the CPU. Unknown unicast and multicast packets are still forwarded in hardware, although selective packets such as IGMP are sent to the CPU for analysis. When DHCP Assist is not enabled, Layer 2 broadcast packets are forwarded in hardware.

Configuring DHCP Assist

You can associate a gateway list with a port. You must configure a gateway list when DHCP Assist is enabled on a Ruckus Layer 2 switch. The gateway list contains a gateway address for each subnet that will be requesting addresses from a DHCP server. The list allows the stamping process to occur. Each gateway address defined on the Layer 2 switch corresponds to an IP address of the Ruckus router interface or other router involved.

IP Configuration

IPv4 point-to-point GRE tunnels

Up to eight addresses can be defined for each gateway list in support of ports that are multi-homed. When multiple IP addresses are configured for a gateway list, the Layer 2 switch inserts the addresses into the discovery packet in a round robin fashion.

Up to 32 gateway lists can be defined for each Layer 2 switch.

To create the configuration indicated in [How DHCP Assist works](#) on page 101, enter commands such as the following.

```
device(config)# dhcp-gateway-list 1 10.95.5.1
device(config)# dhcp-gateway-list 2 10.95.6.1
device(config)# dhcp-gateway-list 3 10.95.1.1 10.95.5.1
device(config)# interface ethernet 2
device(config-if-e1000-2)# dhcp-gateway-list 1
device(config-if-e1000-2)# interface ethernet 8
device(config-if-e1000-8)# dhcp-gateway-list 3
device(config-if-e1000-8)# interface ethernet 14
device(config-if-e1000-14)# dhcp-gateway-list 2
```

Syntax: `dhcp-gateway-list num ip-addr`

IPv4 point-to-point GRE tunnels

NOTE

This feature is supported on FCX, ICX 6610, ICX 6450, ICX 6650, ICX 7250, ICX 7450, ICX 7750, and FastIron SX devices only.

This section describes support for point-to-point Generic Routing Encapsulation (GRE) tunnels and how to configure them on a Ruckus device.

GRE tunnels support includes the following:

- IPv4 over GRE tunnels. IPv6 over GRE tunnels is not supported.
- Static and dynamic unicast routing over GRE tunnels
- Multicast routing over GRE tunnels
- Hardware forwarding of IP data traffic across a GRE tunnel.
- Path MTU Discovery (PMTUD)

IPv4 GRE tunnel overview

Generic Routing Encapsulation is described in RFC 2784. Generally, GRE provides a way to encapsulate arbitrary packets (payload packet) inside of a transport protocol, and transmit them from one tunnel endpoint to another. The payload is encapsulated in a GRE packet. The resulting GRE packet is then encapsulated in a delivery protocol, then forwarded to the tunnel destination. At the tunnel destination, the packet is decapsulated to reveal the payload. The payload is then forwarded to its final destination.

Ruckus devices allow the tunneling of packets of the following protocols over an IPv4 network using GRE:

- OSPF V2
- BGP4
- RIP V1 and V2

NOTE

This is not supported on ICX 6450 devices.

GRE packet structure and header format

FIGURE 13 GRE encapsulated packet structure

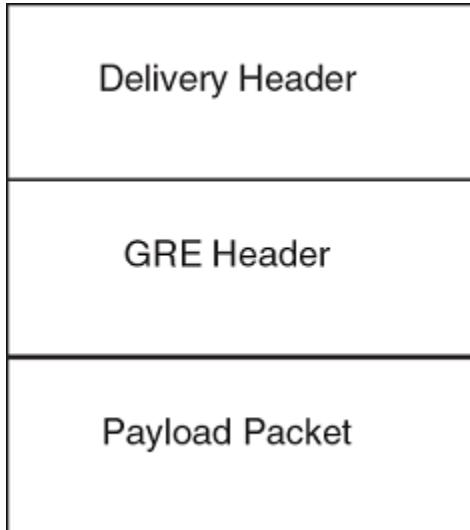


FIGURE 14 GRE header format

Checksum	Reserved0	Ver	Protocol Type	Checksum (optional)	Reserved (optional)
----------	-----------	-----	---------------	---------------------	---------------------

The GRE header has the following fields:

- Checksum - 1 bit. This field is assumed to be zero in this version. If set to 1, this means that the Checksum (**optional**) and Reserved (**optional**) fields are present and the **Checksum (optional)** field contains valid information.
- Reserved0 - 12 bits. If bits 1 - 5 are non-zero, then a receiver must discard the packet unless RFC 1701 is implemented. Bits 6 - 12 are reserved for future use and must be set to zero in transmitted packets. This field is assumed to be zero in this version.
- Ver - 3 bits. The GRE protocol version. This field must be set to zero in this version.
- Protocol Type - 16 bits. The Ethernet protocol type of the packet, as defined in RFC 1700.
- Checksum (optional) - 16 bits. This field is optional. It contains the IP checksum of the GRE header and the payload packet.
- Reserved (optional) - 16 bits. This field is optional. It is reserved for Ruckus internal use.

Path MTU Discovery support

Brocade IronWare software supports the following RFCs for handling large packets over a GRE tunnel:

- RFC 1191, Path MTU Discovery
- RFC 4459, MTU and Fragmentation Issues with In-the-Network Tunneling

IP Configuration

IPv4 point-to-point GRE tunnels

RFC 1191 describes a method for dynamically discovering the maximum transmission unit (MTU) of an arbitrary internet path. When a FastIron device receives an IP packet that has its Do not Fragment (DF) bit set, and the packet size is greater than the MTU value of the outbound interface, then the FastIron device returns an ICMP Destination Unreachable message to the source of the packet, with the code indicating "fragmentation needed and DF set". The ICMP Destination Unreachable message includes the MTU of the outbound interface. The source host can use this information to help determine the minimum MTU of a path to a destination.

RFC 4459 describes solutions for issues with large packets over a tunnel. The following methods, from RFC 4459, are supported in Ruckus IronWare software:

- If a source attempts to send packets that are larger than the lowest MTU value along the path, Path MTU Discovery (PMTUD) can signal to the source to send smaller packets. This method is described in Section 3.2 of RFC 4459.
- Inner packets can be fragmented before encapsulation, in such a manner that the encapsulated packet fits in the tunnel path MTU, which is discovered using PMTUD. This method is described in Section 3.4 of RFC 4459.

By default, PMTUD is enabled.

Configuration considerations for PMTUD support

Consider the following when configuring PMTUD support.

- On FCX devices, only eight different MTU values can be configured over the whole system. When the SX-FI48GPP module is installed in the FastIron SX device, the maximum number of different MTU values that can be configured is 16.
- On both FCX devices, and the SX-FI-24GPP, SX-FI48GPP, SX-FI-24HF, SX-FI-2XG, and SX-FI-8XG modules, PMTUD will not be enabled on the device if the maximum number of MTU values has already been configured in the system.
 - When a new PMTUD value is discovered, and the maximum number of different MTU values for the system is already configured, the new value will search for the nearest, but smallest MTU value relative to its own value in the system. For example, in a FCX system, the new PMTUD value is 800, and the eight different MTU values configured in the system are 600, 700, 820, 1000, 1100, 1200, 1300, and 1500. The range of MTU values that can be configured is from 576 through 1500. The new PMTUD value 800 cannot be added to the system so the nearest, but smallest MTU value is used. In this example, the MTU value of 700 is considered as the nearest MTU value already configured in the system.
 - When the new PMTUD value is smaller than all of the eight MTU values configured in the system, the PMTUD feature is disabled for the tunnel, and the value is not added to the system. For example, the new PMTUD value is 620 which is smaller in value than all of the eight, different MTU path values configured in the system. The following warning message is displayed on the CLI:

```
Warning - All MTU profiles used, disabling PMTU for tunnel
tunnel_id
; new PMTU was
new pmtu discovered
```

Tunnel loopback ports for GRE tunnels

For SX-FI624C, SX-FI624P, SX-FI624HF, and SX-FI62XG modules a physical tunnel loopback port is required for routing a decapsulated packet. When a GRE-encapsulated packet is received on a tunnel interface, and the packet needs to be decapsulated, the packet is decapsulated and sent to the tunnel loopback port. The packet is then looped back and forwarded based on the payload packets.

If a tunnel loopback port is not configured, tunnel termination is performed by the CPU. Each GRE tunnel interface can have one assigned tunnel loopback port and the same tunnel loopback port can be used for multiple tunnels.

Tunnel loopback ports for GRE tunnels are supported on:

- Untagged ports
- Ports that are enabled by default
- 10 Gbps and 1 Gbps copper and fiber ports

Note the following hardware limitations for these port types:

- On 10 Gbps ports, the port LEDs will be ON (green) when the ports are configured as tunnel loopback ports for GRE tunnels. Also, the LEDs will blink when data packets are forwarded.
- On 1 Gbps fiber and copper ports, port LEDs will not be ON when the ports are configured as tunnel loopback ports for GRE tunnels, nor will the LEDs blink when data packets are forwarded.

Tunnel loopback ports for GRE tunnels are *not* applicable on:

- Tagged ports
- Trunk ports
- Ports that are members of a VE
- Ports that are disabled
- Ports that have an IP address
- Flow control
- The SX-FI48GPP module

Support for IPv4 multicast routing over GRE tunnels

PIM-DM and PIM-SM Layer 3 multicast protocols and multicast data traffic are supported over GRE tunnels. When a multicast protocol is enabled on both ends of a GRE tunnel, multicast packets can be sent from one tunnel endpoint to another. To accomplish this, the packets are encapsulated using the GRE unicast tunneling mechanism and forwarded like any other IPv4 unicast packet to the destination endpoint of the tunnel. The router that terminates the tunnel (i.e., the router where the tunnel endpoint is an ingress interface) de-encapsulates the GRE tunneled packet to retrieve the native multicast data packets. After de-encapsulation, data packets are forwarded in the direction of its receivers, and control packets may be consumed. This creates a PIM-enabled virtual or logical link between the two GRE tunnel endpoints.

Strict RPF check for multicast protocols

IronWare software enforces strict Reverse Path Forwarding (RPF) check rules on an (s,g) entry on a GRE tunnel interface. The (s,g) entry uses the GRE tunnel as an RPF interface. During unicast routing transit, GRE tunnel packets may arrive at different physical interfaces. The strict RPF check limits GRE PIM tunnel interfaces to accept the (s,g) GRE tunnel traffic.

NOTE

For the SX-FI624C, SX-FI624P, SX-FI624HF, and the SX-FI62XG modules loopback ports are required for de-encapsulating the GRE tunneled packet. On these hardware devices, when the GRE-encapsulated multicast packet is received, the unicast GRE mechanism takes care of de-encapsulating the packet. The packet then egresses and re-ingresses the tunnel interface loopback port as the native multicast packet. The hardware RPF check is done, not on the tunnel interface directly, but on the loopback port - the hardware compares this port number with the port number configured in the Multicast table (s,g) entry. If they match, the packet is routed. Otherwise it is sent to the CPU for error processing. In unicast, it is permissible for multiple tunnel interfaces to use a single loopback port. However, in multicast, this will not allow the hardware to determine the tunnel interface that the packet was received on in order to do an RPF check. Therefore, when IPv4 Multicast Routing is enabled on a GRE tunnel, the tunnel interface must have a dedicated loopback port.

GRE support with other features

This section describes how GRE tunnels may affect other features on FSX, FCX, and ICX6610 devices.

Support for ECMP for routes through a GRE tunnel

Equal-Cost Multi-Path (ECMP) load sharing allows for load distribution of traffic among available routes. When GRE is enabled, a mix of GRE tunnels and normal IP routes is supported. If multiple routes are using GRE tunnels to a destination, packets are automatically load-balanced between tunnels, or between tunnels and normal IP routes.

ACL, QoS, and PBR support for traffic through a GRE tunnel

NOTE

PBR and ACL filtering for packets terminating on a GRE tunnel is not supported on FCX devices. However, PBR can be used to map IP traffic into a GRE tunnel, but it cannot be used to route GRE traffic. On FCX devices, QoS support for GRE encapsulated packets is limited to copying DSCP values from the inner header onto the outer header.

For FastIron SX devices only, traffic coming from a tunnel can be filtered by an ACL both before and after the tunnel is terminated and also redirected by PBR after tunnel is terminated. An ACL classifies and sets QoS for GRE traffic. If the ACL or PBR is applied to the tunnel loopback port, it would apply to the inner IP packet header (the payload packet) after the tunnel is terminated. If the ACL is applied to the tunnel ingress port, then the delivery header (outer header) would be classified or filtered before the tunnel is terminated.

NOTE

Restrictions for using ACLs in conjunction with GRE are noted in the section [Configuration considerations for GRE IP tunnels](#) on page 108. PBR can be configured on tunnel loopback ports for tunnel interfaces with no restrictions. PBR with GRE tunnel is not supported on FSX 800 and FSX 1600 with the SX-FI48GPP module.

Syslog messages related to GRE IP tunnels

Syslog messages provide management applications with information related to GRE IP tunnels. The following Syslog message is supported.

```
Tunnel: TUN-RECURSIVE-DOWN tnnl 1, Tnl disabled due to recursive routing
```

Configuration considerations for GRE IP tunnels

Before configuring GRE tunnels and tunnel options, consider the configuration notes in this section.

- When GRE is enabled on a Layer 3 switch, the following features are not supported on Virtual Ethernet (VE) ports, VE member ports (ports that have IP addresses), and GRE tunnel loopback ports:
 - ACL logging
 - ACL statistics (also called ACL counting)
 - MAC address filters
 - IPv6 filters

NOTE

The above features are supported on VLANs that do not have VE ports.

- Whenever multiple IP addresses are configured on a tunnel source, the primary address of the tunnel is always used for forming the tunnel connections. Therefore, carefully check the configurations when configuring the tunnel destination.

- When a GRE tunnel is configured, you cannot configure the same routing protocol on the tunnel through which you learn the route to the tunnel destination. For example, if the FastIron learns the tunnel destination route through the OSPF protocol, you cannot configure the OSPF protocol on the same tunnel and vice-versa. When a tunnel has OSPF configured, the FastIron cannot learn the tunnel destination route through OSPF. This could cause the system to become unstable.
- The tunnel destination cannot be resolved to the tunnel itself or any other local tunnel. This is called recursive routing. This scenario would cause the tunnel interface to flap and the Syslog message TUN-RECURSIVE-DOWN to be logged. To resolve this issue, create a static route for the tunnel destination.

Configuration considerations for tunnel loopback ports

NOTE

The configuration considerations for tunnel loopback ports are only required for Generation 2 modules supported on FSX devices.

NOTE

When a tunnel loopback port is configured, it is automatically added to the default vrf.

Consider the following when configuring tunnel loopback ports for GRE tunnels:

- For multicast traffic over a GRE tunnel, each PIM-enabled tunnel interface must have a dedicated tunnel loopback port.
- For unicast traffic, a tunnel loopback port can be oversubscribed, meaning multiple GRE tunnels (up to the maximum supported) can use the same tunnel loopback port for traffic. When oversubscribed, proper traffic classification on the tunnel loopback port is necessary in order to avoid traffic congestion. In this case, Ruckus recommends that you configure the trust level at the DSCP level for QoS by adding an ACL that maps DSCP 46 to priority 5. Otherwise, loss of loopback packets may flap the tunnel interface.
- By default, when you create a tunnel loopback port for a GRE tunnel on a port that is part of the default VLAN, the port will stay in the default VLAN. Before configuring a port as a tunnel loopback port for a GRE tunnel, if the port is in the default VLAN (VLAN 1), first create a VLAN, then add the port to the VLAN. Otherwise, an error message such as the following will appear on the console when you attempt to configure a router interface for the default VLAN.

ERROR: Router-interface cannot be applied because of GRE loopback port 1/1/2

- Configuration of tunnel loopback ports are not applicable on the SX-FI48GPP interface module.

GRE MTU configuration considerations

When jumbo is enabled, the default Ethernet MTU size is 9216 bytes. The maximum Ethernet MTU size is 10200 bytes for ICX 6610 devices, 10178 bytes for ICX 6450 devices and 10218 bytes for other devices. The MTU of the GRE tunnel is compared with the outgoing packet before the packet is encapsulated. After encapsulation, the packet size increases by 24 bytes. Therefore, when changing the GRE tunnel MTU, set the MTU to at least 24 bytes less than the IP MTU of the outgoing interface. If the MTU is not set to at least 24 bytes less than the IP MTU, the size of the encapsulated packet will exceed the IP MTU of the outgoing interface. This will cause the packet to either be sent to the CPU for fragmentation, or the packet will be dropped if the DF (Do-Not-Fragment) bit is set in the original IP packet, and an ICMP message is sent.

NOTE

The fragmentation behavior depends on the mtu-exceed setting on the router. This feature is not supported on FSX devices.

Configuration tasks for GRE tunnels

Perform the configuration tasks in the order listed.

TABLE 17 Configuration tasks for GRE tunnels

Configuration tasks	Default behavior
Required tasks	
Create a tunnel interface.	Not assigned
Configure the source address or source interface for the tunnel interface.	Not assigned
Configure the destination address of the tunnel interface.	Not assigned
Enable GRE encapsulation on the tunnel interface. NOTE Step 4 must be performed before step 6.	Disabled
If packets need to be terminated in hardware, configure a tunnel loopback port for the tunnel interface. NOTE Step 5 is not applicable to FCX devices.	Not assigned
Configure an IP address for the tunnel interface.	Not assigned
If a route to the tunnel destination does not already exist, create a static route and specify that the route is through the tunnel interface.	Not assigned
Optional tasks	
Change the maximum transmission unit (MTU) value for the tunnel interface.	1476 bytes or 9192 bytes (jumbo mode)
Change the number of GRE tunnels supported on the device.	Support for 32 GRE tunnels
Enable and configure GRE link keepalive on the tunnel interface.	Disabled
Change the Path MTU Discovery (PMTUD) configuration on the GRE tunnel interface.	Enabled
Enable support for IPv4 multicast routing.	Disabled

The following features are also supported on GRE tunnel interfaces:

- Naming the tunnel interface (CLI command **port-name**).
- Changing the Maximum Transmission Unit (MTU) (CLI command **ip mtu**).
- Increasing the cost of routes learned on the port (CLI command **ip metric**).

After configuring GRE tunnels, you can view the GRE configuration and observe the routes that use GRE tunnels.

Creating a tunnel interface

To create a tunnel interface, enter the following command at the Global CONFIG level of the CLI.

```
device(config)# interface tunnel 1
device(config-tunif-1) #
```

Syntax: [no] interface tunnel *tunnel-number*

The *tunnel-number* is a numerical value that identifies the tunnel being configured.

NOTE

You can also use the **port-name** command to name the tunnel. To do so, follow the configuration instructions in "Assigning a port name" section in the *FastIron Ethernet Switch Administration Guide*.

Assigning a VRF routing instance to a GRE tunnel interface

A GRE tunnel interface can be assigned to an existing user defined VRF. When the VRF is configured on a tunnel, all IPv4 and IPv6 addresses are removed. The tunnel loopback configuration is removed.

To assign the VRF named VRF1 to tunnel 1, enter the following commands.

```
Brocade(config) # interface tunnel 1
Brocade(config-tnif-1) # vrf forwarding VRF1
```

Syntax: [no] **vrf forwarding** *vrf-name*

The *vrf-name* variable is the name of the VRF that the interface is being assigned to.

Configuring the source address or source interface for a tunnel interface

To configure the source for a tunnel interface, specify either a source address or a source interface.

NOTE

If the destination address for a tunnel interface is not resolved, Ruckus recommends that you either configure the *source interface* (instead of the *source address*) as the source for a tunnel interface, or enable GRE link keepalive on the tunnel interface.

The tunnel source address should be one of the router IP addresses configured on a physical, loopback, or VE interface, through which the other end of the tunnel is reachable.

To configure the source address for a specific tunnel interface, enter commands such as the following.

```
device(config) # interface tunnel 1
device(config-tnif-1) # tunnel source 10.0.8.108
```

The source interface should be the port number of the interface configured on a physical, loopback, or VE interface. The source interface should have at least one IP address configured on it. Otherwise, the interface will not be added to the tunnel configuration and an error message similar to the following will be displayed:

```
ERROR - Tunnel source interface 1/3/1 has no configured IP address.
```

To configure the source interface for a specific tunnel interface, enter commands such as the following.

```
device(config) # interface tunnel 1
device(config-tnif-1) # tunnel source ethernet 1/3/1
```

Syntax: [no] **tunnel source** { *ip-address* | **ethernet unit / slot / port** | **ve number** | **loopback number** }

The *ip-address* variable is the source IP address being configured for the specified tunnel.

The **ethernet unit / slot / port** parameter identifies a physical interface being configured for the specified tunnel, for example 1/3/1.

The *ve number* variable is the VE interface number being configured for the specified tunnel.

IP Configuration

IPv4 point-to-point GRE tunnels

Deleting an IP address from an interface configured as a tunnel source

To delete an IP address from an interface that is configured as a tunnel source, first remove the tunnel source from the tunnel interface then delete the IP address, as shown in the following example.

```
device(config-if-e1000-1/1/3)# interface tunnel 8
device(config-tnif-8)# no tunnel source 10.1.83.15
device(config-tnif-8)# interface ethernet 1/1/3
device(config-if-e1000-1/1/3)# no ip address 10.1.83.15/24
```

If you attempt to delete an IP address without first removing the tunnel source, the console will display an error message, as shown in the following example.

```
device# config terminal
device(config)# interface ethernet 1/1/3
device(config-if-e1000-1/1/3)# no ip address 10.1.83.15/24
Error - Please remove tunnel source from tnnl 8 before removing IP address
```

NOTE

The previous error message will also display on the CLI when an interface is part of a VLAN. A VLAN cannot be deleted until the tunnel source is first removed.

Configuring the destination address for a tunnel interface

The destination address should be the address of the IP interface of the device on the other end of the tunnel.

To configure the destination address for a specific tunnel interface, enter commands such as the following.

```
device(config)# interface tunnel 1
device(config-tnif-1)# tunnel destination 131.108.5.2
```

Syntax: [no] tunnel destination *ip-address*

The *ip-address* variable is the destination IP address being configured for the specified tunnel.

NOTE

Ensure a route to the tunnel destination exists on the tunnel source device. Create a static route if necessary.

Enabling GRE encapsulation on a tunnel interface

To enable GRE encapsulation on a tunnel interface, enter commands such as the following.

```
device(config)# interface tunnel 1
device(config-tnif-1)# tunnel mode gre ip
```

Syntax: [no] tunnel mode gre *ip*

- **gre** specifies that the tunnel will use GRE encapsulation (IP protocol 47).
- **ip** specifies that the tunneling protocol is IPv4.

NOTE

Before configuring a new GRE tunnel, the system should have at least one slot available for adding the default tunnel MTU value to the system tables. Depending on the configuration, the default tunnel MTU range is ((1500 or 10218) - 24). To check for slot availability, or to see if the MTU value is already configured in the IP table, use the **show ip mtu** command.

Configuring a tunnel loopback port for a tunnel interface

NOTE

Configuring a tunnel loopback port for a tunnel interface is not applicable on ICX6610, FCX devices, and SX-FI-24GPP, SX-FI48GPP, SX-FI-24HF, SX-FI-2XG, and SX-FI-8XG modules.

For details and important configuration considerations regarding tunnel loopback ports for GRE tunnels, refer to [Tunnel loopback ports for GRE tunnels](#) on page 106 and [Configuration considerations for tunnel loopback ports](#) on page 109.

To configure a tunnel loopback port, enter commands such as the following:

```
device(config)# interface tunnel 1
device(config-tnif-1)# tunnel loopback 1/3/1
```

Syntax: [no] **tunnel loopback** *unit / slot / port*

The *unit / slot / port* parameter identifies the tunnel loopback port for the specified tunnel interface, for example 1/3/1.

Applying an ACL or PBR to a tunnel interface on a FastIron X Series module

To apply an ACL or PBR policy to a tunnel interface on a FastIron X Series module other than the SX-FI48GPP (48-port 10/100/1000 Mbps Ethernet POE interface module), enter commands such as the following:

Applying a PBR policy to a tunnel interface

```
device(config)# interface tunnel 1
device(config-tnif-1)# tunnel mode gre ip
device(config-tnif-1)# tunnel loopback 3
device(config-tnif-1)# interface ethernet 3
device(config-if-e1000-3)# ip policy route-map test-route
```

Applying an ACL policy to a tunnel interface

```
device(config)# interface tunnel 1
device(config-tnif-1)# tunnel mode gre ip
device(config-tnif-1)# tunnel loopback 3
device(config-tnif-1)# interface ethernet 3
device(config-if-e1000-3)# ip access-group 10 in
```

Applying an ACL or PBR to a tunnel interface on the SX-FI48GPP interface module

To apply an ACL or PBR policy to a tunnel interface on the SX-FI48GPP interface module, enter commands such as the following:

NOTE

Configuration of tunnel loopback ports are not applicable on the SX-FI48GPP interface module.

Applying a PBR policy to a tunnel interface

```
device(config)# interface tunnel 1
device(config-tnif-1)# tunnel mode gre ip
device(config-tnif-1)# ip policy route-map test-route
```

Applying an ACL policy to a tunnel interface

```
device(config)# interface tunnel 1
device(config-tnif-1)# tunnel mode gre ip
device(config-tnif-1)# ip access-group 10 in
```

IP Configuration

IPv4 point-to-point GRE tunnels

Configuring an IP address for a tunnel interface

An IP address sets a tunnel interface as an IP port and allows the configuration of Layer 3 protocols, such as OSPF, BGP, and Multicast (PIM-DM and PIM-SM) on the port. Note that the subnet cannot overlap other subnets configured on other routing interfaces, and both ends of the tunnel should be in the same subnet.

To configure an IP address for a specified tunnel interface, enter commands such as the following.

```
device(config)# interface tunnel 1  
device(config-tunif-1)# ip address 10.10.3.1/24
```

Syntax: [no] ip address *ip-address*

The *ip-address* is the IP address being configured for the specified tunnel interface.

Configuring a static route to a tunnel destination

If a route to the tunnel destination does not already exist on the tunnel source, create a static route and set the route to go through the tunnel interface.

```
device(config)# ip route 131.108.5.0/24 10.0.8.1  
device(config)# ip route 10.10.2.0/24 tunnel 1
```

Syntax: [no] ip route *ip-address* tunnel *tunnel-ID*

- The *ip-address* variable is the IP address of the tunnel interface.
- The *tunnel-ID* variable is a valid tunnel number or name.

Changing the MTU value for a tunnel interface

For important configuration considerations regarding this feature, refer to [GRE MTU configuration considerations](#) on page 109.

You can set an MTU value for packets entering the tunnel. Packets that exceed either the default MTU value of 1476/9192 bytes (for jumbo case) or the value that you set using this command, are fragmented and encapsulated with IP/GRE headers for transit through the tunnel (if they do not have the DF bit set in the IP header). All fragments will carry the same DF bit as the incoming packet. Jumbo packets are supported, although they may be fragmented based on the configured MTU value.

NOTE

For the SX-FI8GMR6, SX-FI2XGMR6, SX-FI624HF, SX-FI624C, SX-FI624P, and the SX-FI62XG modules, all fragments will carry the same DF bit as the incoming packet. For the SX-FI-24GPP, SX-FI48GPP, SX-FI-24HF, SX-FI-2XG, and SX-FI-8XG modules and the FCX modules, the DF bit on the outer IP header after encapsulation will be set if the PMTU is enabled. If PMTU is disabled, the DF bit will be unset irrespective of the DF bit of the incoming packet.

The following command allows you to change the MTU value for packets transiting "tunnel 1":

```
device(config)# interface tunnel 1  
device(config-tunif-1)# ip mtu 1200
```

Syntax: ip mtu *packet-size*

The *packet-size* variable specifies the maximum size in bytes for the packets transiting the tunnel. Enter a value from 576 through 1476. The default value is 1476.

NOTE

To prevent packet loss after the 24 byte GRE header is added, make sure that any physical interface that is carrying GRE tunnel traffic has an IP MTU setting at least 24 bytes greater than the tunnel MTU setting. This configuration is only allowed on the system if the tunnel mode is set to GRE.

Changing the maximum number of tunnels supported

By default, FastIron X Series IPv6 devices support up to 32 GRE tunnels. You can configure the device to support 16 - 64 GRE tunnels. To change the maximum number of tunnels supported, enter commands such as the following.

```
device(config)# system-max gre-tunnels 16
Reload required. Please write memory and then reload or power cycle.
device(config)# write memory
device(config)# exit
device# reload
```

NOTE

You must save the configuration (write memory) and reload the software to place the change into effect.

Syntax: **system-max gre-tunnels** *number*

The *number* variable specifies the number of GRE tunnels that can be supported on the device. The permissible range is 16 - 64. The **system-max gre-tunnels** command determines the interface range that is supported for an interface tunnel. For example, if the system-max value is reduced, it is possible that the configured interfaces may be rejected after a system reload.

Configuring GRE link keepalive

When GRE tunnels are used in combination with static routing or policy-based routing, and a dynamic routing protocol such as RIP, BGP, or OSPF is not deployed over the GRE tunnel, a configured tunnel does not have the ability to bring down the line protocol of either tunnel endpoint, if the far end becomes unreachable. Traffic sent on the tunnel cannot follow alternate paths because the tunnel is always UP. To avoid this scenario, enable GRE link keepalive, which will maintain or place the tunnel in an UP or DOWN state based upon the periodic sending of keepalive packets and the monitoring of responses to the packets. If the packets fail to reach the tunnel far end more frequently than the configured number of retries, the tunnel is placed in the DOWN state.

To enable GRE link keepalive, configure it on one end of the tunnel and ensure the other end of the tunnel has GRE enabled.

NOTE

Keepalives are not supported when a tunnel interface is not within the default-VRF.

To configure GRE link keepalive, enter commands such as the following.

```
device(config)# interface tunnel 1
device(config-tunif-1)# keepalive 12 4
```

These commands configure the device to wait for 4 consecutive lost keepalive packets before bringing the tunnel down. There will be a 12 second interval between each packet. Note that when the tunnel comes up, it would immediately (within one second) send the first keepalive packet.

Syntax: **[no] keepalive** *seconds retries*

Use the **no** form of the command to disable the keepalive option.

The *seconds* variable specifies the number of seconds between each initiation of a keepalive message. The range for this interval is 2 - 32767 seconds. The default value is 10 seconds.

The *retries* variable specifies the number of times that a packet is sent before the system places the tunnel in the DOWN state. Possible values are from 1 through 255. The default number of retries is 3.

Use the **show interface tunnel** and **show ip tunnel traffic** commands to view the GRE link keepalive configuration.

Configuring Path MTU Discovery (PMTUD)

PMTUD is enabled by default on tunnel interfaces. This section describes how to disable and re-enable PMTUD on a tunnel interface, change the PMTUD age timer, manually clear the tunnel PMTUD, and view the PMTUD configuration.

NOTE

For the SX-FI8GMR6, SX-FI2XGMR6, SX-FI624HF, SX-FI624C, SX-FI624P, and the SX-FI62XG modules, all fragments will carry the same DF bit as the incoming packet. For the SX-FI-24GPP, SX-FI48GPP, SX-FI-24HF, SX-FI-2XG, and SX-FI-8XG modules and the FCX modules, the DF bit on the outer IP header after encapsulation will be set if the PMTU is enabled. If PMTU is disabled, the DF bit will be unset irrespective of the DF bit of the incoming packet.

Disabling and re-enabling PMTUD

PMTUD is enabled by default. To disable it, enter the following command:

```
device(config-tnif-1) # tunnel path-mtu-discovery disable
```

To re-enable PMTUD after it has been disabled, enter the following command:

```
device(config-tnif-1) # no tunnel path-mtu-discovery disable
```

Syntax: [no] tunnel path-mtu-discovery disable

Changing the age timer for PMTUD

By default, when PMTUD is enabled on a tunnel interface, the path MTU is reset to its original value every 10 minutes. If desired, you can change the reset time (default age timer) to a value of up to 30 minutes. To do so, enter a command such as the following on the GRE tunnel interface.

```
device(config-tnif-1) # tunnel path-mtu-discovery age-timer 20
```

This command configures the device to wait for 20 minutes before resetting the path MTU to its original value.

Syntax:[no] tunnel path-mtu-discovery { age-timer minutes | infinite }

For *minutes*, enter a value from 10 to 30.

Enter **infinite** to disable the timer.

Clearing the PMTUD dynamic value

To reset a dynamically-configured MTU on a tunnel Interface back to the configured value, enter the following command.

```
device(config)# clear ip tunnel pmtud 1
```

Syntax: clear ip tunnel pmtud *tunnel-ID*

The *tunnel-ID* variable is a valid tunnel number or name.

Viewing PMTUD configuration details

Use the **show interface tunnel** command to view the PMTUD configuration and to determine whether PMTUD has reduced the size of the MTU.

Enabling IPv4 multicast routing over a GRE tunnel

This section describes how to enable IPv4 multicast protocols, PIM Sparse (PIM-SM) and PIM Dense (PIM-DM), on a GRE tunnel. Perform the procedures in this section after completing the required tasks in [Enabling IPv4 multicast routing over a GRE tunnel](#).

For an overview of multicast routing support over a GRE tunnel, refer to [Support for IPv4 multicast routing over GRE tunnels](#) on page 107. To view information about multicast protocols and GRE tunnel-specific information, refer to [Displaying multicast protocols and GRE tunneling information](#) on page 121.

NOTE

For the SX-FI624C, SX-FI624P, SX-FI624HF, and the SX-FI62XG modules, each PIM-enabled tunnel interface must have a *dedicated* tunnel loopback port. This differs from GRE tunnels that support unicast traffic only. For unicast traffic, multiple GRE tunnels can use the same tunnel loopback port for traffic.

Enabling PIM-SM on a GRE tunnel

To enable PIM-SM on a GRE tunnel interface, enter commands such as the following:

```
device(config)# interface tunnel 10
device(config-tunif-10)# ip pim-sparse
```

Syntax: [no] ip pim-sparse

Use the **no** form of the command to disable PIM-SM on the tunnel interface.

Enabling PIM-DM on a GRE tunnel interface

To enable PIM-DM on a GRE tunnel interface, enter commands such as the following:

```
device(config)# interface tunnel 10
device(config-tunif-10)# ip pim
```

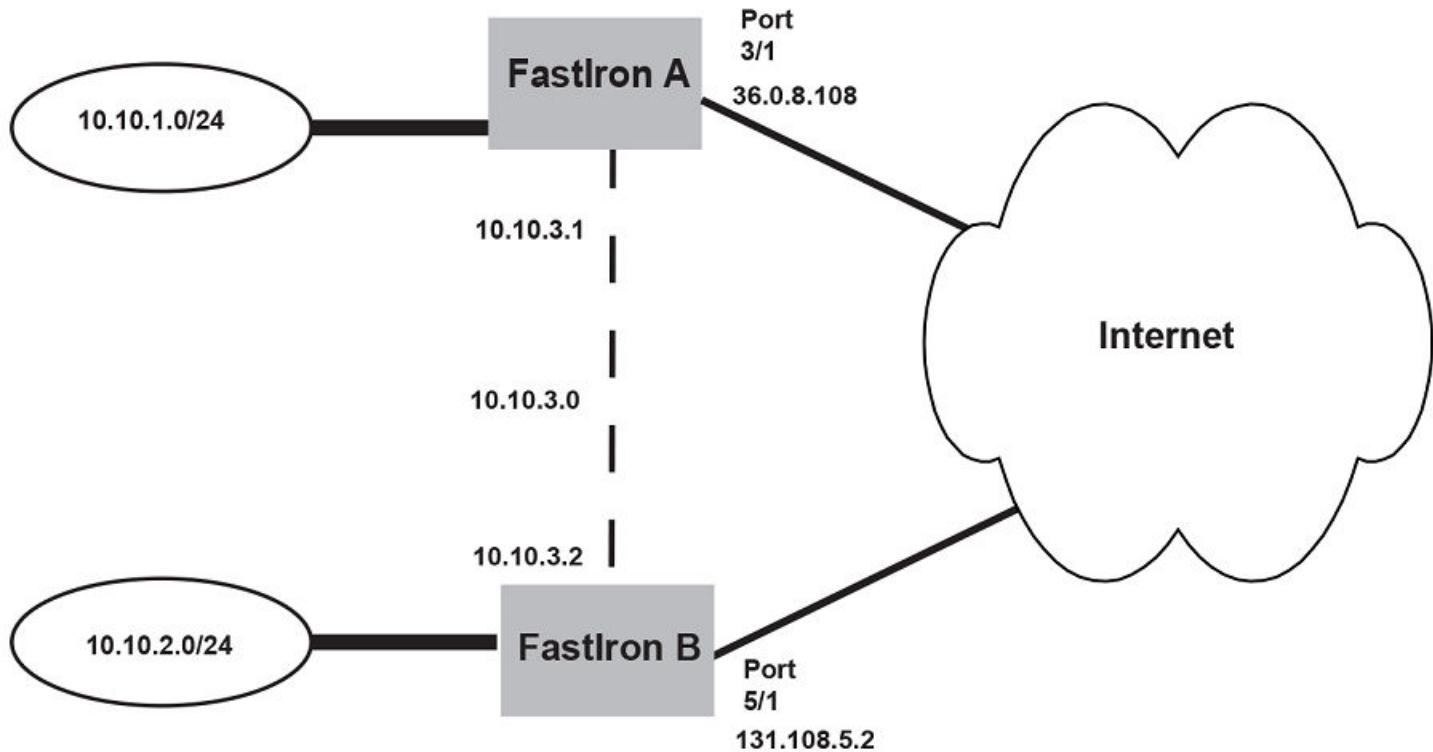
Syntax: [no] ip pim

Use the **no** form of the command to disable PIM-DM on the tunnel interface.

Example point-to-point GRE tunnel configuration

A GRE Tunnel is configured between FastIron A and device B. Traffic between networks 10.10.1.0/24 and 10.10.2.0/24 is encapsulated in a GRE packet sent through the tunnel on the 10.10.3.0 network, and unpacked and sent to the destination network. A static route is configured at each Layer 3 switch to go through the tunnel interface to the target network.

FIGURE 15 Point-to-point GRE tunnel configuration example



The following shows the configuration commands for this example.

NOTE

The configuration examples for FastIron A and FastIron B applies only to FastIron SX devices.

Configuring point-to-point GRE tunnel for FastIron A

```
device (config) # interface ethernet 3/1
device (config-if-e1000-3/1) # ip address 10.0.8.108/24
device (config) # exit
device (config) # interface tunnel 1
device(config-tnif-1) # tunnel source 10.0.8.108
device(config-tnif-1) # tunnel destination 131.108.5.2
device(config-tnif-1) # tunnel mode gre ip
device(config-tnif-1) # tunnel loopback 4/1
device(config-tnif-1) # ip address 10.10.3.1/24
device(config-tnif-1) # exit
device (config) # ip route 131.108.5.0/24 10.0.8.1
device(config) # ip route 10.10.2.0/24 tunnel 1
```

Configuring point-to-point GRE tunnel for FastIron B

```
device(config) # interface ethernet 5/1
device(config-if-e1000-5/1) # ip address 131.108.5.2/24
device(config) # exit
device(config) # interface tunnel 1
device(config-tnif-1) # tunnel source 131.108.5.2
device(config-tnif-1) # tunnel destination 10.0.8.108
device(config-tnif-1) # tunnel mode gre ip
device(config-tnif-1) # tunnel loopback 1/1
```

```
device(config-tnif-1) # ip address 10.10.3.2/24
device(config-tnif-1) # exit
device(config) # ip route 10.0.8.0/24 131.108.5.1
device(config) # ip route 10.10.1.0/24 tunnel
```

Displaying GRE tunneling information

This section describes the **show** commands that display the GRE tunnels configuration, the link status of the GRE tunnels, and the routes that use GRE tunnels.

To display GRE tunneling Information, use the following commands:

- **show ip interface**
- **show ip route**
- **show ip interface tunnel**
- **show ip tunnel traffic**
- **show interface tunnel**
- **show statistics tunnel**

The following shows an example output of the **show ip interface** command, which includes information about GRE tunnels.

Interface	IP-Address	OK?	Method	Status	Protocol
VRF Tunnel 1 red	101.1.1.1	YES	NVRAM	up	up
Tunnel 3 default-vrf	89.1.1.1	YES	NVRAM	up	up

For field definitions, refer to [Displaying IP interface information](#) on page 129.

Syntax: show ip interface

The **show ip route** command displays routes that are pointing to a GRE tunnel as shown in the following example.

B:BGP D:Connected R:RIP S:Static O:OSPF *:Candidate default						
Destination	NetMask	Gateway	Port	Cost	Type	
1 10.1.1.0	255.255.255.0	0.0.0.0		7	1	D
2 10.1.2.0	255.255.255.0	10.1.1.3		7	1	S
3 10.34.3.0	255.255.255.0	0.0.0.0	tn3	1	D	

For field definitions, refer to [Displaying the IP route table](#) on page 134.

Syntax: show ip route

The **show ip interface tunnel** command displays the link status and IP address configuration for an IP tunnel interface as shown in the following example.

```
device# show ip interface tunnel 64
Interface Tunnel 64
  port enabled
  port state: UP
  ip address: 223.224.64.0/31
  Port belongs to VRF: default-vrf
  encapsulation: GRE, mtu: 1476, metric: 1
  directed-broadcast-forwarding: disabled
  proxy-arp: disabled
  ip arp-age: 10 minutes
  No Helper Addresses are configured.
  No inbound ip access-list is set
  No outgoing ip access-list is set
```

IP Configuration

IPv4 point-to-point GRE tunnels

Syntax: show ip interface tunnel [tunnel-ID]

The *tunnel-ID* variable is a valid tunnel number between 1 and 72.

The **show interface tunnel** command displays the GRE tunnel configuration and the pmtd aging timer information.

```
device# show interface tunnel 10
Tunnel10 is up, line protocol is up
  Hardware is Tunnel
    Tunnel source 1.1.41.10
    Tunnel destination is 1.1.14.10
    Tunnel mode gre ip
      Port name is GRE_10_to_VR1_on_FCX_STACK
      Internet address is 223.223.1.1/31, MTU 1476 bytes, encapsulation GRE
      Keepalive is not Enabled
      Path MTU Discovery: Enabled, MTU is 1428 bytes, age-timer: 10 minutes
      Path MTU will expire in 0 minutes 50 secs
```

Syntax: show interface tunnel [tunnel-ID]

TABLE 18 show interface tunnel output descriptions

Field	Definition
Hardware is Tunnel	The interface is a tunnel interface.
Tunnel source	The source address for the tunnel.
Tunnel destination	The destination address for the tunnel.
Tunnel mode	The tunnel mode. The gre specifies that the tunnel will use GRE encapsulation (IP protocol 47).
Port name	The port name (if applicable).
Internet address	The internet address.
MTU	The configured path maximum transmission unit.
encapsulation GRE	GRE encapsulation is enabled on the port.
Keepalive	Indicates whether or not GRE link keepalive is enabled.
Path MTU Discovery	Indicates whether or not PMTUD is enabled. If PMTUD is enabled, the MTU value is also displayed.
Path MTU	The PMTU that is dynamically learned.
Age-timer	Indicates the pmtd aging timer configuration in minutes. The default is 10. The range is from 10 - 30.
Path MTU will expire	Indicates the time after which the learned PMTU expires. This line is displayed only when a PMTU is dynamically learned.

The **show ip tunnel traffic** command displays the link status of the tunnel and the number of keepalive packets received and sent on the tunnel.

```
device# show ip tunnel traffic
IP GRE Tunnels
  Tunnel Status   Packet Received   Packet Sent   KA recv   KA sent
  1  up/up        362                0            362        362
  3  up/up        0                 0            0          0
  10 down/down    0                 0            0          0
```

Syntax: show ip tunnel traffic

The **show statistics tunnel** command displays GRE tunnel statistics for a specific tunnel ID number. The following shows an example output for tunnel ID 1.

```
device(config-tunif-10)#show statistics tunnel 1
IP GRE Tunnels
```

```

Tunnel Status   Packet Received  Packet Sent  KA recv  KA sent
1    up/up        87120          43943      43208     43855

```

RFC 2784 supports GRE tunnel ports. The show statistics tunnel command output now includes information from the hardware counters for each tunnel. For example:

```

IP GRE Tunnel 1 HW Counters:
  InOctets           0          OutOctets         0
  InPkts            0          OutPkts          0

```

NOTE

This CLI enhancement is supported only on FCX devices.

Syntax: show statistics tunnel [*tunnel-ID*]

The *tunnel-ID* variable specifies the tunnel ID number.

TABLE 19 show ip tunnel traffic output descriptions

Field	Description
Tunnel Status	Indicates whether the tunnel is up or down. Possible values are: <ul style="list-style-type: none"> • Up/Up - The tunnel and line protocol are up. • Up/Down - The tunnel is up and the line protocol is down. • Down/Up - The tunnel is down and the line protocol is up. • Down/Down - The tunnel and line protocol are down.
Packet Received	The number of packets received on the tunnel since it was last cleared by the administrator.
Packet Sent	The number of packets sent on the tunnel since it was last cleared by the administrator.
KA recv	The number of keepalive packets received on the tunnel since it was last cleared by the administrator.
KA sent	The number of keepalive packets sent on the tunnel since it was last cleared by the administrator.

Displaying multicast protocols and GRE tunneling information

The following **show** commands display information about multicast protocols and GRE tunnels:

- **show ip pim interface**
- **show ip pim nbr**
- **show ip pim mcache**
- **show ip pim flow**
- **show statistics**
- **show ip mtu**

NOTE

All other **show** commands that are supported currently for Ethernet, VE, and IP loopback interfaces, are also supported for tunnel interfaces. To display information for a tunnel interface, specify the tunnel in the format **tn num**. For example, **show interface tn 1**. In some cases, the Ethernet port that the tunnel is using will be displayed in the format **tnnum:eport**.

IP Configuration

IPv4 point-to-point GRE tunnels

The following shows an example output of the **show ip pim interface** command.

```
device# show ip pim interface
Interface e1
PIM Dense: V2
TTL Threshold: 1, Enabled, DR: itself
Local Address: 10.10.10.10
Interface tn1
PIM Dense: V2
TTL Threshold: 1, Enabled, DR: 10.1.1.20 on tn1:e2
Local Address: 10.1.1.10
Neighbor:
  10.1.1.20
```

Syntax:show ip pim interface

The following shows an example output of the **show ip pim nbr** command.

```
device# show ip pim nbr
Total number of neighbors: 1 on 1 ports
Port   Phy_p      Neighbor      Holdtime Age   UpTime
tn1    tn1:e2    10.1.1.20     180       60    1740
```

Syntax: show ip pim nbr

The following shows an example output of the **show ip pim mcache** command.

```
device# show ip pim mcache 230.1.1.1
1  (10.10.10.1 230.1.1.1) in e1 (e1), cnt=629
  Source is directly connected

L3 (HW) 1: tn1:e2(VL1)
  fast=1 slow=0 pru=1 graft
  age=120s up-time=8m HW=1 L2-vidx=8191 has mll
```

Syntax:show ip pim mcache ip-address

The following shows an example output of the **show ip pim flow** command.

```
device# show ip pim flow 230.1.1.1
Multicast flow (10.10.10.1 230.1.1.1):
  Vidx for source vlan forwarding: 8191 (Blackhole, no L2 clients)
  Hardware MC Entry hit on devices: 0 1 2 3
  MC Entry[0x0c008040]: 00014001 000022ee 0fffc0001 00000000
  --- MLL contents read from Device 0 ---
  MLL Data[0x018c0010]: 0021ff8d 00000083 00000000 00000000
  First : Last:1, outlif:60043ff1 00000000, TNL:1(e2)
1 flow printed
```

Syntax: show ip pim flow

The following shows an example output of the **show statistics** command. The following statistics demonstrate an example where the encapsulated multicast traffic ingresses a tunnel endpoint on port e 2, egresses and re-ingresses as native multicast traffic on the loopback port e 4, and is then forwarded to the outbound interface e 1.

Port	In Packets	Out Packets	In Errors	Out Errors
1	0	1670	0	0
2	1668	7	0	0
3	0	0	0	0
4	1668	1668	0	0

Syntax: show statistics

The **show ip mtu** command can be used to see if there is space available for the ip_default_mtu_24 value in the system, or if the MTU value is already configured in the IP table. The following shows an example output of the **show ip mtu** command.

```
device(config-snif-10)#show ip mtu
idx size usage ref-count
 0 10218    1      default
 1   800    0      1
 2   900    0      1
 3   750    0      1
 4 10194    1      1
 5 10198    0      1
```

Syntax: **show ip mtu**

Clearing GRE statistics

Use the **clear ip tunnel** command to clear statistics related to GRE tunnels.

To clear GRE tunnel statistics, enter a command such as the following.

```
device(config)# clear ip tunnel stat 3
```

To reset a dynamically-configured MTU on a tunnel Interface back to the configured value, enter a command such as the following.

```
device(config)#clear ip tunnel pmtud 3
```

Syntax: **clear ip tunnel { pmtud tunnel-ID | stat tunnel-ID }**

Use the **pmtud** option to reset a dynamically-configured MTU on a tunnel Interface back to the configured value.

Use the **stat** option to clear tunnel statistics.

The *tunnel-ID* variable is a valid tunnel number or name.

Use the **clear statistics tunnel** command to clear GRE tunnel statistics for a specific tunnel ID number. To clear GRE tunnel statistics for tunnel ID 3, enter a command such as the following.

```
device(config)# clear statistics tunnel 3
```

Syntax: **clear statistics tunnel [tunnel-ID]**

The *tunnel-ID* variable specifies the tunnel ID number.

Bandwidth for IP interfaces

The bandwidth for an IP interface can be specified so that higher level protocols, such as OSPFv2 and OSPFv3, can use this setting to influence the routing cost for routes learned on these interfaces.

When the interface bandwidth is configured, the number of network and router link state advertisement generation is reduced during an operation down or a shutdown of one or more of the associated interfaces of the VE interface. For OSPF, when the dynamic cost feature is enabled, the bandwidth for a VE interface is the sum of bandwidth for either all associated ports or all active associated ports. However, when the interface bandwidth is configured on the VE interface itself, the bandwidth of the associated ports are not used in the OSPF cost calculation. This means that even when one of the associated ports of the VE interface goes down, there is no OSPF cost recalculation.

The bandwidth for IP interfaces feature can be configured for a physical interface, Link aggregation (LAG) groups, a VE interface, and a tunnel interface.

IP Configuration

Bandwidth for IP interfaces

The bandwidth for IP interfaces feature can be used to:

- Query the bandwidth for an interface.
- Help OSPF avoid generating numerous LSAs while updating the cost value for a VE interface due to changes in associated physical interfaces.
- Influence the cost on OSPF interfaces for specific tunnels, VE interfaces, and physical interfaces.

The bandwidth for IP interfaces feature enables OSPF to calculate its interface metric cost more precisely, based on the specified interface bandwidth. If the interface bandwidth feature is disabled, OSPF calculates the cost as the reference-bandwidth divided by the fixed port bandwidth, as outlined in the [Changing the reference bandwidth for the cost on OSPF interfaces](#) on page 250 section. When the interface bandwidth feature is enabled, OSPF calculates the cost as the reference-bandwidth divided by the interface bandwidth. For a physical interface, the interface bandwidth is assigned by default to the port speed.

The interface bandwidth feature also enables OSPF to use the configured interface bandwidth for a VE interface to calculate its routing metric, without considering the bandwidth of the associated physical ports. When this feature is enabled, the bandwidth for a VE interface is the interface bandwidth value if it is configured under the VE. Alternatively, it is the sum of the interface bandwidth for all associated ports or all active ports when OSPF dynamic cost is enabled.

The bandwidth of a trunk port for OSPF is, by default, the sum of either all the associated ports or all active associated ports when OSPF dynamic cost is enabled. The interface bandwidth of the primary port is used if the interface bandwidth is configured; otherwise it reverts to the default behavior.

NOTE

If the interface bandwidth configuration of the primary port is different to any of the secondary ports, then the LAG is not deployed. When the LAG is undeployed, the interface bandwidth value for all secondary ports is reset to the port speed.

The configured value is exposed in SNMP via ifSpeed (in ifTable) and ifHighSpeed (in ifXTable) objects.

NOTE

GRE or IPv6 tunnel bandwidth may limit routing protocol traffic propagating through the tunnel. For example, if the tunnel defaults to 8kbps , OSPF uses 50% of the tunnel bandwidth for Hello and update traffic. Therefore, it is good practice to increase the tunnel bandwidth when a routing protocol runs over it to eliminate flapping, and give the routing protocol more capacity to send its update and Hello messages.

From FastIron Release 08.0.30, this feature is supported on all platforms.

Limitations and pre-requisites

- The bandwidth for IP interfaces feature does not support setting and adjusting GRE or IPv6 receiving and transmission bandwidth.
- SNMP does not support any IP interface bandwidth related configurations.

OSPF cost calculation with interface bandwidth

OSPF uses a formula to calculate a path cost when interface bandwidth is available.

If the interface bandwidth feature is disabled, OSPF calculates the cost as the reference-bandwidth divided by the fixed port bandwidth, as outlined in the [Changing the reference bandwidth for the cost on OSPF interfaces](#) on page 250 section. When the interface bandwidth feature is enabled, OSPF calculates the cost as the reference-bandwidth divided by the interface bandwidth.

OSPF uses the following formula to calculate the path cost when interface bandwidth is available:

- OSPF path cost = $((\text{auto-cost} \times \text{reference-bandwidth} + \text{interface bandwidth}) - 1) / \text{interface bandwidth}$.

In the above formula, the cost is calculated in megabits per second (Mbps). The auto-cost is configured using the **auto-cost reference-bandwidth** command in OSPF router configuration mode or OSPFv3 router configuration mode. For more information on changing the OSPF auto-cost reference-bandwidth, refer to the [Changing the reference bandwidth](#) on page 251 section.

Setting the bandwidth value for an Ethernet interface

The current bandwidth value for an Ethernet interface can be set and communicated to higher-level protocols such as OSPF.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **interface ethernet** command to configure an Ethernet interface and enter interface configuration mode.

```
device(config)# interface ethernet 1/1/1
```

3. Enter the **bandwidth** command and specify a value to set the bandwidth value on the interface.

```
device(config-if-e1000-1/1/1)# bandwidth 2000
```

This example sets the bandwidth to 2000 kbps on a specific Ethernet interface.

```
device# configure terminal
device(config)# interface ethernet 1/1/1
device(config-if-e1000-1/1/1)# bandwidth 2000
```

The bandwidth specified in this example results in the following OSPF cost, assuming the auto-cost is 100:

- OSPF cost is equal to $((100 * 1000) + (2000 - 1) / 2000) = 50$

Setting the bandwidth value for a VE interface

The current bandwidth value for a VE interface can be set and communicated to higher-level protocols such as OSPF.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **vlan** command and specify a value to configure a VLAN.

```
device(config)# vlan 10
```

3. Enter the **tagged ethernet** command and specify an interface to add a port that is connected to the device and host in the same port-based VLAN.

```
device(config-vlan-10)# tagged ethernet 1/1/1
```

4. Enter the **router-interface ve** command and specify a value to create a virtual interface as the routing interface for the VLAN.

```
device(config-vlan-10)# router-interface ve 10
```

Creates VE 10 as the routing interface for the VLAN.

IP Configuration

Bandwidth for IP interfaces

5. Enter the **interface ve** command and specify a value.

```
device(config-vlan-10) # interface ve 10
```

Creates a VE interface with the VLAN ID of 10.

6. Enter the **bandwidth** command and specify a value to set the bandwidth value on the interface.

```
device(config-vif-10) # bandwidth 2000
```

This example sets the bandwidth to 2000 kbps on a specific VE interface .

```
device# configure terminal  
device(config)# vlan 10  
device(config-vlan-10) # tagged ethernet 1/1/1  
device(config-vlan-10) # router-interface ve 10  
device(config-vlan-10) # interface ve 10  
device(config-vif-10) # bandwidth 2000
```

The bandwidth specified in this example results in the following OSPF cost, assuming the auto-cost is 100:

- OSPF cost is equal to $((100 * 1000) + (2000 - 1)) / 2000 = 50$

Setting the bandwidth value for a tunnel interface

The current bandwidth value for a tunnel interface can be set and communicated to higher-level protocols such as OSPF.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **interface tunnel** command and specify a value to configure a tunnel interface.

```
device(config) # interface tunnel 2
```

3. Enter the **tunnel mode gre ip** command to enable GRE IP encapsulation on the tunnel interface.

```
device(config-tnif-2) # tunnel mode gre ip
```

4. Enter the **tunnel source** command and specify an IP address to configure the source address for the tunnel interface.

```
device(config-tnif-2) # tunnel source 10.0.0.1
```

5. Enter the **tunnel destination** command and specify an IP address to configure the destination address for the tunnel interface.

```
device(config-tnif-2) # tunnel destination 10.10.0.1
```

6. Enter the **ip address** command and specify an IP address and a network mask to assign an IP address to the tunnel interface.

```
device(config-tnif-2) # ip address 10.0.0.1/24
```

7. Enter the **bandwidth** command and specify a value to set the bandwidth value on the interface.

```
device(config-tnif-2) # bandwidth 2000
```

This example sets the bandwidth to 2000 kbps on a specific tunnel interface .

```
device# configure terminal
device(config)# interface tunnel 2
device(config-tnif-2)# tunnel mode gre ip
device(config-tnif-2)# tunnel source 10.0.0.1
device(config-tnif-2)# tunnel destination 10.10.0.1
device(config-tnif-2)# ip address 10.0.0.1/24
device(config-tnif-2)# bandwidth 2000
```

The bandwidth specified in this example results in the following OSPF interface costs, assuming the auto-cost is 100:

- OSPF Interface Cost for the Trunk Group is equal to $((100 * 1000) + (2000 - 1) \div 2000) = 50$
- OSPF Interface Cost for the GRE/IPv6 tunnel is equal to $((100 * 1000) + (2000 - 1) \div 2000) = 50$

Displaying IP configuration information and statistics

The following sections describe IP display options for Layer 3 switches and Layer 2 switches.

Changing the network mask display to prefix format

By default, the CLI displays network masks in classical IP address format (example: 255.255.255.0). You can change the displays to prefix format (example: /18) on a Layer 3 switch or Layer 2 switch using the following CLI method.

NOTE

This option does not affect how information is displayed in the Web Management Interface.

To enable CIDR format for displaying network masks, entering the following command at the global CONFIG level of the CLI.

```
device(config)# ip show-subnet-length
```

Syntax: [no] ip show-subnet-length

Displaying IP information - Layer 3 switches

You can display the following IP configuration information statistics on Layer 3 switches:

- Global IP parameter settings and IP access policies
- CPU utilization statistics
- IP interfaces
- ARP entries
- Static ARP entries
- IP forwarding cache
- IP route table
- IP traffic statistics

IP Configuration

Displaying IP configuration information and statistics

Displaying global IP configuration information

To display IP configuration information, enter the following command at any CLI level.

```
device# show ip
Global Settings
  ttl: 64, arp-age: 10, bootp-relay-max-hops: 4
  router-id : 10.95.11.128
  enabled : UDP-Broadcast-Forwarding  Source-Route  Load-Sharing  RARP  OSPF  VRRP-Extended  VSRP
  disabled: Route-Only  Directed-Broadcast-Forwarding  BGP4  IRDP  Proxy-ARP  RIP  VRRP  ICMP-Redirect
Static Routes
  Index  IP Address          Subnet Mask        Next Hop Router    Metric Distance
  1      0.0.0.0              0.0.0.0           10.157.23.2       1             1
Policies
  Index  Action   Source      Destination      Protocol   Port   Operator
  1      deny     any        10.157.22.34    10.157.22.26    tcp      http   =
```

Syntax: show ip

NOTE

This command has additional options, which are explained in other sections in this guide, including the sections following this one.

This display shows the following information.

TABLE 20 CLI display of global IP configuration information - Layer 3 switch

Field	Description
Global settings	
ttl	The Time-To-Live (TTL) for IP packets. The TTL specifies the maximum number of router hops a packet can travel before reaching the Ruckus router. If the packet TTL value is higher than the value specified in this field, the Ruckus router drops the packet.
arp-age	The ARP aging period. This parameter specifies how many minutes an inactive ARP entry remains in the ARP cache before the router ages out the entry.
bootp-relay-max-hops	The maximum number of hops away a BootP server can be located from the Ruckus router and still be used by the router clients for network booting.
router-id	The 32-bit number that uniquely identifies the Ruckus router. By default, the router ID is the numerically lowest IP interface configured on the router.
enabled	The IP-related protocols that are enabled on the router.
disabled	The IP-related protocols that are disabled on the router.
Static routes	
Index	The row number of this entry in the IP route table.
IP Address	The IP address of the route destination.
Subnet Mask	The network mask for the IP address.
Next Hop Router	The IP address of the router interface to which the Ruckus router sends packets for the route.
Metric	The cost of the route. Usually, the metric represents the number of hops to the destination.
Distance	The administrative distance of the route. The default administrative distance for static IP routes in Ruckus routers is 1.
Policies	

TABLE 20 CLI display of global IP configuration information - Layer 3 switch (continued)

Field	Description
Index	The policy number. This is the number you assigned the policy when you configured it.
Action	The action the router takes if a packet matches the comparison values in the policy. The action can be one of the following: <ul style="list-style-type: none"> • deny - The router drops packets that match this policy. • permit - The router forwards packets that match this policy.
Source	The source IP address the policy matches.
Destination	The destination IP address the policy matches.
Protocol	The IP protocol the policy matches. The protocol can be one of the following: <ul style="list-style-type: none"> • ICMP • IGMP • IGRP • OSPF • TCP • UDP
Port	The Layer 4 TCP or UDP port the policy checks for in packets. The port can be displayed by its number or, for port types the router recognizes, by the well-known name. For example, TCP port 80 can be displayed as HTTP. <p>NOTE This field applies only if the IP protocol is TCP or UDP.</p>
Operator	The comparison operator for TCP or UDP port names or numbers. <p>NOTE This field applies only if the IP protocol is TCP or UDP.</p>

Displaying IP interface information

To display IP interface information, enter the following command at any CLI level.

```
device# show ip interface
Interface      IP-Address      OK?   Method      Status      Protocol
Ethernet 1/1/1  10.95.6.173    YES   NVRAM      up        up
Ethernet 1/1/2  10.3.3.3      YES   manual     up        up
Loopback 1      10.2.3.4      YES   NVRAM      down     down
```

Syntax: **show ip interface [ethernet unit / slot / port | loopback num | tunnel num | venum]**

This display shows the following information.

TABLE 21 CLI display of interface IP configuration information

Field	Description
Interface	The type and the slot and port number of the interface.
IP-Address	The IP address of the interface.

IP Configuration

Displaying IP configuration information and statistics

TABLE 21 CLI display of interface IP configuration information (continued)

Field	Description
	<p>NOTE If an "s" is listed following the address, this is a secondary address. When the address was configured, the interface already had an IP address in the same subnet, so the software required the "secondary" option before the software could add the interface.</p>
OK?	Whether the IP address has been configured on the interface.
Method	Whether the IP address has been saved in NVRAM. If you have set the IP address for the interface in the CLI or Web Management Interface, but have not saved the configuration, the entry for the interface in the Method field is "manual".
Status	The link status of the interface. If you have disabled the interface with the disable command, the entry in the Status field will be "administratively down". Otherwise, the entry in the Status field will be either "up" or "down".
Protocol	Whether the interface can provide two-way communication. If the IP address is configured, and the link status of the interface is up, the entry in the protocol field will be "up". Otherwise the entry in the protocol field will be "down".

To display detailed IP information for a specific interface, enter a command such as the following.

```
device# show ip interface ve 1
Interface Ve 1
members: ethe 1/1/4 to 1/1/24 ethe 1/1/27 to 1/1/48 ethe 1/2/1 to 1/2/2 ethe 2/1/1 to 2/1/2
ethe 2/1/4 to 2/1/12 ethe 2/1/15 to 2/1/24 ethe 2/2/1 to 2/2/2 ethe 3/1/1 to 3/1/2 ethe 3/1/4 to 3/1/12
ethe 3/1/14 to 3/1/24 ethe 3/2/3 to 3/2/4 ethe 4/1/1 to 4/1/12 ethe 4/1/15 to 4/1/24 ethe 4/2/3 to 4/2/4
ethe 5/1/1 to 5/1/12 ethe 5/1/14 to 5/1/24 ethe 5/2/3
active: ethe 4/2/4
port enabled
port state: UP
ip address: 66.66.66.66      subnet mask: 255.255.255.0
Port belongs to VRF: default-vrf
encapsulation: ETHERNET, mtu: 9216, metric: 1
directed-broadcast-forwarding: disabled
ICMP redirect: enabled
proxy-arp: disabled
ip arp-age: 10 minutes
No Helper Addresses are configured.
No inbound ip access-list is set
No outgoing ip access-list is set
```

Displaying ARP entries

You can display the ARP cache and the static ARP table. The ARP cache contains entries for devices attached to the Layer 3 switch. The static ARP table contains the user-configured ARP entries. An entry in the static ARP table enters the ARP cache when the entry interface comes up.

The tables require separate display commands or Web management options.

Displaying the ARP cache

To display the contents of the ARP cache, enter the following command at any CLI level.

```
Brocade# show arp
Total number of ARP entries: 70
```

```
Entries in default routing instance:
No.   IP Address      MAC Address    Type     Age  Port      Status
1    10.63.61.2       000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
2    10.63.53.2       000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
3    10.63.45.2       000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
4    10.63.37.2       000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
5    10.63.29.2       000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
6    10.63.21.2       000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
7    10.63.13.2       000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
8    10.63.0.1        000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
9    10.63.5.2        000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
10   10.63.62.2       000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
11   10.63.54.2       000c.000c.000c Dynamic  0    1/1/16-1/1/17 Valid
--More--
```

To display the contents of the ARP cache when a VRF is configured, enter the following command at any CLI level.

```
Brocade# show arp vrf one
Total number of ARP entries: 1
Entries in VRF one:
No.   IP Address      MAC Address    Type     Age  Port      Status
1    10.65.0.2        000c.000c.000c Dynamic  1    1/1/16-1/1/17 Valid
```

Syntax: **show arp [ip-addr [ip-mask] | num-entries-to-skip | ethernet unit / slot / port | inspect | mac-address xxxx.xxxx.xxxx [MAC-mask] | management man-port | resource | vrf vrf-name]**

The *ip-addr* and *ip-mask* parameters let you restrict the display to entries for a specific IP address and network mask. Specify the IP address masks in standard decimal mask format (for example, 255.255.0.0).

The **mac-address** xxxx.xxxx.xxxx parameter lets you restrict the display to entries for a specific MAC address.

The *MAC-mask* parameter lets you specify a mask for the **mac-address** xxxx.xxxx.xxxx parameter, to display entries for multiple MAC addresses. Specify the MAC address mask as "f"s and "0"s, where "f"s are significant bits.

NOTE

The *ip-mask* parameter and *mask* parameter perform different operations. The *ip-mask* parameter specifies the network mask for a specific IP address, whereas the *mask* parameter provides a filter for displaying multiple MAC addresses that have specific values in common.

The **vrf** *vrf-name* parameter lets you restrict the display to entries for a specific VRF.

The *num-entries-to-skip* parameter lets you display the table beginning with a specific entry number.

NOTE

The entry numbers in the ARP cache are not related to the entry numbers for static ARP table entries.

This display shows the following information. The number in the left column of the CLI display is the row number of the entry in the ARP cache. This number is not related to the number you assign to static MAC entries in the static ARP table.

TABLE 22 CLI display of ARP cache

Field	Description
Total number of ARP Entries	The number of entries in the ARP cache.
Entries in default routing instance	The total number of ARP entries supported on the device.
Entries in VRF <i>vrf-name</i>	The total number of ARP entries for the specified VRF.
IP Address	The IP address of the device.
MAC Address	The MAC address of the device.
Type	The ARP entry type, which can be one of the following: <ul style="list-style-type: none"> • Dynamic - The Layer 3 switch learned the entry from an incoming packet.

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TABLE 22 CLI display of ARP cache (continued)

Field	Description
	<ul style="list-style-type: none">• Static - The Layer 3 switch loaded the entry from the static ARP table when the device for the entry was connected to the Layer 3 switch.• DHCP - The Layer 3 Switch learned the entry from the DHCP binding address table. <p>NOTE If the type is DHCP, the port number will not be available until the entry gets resolved through ARP.</p>
Age	The number of minutes before which the ARP entry was refreshed. If this value reaches the ARP aging period, the entry is removed from the table. <p>NOTE Static entries do not age out.</p>
Port	The port on which the entry was learned. <p>NOTE If the ARP entry type is DHCP, the port number will not be available until the entry gets resolved through ARP.</p>
Status	The status of the entry, which can be one of the following: <ul style="list-style-type: none">• Valid - This a valid ARP entry.• Pend - The ARP entry is not yet resolved.

Displaying the static ARP table

To display the static ARP table instead of the ARP cache, enter the following command at any CLI level.

```
device# show ip static-arp
Static ARP table size: 512, configurable from 512 to 1024
Index IP Address      MAC Address      Port
  1  10.95.6.111       0000.003b.d210   1/1/1
  3  10.95.6.123       0000.003b.d211   1/1/1
```

This example shows two static entries. Note that because you specify an entry index number when you create the entry, it is possible for the range of index numbers to have gaps, as shown in this example.

NOTE

The entry number you assign to a static ARP entry is not related to the entry numbers in the ARP cache.

Syntax: **show ip static-arp** [*ip-addr* [*ip-mask*] | *num-entries-to-skip* | **ethernet** *unit / slot / port* | **mac-address** *xxxx.xxxx.xxxx* [*MAC-mask*]]

The *ip-addr* and *ip-mask* parameters let you restrict the display to entries for a specific IP address and network mask. Specify the IP address masks in standard decimal mask format (for example, 255.255.0.0).

The **mac-address***xxxx.xxxx.xxxx* parameter lets you restrict the display to entries for a specific MAC address.

The *mask* parameter lets you specify a mask for the **mac-address***xxxx.xxxx.xxxx* parameter, to display entries for multiple MAC addresses. Specify the MAC address mask as "f"s and "0"s, where "f"s are significant bits.

NOTE

The *ip-mask* parameter and *mask* parameter perform different operations. The *ip-mask* parameter specifies the network mask for a specific IP address, whereas the *mask* parameter provides a filter for displaying multiple MAC addresses that have specific values in common.

The *num-entries-to-skip* parameter lets you display the table beginning with a specific entry number.

TABLE 23 CLI display of static ARP table

Field	Description
Static ARP table size	The maximum number of static entries that can be configured on the device using the current memory allocation. The range of valid memory allocations for static ARP entries is listed after the current allocation.
Index	The number of this entry in the table. You specify the entry number when you create the entry.
IP Address	The IP address of the device.
MAC Address	The MAC address of the device.
Port	The port attached to the device the entry is for.

Displaying the forwarding cache

To display the IP forwarding cache, enter the following command at any CLI level.

```
device# show ip cache
Total number of cache entries: 3
D:Dynamic P:Permanent F:Forward U:Us C:Complex Filter
W:Wait ARP I:ICMP Deny K:Drop R:Fragment S:Snap Encap
          IP Address      Next Hop       MAC        Type  Port  Vlan  Pri
 1    192.168.1.11    DIRECT  0000.0000.0000  PU    n/a   0
 2    192.168.1.255   DIRECT  0000.0000.0000  PU    n/a   0
 3    255.255.255.255 DIRECT  0000.0000.0000  PU    n/a   0
```

Syntax: **show ip cache [ip-addr | num]**

The *ip-addr* parameter displays the cache entry for the specified IP address.

The *num* parameter displays the cache beginning with the row following the number you enter. For example, to begin displaying the cache at row 10, enter the following command.

```
device# show ip cache 9
```

The **show ip cache** command displays the following information.

TABLE 24 CLI display of IP forwarding cache - Layer 3 switch

Field	Description
IP Address	The IP address of the destination.
Next Hop	The IP address of the next-hop router to the destination. This field contains either an IP address or the value DIRECT. DIRECT means the destination is either directly attached or the destination is an address on this Ruckus device. For example, the next hop for loopback addresses and broadcast addresses is shown as DIRECT.
MAC	The MAC address of the destination. NOTE If the entry is type U (indicating that the destination is this Ruckus device), the address consists of zeroes.

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TABLE 24 CLI display of IP forwarding cache - Layer 3 switch (continued)

Field	Description
Type	The type of host entry, which can be one or more of the following: <ul style="list-style-type: none"> • D - Dynamic • P - Permanent • F - Forward • U - Us • C - Complex Filter • W - Wait ARP • I - ICMP Deny • K - Drop • R - Fragment • S - Snap Encap
Port	The port through which this device reaches the destination. For destinations that are located on this device, the port number is shown as "n/a".
VLAN	Indicates the VLANs the listed port is in.
Pri	The QoS priority of the port or VLAN.

Displaying the IP route table

To display the IP route table, enter the **show ip route** command at any CLI level.

```
device# show ip route
Total number of IP routes: 514
Start index: 1 B:BGP D:Connected R:RIP S:Static O:OSPF *:Candidate default
Destination NetMask Gateway Port Cost Type
10.1.0.0 255.255.0.0 10.1.1.2 1/1/1 2 R
10.2.0.0 255.255.0.0 10.1.1.2 1/1/1 2 R
10.3.0.0 255.255.0.0 10.1.1.2 1/1/1 2 R
10.4.0.0 255.255.0.0 10.1.1.2 1/1/1 2 R
10.5.0.0 255.255.0.0 10.1.1.2 1/1/1 2 R
10.6.0.0 255.255.0.0 10.1.1.2 1/1/1 2 R
10.7.0.0 255.255.0.0 10.1.1.2 1/1/1 2 R
10.8.0.0 255.255.0.0 10.1.1.2 1/1/1 2 R
10.9.0.0 255.255.0.0 10.1.1.2 1/1/1 2 R
10.10.0.0 255.255.0.0 10.1.1.2 1/1/1 2 S
```

Syntax: **show ip route** [*ip-addr* [*ip-mask*] [**longer**] [**none-bgp**]] {*num* | **bgp** | **direct** | **ospf** | **rip** | **static** }

The *ip-addr* parameter displays the route to the specified IP address.

The *ip-mask* parameter lets you specify a network mask or, if you prefer CIDR format, the number of bits in the network mask. If you use CIDR format, enter a forward slash immediately after the IP address, then enter the number of mask bits (for example: 10.157.22.0/24 for 10.157.22.0 255.255.255.0).

The **longer** parameter applies only when you specify an IP address and mask. This option displays only the routes for the specified IP address and mask. Refer to the following example.

The **none-bgp** parameter displays only the routes that did not come from BGP4.

The *num* option display the route table entry whose row number corresponds to the number you specify. For example, if you want to display the tenth row in the table, enter "10".

The **bgp** option displays the BGP4 routes.

The **direct** option displays only the IP routes that are directly attached to the Layer 3 switch.

The **ospf** option displays the OSPF routes.

The **rip** option displays the RIP routes.

The **static** option displays only the static IP routes.

The **default** routes are displayed first.

Here is an example of how to use the **direct** option. To display only the IP routes that go to devices directly attached to the Layer 3 switch, enter the following command.

```
device# show ip route direct
Start index: 1 B:BGP D:Connected R:RIP S:Static O:OSPF *:Candidate default
Destination NetMask Gateway Port Cost Type
10.157.22.0 255.255.255.0 0.0.0.0 1/4/11 1 D
```

Notice that the route displayed in this example has "D" in the Type field, indicating the route is to a directly connected device.

Here is an example of how to use the **static** option. To display only the static IP routes, enter the following command.

```
device# show ip route static
Start index: 1 B:BGP D:Connected R:RIP S:Static O:OSPF *:Candidate default
Destination NetMask Gateway Port Cost Type
10.144.33.11 255.255.255.0 10.157.22.12 1/1/1 2 S
```

Notice that the route displayed in this example has "S" in the Type field, indicating the route is static.

Here is an example of how to use the **longer** option. To display only the routes for a specified IP address and mask, enter a command such as the following.

```
device# show ip route 10.159.0.0/16 longer
Starting index: 1 B:BGP D:Directly-Connected R:RIP S:Static O:OSPF
Destination NetMask Gateway Port Cost Type
52 10.159.38.0 255.255.255.0 10.95.6.101 1/1/1 1 S
53 10.159.39.0 255.255.255.0 10.95.6.101 1/1/1 1 S
54 10.159.40.0 255.255.255.0 10.95.6.101 1/1/1 1 S
55 10.159.41.0 255.255.255.0 10.95.6.101 1/1/1 1 S
56 10.159.42.0 255.255.255.0 10.95.6.101 1/1/1 1 S
57 10.159.43.0 255.255.255.0 10.95.6.101 1/1/1 1 S
58 10.159.44.0 255.255.255.0 10.95.6.101 1/1/1 1 S
59 10.159.45.0 255.255.255.0 10.95.6.101 1/1/1 1 S
60 10.159.46.0 255.255.255.0 10.95.6.101 1/1/1 1 S
```

This example shows all the routes for networks beginning with 10.159. The mask value and **longer** parameter specify the range of network addresses to be displayed. In this example, all routes within the range 10.159.0.0 - 10.159.255.255 are listed.

The **summary** option displays a summary of the information in the IP route table. The following is an example of the output from this command.

```
device# show ip route summary
IP Routing Table - 35 entries:
 6 connected, 28 static, 0 RIP, 1 OSPF, 0 BGP, 0 ISIS, 0 MPLS
 Number of prefixes:
 /0: 1 /16: 27 /22: 1 /24: 5 /32: 1
```

Syntax: show ip route summary

In this example, the IP route table contains 35 entries. Of these entries, 6 are directly connected devices, 28 are static routes, and 1 route was calculated through OSPF. One of the routes has a zero-bit mask (this is the default route), 27 have a 22-bit mask, 5 have a 24-bit mask, and 1 has a 32-bit mask.

The following table lists the information displayed by the **show ip route** command.

IP Configuration

Displaying IP configuration information and statistics

TABLE 25 CLI display of IP route table

Field	Description
Destination	The destination network of the route.
NetMask	The network mask of the destination address.
Gateway	The next-hop router.
Port	The port through which this router sends packets to reach the route's destination.
Cost	The route's cost.
Type	<p>The route type, which can be one of the following:</p> <ul style="list-style-type: none">• B - The route was learned from BGP.• D - The destination is directly connected to this Layer 3 switch.• R - The route was learned from RIP.• S - The route is a static route.• * - The route and next-hop gateway are resolved through the ip default-network setting.• O - The route is an OSPF route. Unless you use the ospf option to display the route table, "O" is used for all OSPF routes. If you do use the ospf option, the following type codes are used:<ul style="list-style-type: none">• O - OSPF intra area route (within the same area).• IA - The route is an OSPF inter area route (a route that passes from one area into another).• E1 - The route is an OSPF external type 1 route.• E2 - The route is an OSPF external type 2 route.

Clearing IP routes

If needed, you can clear the entire route table or specific individual routes.

To clear all routes from the IP route table, enter the following command.

```
device# clear ip route
```

To clear route 10.157.22.0/24 from the IP routing table, enter the **clear ip route** command.

```
device# clear ip route 10.157.22.0/24
```

Syntax: **clear ip route [ip-addr ip-mask]**

or

Syntax: **clear ip route [ip-addr/mask-bits]**

Displaying IP traffic statistics

To display IP traffic statistics, enter the **show ip traffic** command at any CLI level.

```
device# show ip traffic
IP Statistics
 139 received, 145 sent, 0 forwarded
 0 filtered, 0 fragmented, 0 reassembled, 0 bad header
 0 no route, 0 unknown proto, 0 no buffer, 0 other errors
ICMP Statistics
Received:
 0 total, 0 errors, 0 unreachable, 0 time exceed
```

```

0 parameter, 0 source quench, 0 redirect, 0 echo,
0 echo reply, 0 timestamp, 0 timestamp reply, 0 addr mask
0 addr mask reply, 0 irdp advertisement, 0 irdp solicitation
Sent:
0 total, 0 errors, 0 unreachable, 0 time exceed
0 parameter, 0 source quench, 0 redirect, 0 echo,
0 echo reply, 0 timestamp, 0 timestamp reply, 0 addr mask
0 addr mask reply, 0 irdp advertisement, 0 irdp solicitation
UDP Statistics
1 received, 0 sent, 1 no port, 0 input errors
TCP Statistics
0 active opens, 0 passive opens, 0 failed attempts
0 active resets, 0 passive resets, 0 input errors
138 in segments, 141 out segments, 4 retransmission
RIP Statistics
0 requests sent, 0 requests received
0 responses sent, 0 responses received
0 unrecognized, 0 bad version, 0 bad addr family, 0 bad req format
0 bad metrics, 0 bad resp format, 0 resp not from rip port
0 resp from loopback, 0 packets rejected

```

The **show ip traffic** command displays the following information.

TABLE 26 CLI display of IP traffic statistics - Layer 3 switch

Field	Description
IP statistics	
received	The total number of IP packets received by the device.
sent	The total number of IP packets originated and sent by the device.
forwarded	The total number of IP packets received by the device and forwarded to other devices.
filtered	The total number of IP packets filtered by the device.
fragmented	The total number of IP packets fragmented by this device to accommodate the MTU of this device or of another device.
reassembled	The total number of fragmented IP packets that this device re-assembled.
bad header	The number of IP packets dropped by the device due to a bad packet header.
no route	The number of packets dropped by the device because there was no route.
unknown proto	The number of packets dropped by the device because the value in the Protocol field of the packet header is unrecognized by this device.
no buffer	This information is used by Ruckus customer support.
other errors	The number of packets dropped due to error types other than those listed above.
ICMP statistics	
The ICMP statistics are derived from RFC 792, "Internet Control Message Protocol", RFC 950, "Internet Standard Subnetting Procedure", and RFC 1256, "ICMP Router Discovery Messages". Statistics are organized into Sent and Received. The field descriptions below apply to each.	
total	The total number of ICMP messages sent or received by the device.
errors	This information is used by Ruckus customer support.
unreachable	The number of Destination Unreachable messages sent or received by the device.
time exceed	The number of Time Exceeded messages sent or received by the device.
parameter	The number of Parameter Problem messages sent or received by the device.

IP Configuration

Displaying IP configuration information and statistics

TABLE 26 CLI display of IP traffic statistics - Layer 3 switch (continued)

Field	Description
source quench	The number of Source Quench messages sent or received by the device.
redirect	The number of Redirect messages sent or received by the device.
echo	The number of Echo messages sent or received by the device.
echo reply	The number of Echo Reply messages sent or received by the device.
timestamp	The number of Timestamp messages sent or received by the device.
timestamp reply	The number of Timestamp Reply messages sent or received by the device.
addr mask	The number of Address Mask Request messages sent or received by the device.
addr mask reply	The number of Address Mask Replies messages sent or received by the device.
irdp advertisement	The number of ICMP Router Discovery Protocol (IRDP) Advertisement messages sent or received by the device.
irdp solicitation	The number of IRDP Solicitation messages sent or received by the device.
UDP statistics	
received	The number of UDP packets received by the device.
sent	The number of UDP packets sent by the device.
no port	The number of UDP packets dropped because they did not have a valid UDP port number.
input errors	This information is used by Ruckus customer support.
TCP statistics	
The TCP statistics are derived from RFC 793, "Transmission Control Protocol".	
active opens	The number of TCP connections opened by sending a TCP SYN to another device.
passive opens	The number of TCP connections opened by this device in response to connection requests (TCP SYNs) received from other devices.
failed attempts	This information is used by Ruckus customer support.
active resets	The number of TCP connections this device reset by sending a TCP RESET message to the device at the other end of the connection.
passive resets	The number of TCP connections this device reset because the device at the other end of the connection sent a TCP RESET message.
input errors	This information is used by Ruckus customer support.
in segments	The number of TCP segments received by the device.
out segments	The number of TCP segments sent by the device.
retransmission	The number of segments that this device retransmitted because the retransmission timer for the segment had expired before the device at the other end of the connection had acknowledged receipt of the segment.
RIP statistics	
The RIP statistics are derived from RFC 1058, "Routing Information Protocol".	
requests sent	The number of requests this device has sent to another RIP router for all or part of its RIP routing table.
requests received	The number of requests this device has received from another RIP router for all or part of this device RIP routing table.

TABLE 26 CLI display of IP traffic statistics - Layer 3 switch (continued)

Field	Description
responses sent	The number of responses this device has sent to another RIP router request for all or part of this device RIP routing table.
responses received	The number of responses this device has received to requests for all or part of another RIP router routing table.
unrecognized	This information is used by Ruckus customer support.
bad version	The number of RIP packets dropped by the device because the RIP version was either invalid or is not supported by this device.
bad addr family	The number of RIP packets dropped because the value in the Address Family Identifier field of the packet header was invalid.
bad req format	The number of RIP request packets this router dropped because the format was bad.
bad metrics	This information is used by Ruckus customer support.
bad resp format	The number of responses to RIP request packets dropped because the format was bad.
resp not from rip port	This information is used by Ruckus customer support.
resp from loopback	The number of RIP responses received from loopback interfaces.
packets rejected	This information is used by Ruckus customer support.

Displaying IP information - Layer 2 switches

You can display the following IP configuration information statistics on Layer 2 switches:

- Global IP settings
- ARP entries
- IP traffic statistics

Displaying global IP configuration information

To display the Layer 2 switch IP address and default gateway, enter the **show ip** command.

```
device# show ip
      Switch IP address: 192.168.1.2
      Subnet mask: 255.255.255.0
      Default router address: 192.168.1.1
      TFTP server address: None
      Configuration filename: None
      Image filename: None
```

Syntax: **show ip**

This display shows the following information.

TABLE 27 CLI display of global IP configuration information - Layer 2 switch

Field	Description
IP configuration	
Switch IP address	The management IP address configured on the Layer 2 switch. Specify this address for Telnet access or Web management access.
Subnet mask	The subnet mask for the management IP address.
Default router address	The address of the default gateway, if you specified one.
Most recent TFTP access	

IP Configuration

Displaying IP configuration information and statistics

TABLE 27 CLI display of global IP configuration information - Layer 2 switch (continued)

Field	Description
TFTP server address	The IP address of the most-recently contacted TFTP server, if the switch has contacted a TFTP server since the last time the software was reloaded or the switch was rebooted.
Configuration filename	The name under which the Layer 2 switch startup-config file was uploaded or downloaded during the most recent TFTP access.
Image filename	The name of the Layer 2 switch flash image (system software file) that was uploaded or downloaded during the most recent TFTP access.

Displaying ARP entries

To display the entries the Layer 2 switch has placed in its ARP cache, enter the **show arp** command from any level of the CLI. This command shows the total number of ARPs for the default VRF instance.

NOTE

To display the ARP maximum capacity for your device, enter the **show default values** command.

```
device# show arp
Total Arp Entries : 1
No.
 1      IP              Mac          Port  Age   VlanId
 192.168.1.170    0000.0011.d042    7     0       1
```

Syntax: show arp

TABLE 28 CLI display of ARP cache

Syntax: show arp	Description
Field	
Total ARP Entries	The number of entries in the ARP cache.
IP	The IP address of the device.
Mac	The MAC address of the device. <p>NOTE If the MAC address is all zeros, the entry is for the default gateway, but the Layer 2 switch does not have a link to the gateway.</p>
Port	The port on which the entry was learned.
Age	The number of minutes the entry has remained unused. If this value reaches the ARP aging period, the entry is removed from the cache.
VlanId	The VLAN the port that learned the entry is in. <p>NOTE If the MAC address is all zeros, this field shows a random VLAN ID, since the Layer 2 switch does not yet know which port the device for this entry is attached to.</p>

Displaying IP traffic statistics

To display IP traffic statistics on a Layer 2 switch, enter the **show ip traffic** command at any CLI level.

```
device# show ip traffic
IP Statistics
 27 received, 24 sent
```

```

0 fragmented, 0 reassembled, 0 bad header
0 no route, 0 unknown proto, 0 no buffer, 0 other errors
ICMP Statistics
Received:
 0 total, 0 errors, 0 unreachable, 0 time exceed
 0 parameter, 0 source quench, 0 redirect, 0 echo,
 0 echo reply, 0 timestamp, 0 timestamp reply, 0 addr mask
 0 addr mask reply, 0 irdp advertisement, 0 irdp solicitation
Sent:
 0 total, 0 errors, 0 unreachable, 0 time exceed
 0 parameter, 0 source quench, 0 redirect, 0 echo,
 0 echo reply, 0 timestamp, 0 timestamp reply, 0 addr mask
 0 addr mask reply, 0 irdp advertisement, 0 irdp solicitation
UDP Statistics
 0 received, 0 sent, 0 no port, 0 input errors
TCP Statistics
 1 current active tcbs, 4 tcbs allocated, 0 tcbs freed 0 tcbs protected
 0 active opens, 0 passive opens, 0 failed attempts
 0 active resets, 0 passive resets, 0 input errors
 27 in segments, 24 out segments, 0 retransmission

```

Syntax: show ip traffic

The **show ip traffic** command displays the following information.

TABLE 29 CLI display of IP traffic statistics - Layer 2 switch

Field	Description
IP statistics	
received	The total number of IP packets received by the device.
sent	The total number of IP packets originated and sent by the device.
fragmented	The total number of IP packets fragmented by this device to accommodate the MTU of this device or of another device.
reassembled	The total number of fragmented IP packets that this device re-assembled.
bad header	The number of IP packets dropped by the device due to a bad packet header.
no route	The number of packets dropped by the device because there was no route.
unknown proto	The number of packets dropped by the device because the value in the Protocol field of the packet header is unrecognized by this device.
no buffer	This information is used by Ruckus customer support.
other errors	The number of packets that this device dropped due to error types other than the types listed above.
ICMP statistics	
The ICMP statistics are derived from RFC 792, "Internet Control Message Protocol", RFC 950, "Internet Standard Subnetting Procedure", and RFC 1256, "ICMP Router Discovery Messages". Statistics are organized into Sent and Received. The field descriptions below apply to each.	
total	The total number of ICMP messages sent or received by the device.
errors	This information is used by Ruckus customer support.
unreachable	The number of Destination Unreachable messages sent or received by the device.
time exceed	The number of Time Exceeded messages sent or received by the device.
parameter	The number of Parameter Problem messages sent or received by the device.
source quench	The number of Source Quench messages sent or received by the device.

IP Configuration

Displaying IP configuration information and statistics

TABLE 29 CLI display of IP traffic statistics - Layer 2 switch (continued)

Field	Description
redirect	The number of Redirect messages sent or received by the device.
echo	The number of Echo messages sent or received by the device.
echo reply	The number of Echo Reply messages sent or received by the device.
timestamp	The number of Timestamp messages sent or received by the device.
timestamp reply	The number of Timestamp Reply messages sent or received by the device.
addr mask	The number of Address Mask Request messages sent or received by the device.
addr mask reply	The number of Address Mask Replies messages sent or received by the device.
irdp advertisement	The number of ICMP Router Discovery Protocol (IRDP) Advertisement messages sent or received by the device.
irdp solicitation	The number of IRDP Solicitation messages sent or received by the device.
UDP statistics	
received	The number of UDP packets received by the device.
sent	The number of UDP packets sent by the device.
no port	The number of UDP packets dropped because the packet did not contain a valid UDP port number.
input errors	This information is used by Ruckus customer support.
TCP statistics	
The TCP statistics are derived from RFC 793, "Transmission Control Protocol".	
current active tcbs	The number of TCP Control Blocks (TCBs) that are currently active.
tcbs allocated	The number of TCBs that have been allocated.
tcbs freed	The number of TCBs that have been freed.
tcbs protected	This information is used by Ruckus customer support.
active opens	The number of TCP connections opened by this device by sending a TCP SYN to another device.
passive opens	The number of TCP connections opened by this device in response to connection requests (TCP SYNS) received from other devices.
failed attempts	This information is used by Ruckus customer support.
active resets	The number of TCP connections this device reset by sending a TCP RESET message to the device at the other end of the connection.
passive resets	The number of TCP connections this device reset because the device at the other end of the connection sent a TCP RESET message.
input errors	This information is used by Ruckus customer support.
in segments	The number of TCP segments received by the device.
out segments	The number of TCP segments sent by the device.
retransmission	The number of segments that this device retransmitted because the retransmission timer for the segment had expired before the device at the other end of the connection had acknowledged receipt of the segment.

Disabling IP checksum check

The **disable-hw-ip-checksum-check** command traps a packet with bad checksum to the CPU. Previously, if the packet processor detected a packet with, for example, the checksum 0xFFFF, it would treat it as a bad checksum even if it was correct and it would drop the packet. Now, the command **disable-hw-ip-checksum-check** traps the packet at the CPU and if the checksum is correct, it forwards the packet.

To set disable hardware ip checksum check for all ports, enter the following command.

```
device# disable-hw-ip-checksum-check
disable-ip-header-check set for all ports
```

To clear disable hardware ip checksum check on all ports, enter the following command.

```
device# no disable-hw-ip-checksum-check ethernet 13
disable-hw-ip-checksum-check cleared for ports the 13 to 24
```

To set disable hardware ip checksum check on for example, port range 0-12, enter the following command.

```
device# disable-hw-ip-checksum-check ethernet 2
disable-ip-header-check set for ports ethe 1 to 12
```

To set disable hardware ip checksum check on, for example, port range 13-24, enter the following command.

```
device# disable-hw-ip-checksum-check ethernet 22
disable-ip-header-check set for ports ethe 13 to 24
```

To clear disable hardware ip checksum check on, for example, port range 13-24, enter the following command.

```
device# no disable-hw-ip-checksum-check ethernet 13
disable-hw-ip-checksum-check cleared for ports the 13 to 24
```

NOTE

The port range could be any consecutive range, it may not necessarily be a decimal number.

Syntax: [no] **disable-hw-ip-checksum-check ethernet portnum**

NOTE

This command only functions on the IPv4 platform.

Layer 3 Routing Protocols

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Adding a static IP route

To configure an IP static route with a destination address of 192.0.0.0 255.0.0.0 and a next-hop router IP address of 195.1.1.1, enter the following.

```
device(config)# ip route 192.0.0.0 255.0.0.0 195.1.1.1
```

To configure a default route, enter the following.

```
device(config)# ip route 0.0.0.0 0.0.0.0
```

To configure a static IP route with an Ethernet port instead of a next-hop address, enter a command such as the following.

```
device(config)# ip route 192.128.2.69 255.255.255.0 ethernet 1/4/1
```

The command configures a static IP route for destination network 192.128.2.69/24. Since an Ethernet port is specified instead of a gateway IP address as the next hop, the Ruckus device always forwards traffic for the 192.128.2.69/24 network to port 1/4/1.

To configure an IP static route that uses virtual interface 3 as its next hop, enter a command such as the following.

```
device(config)# ip route 192.128.2.71 255.255.255.0 ve 3
```

Syntax: [no] **ip route** dest-ip-addr dest-mask | dest-ip-addr/mask-bits next-hop-ip-addr | **ethernet** unit/slot/port | **ve** num [metric] [tag num] [distance num] [name string]

NOTE

Using the **no** form of the command only removes the name if configured. Another **no** command must be issued to remove the actual Static Route.

The *dest-ip-addr* is the route's destination. The *dest-mask* is the network mask for the route's destination IP address. Alternatively, you can specify the network mask information by entering / followed by the number of bits in the network mask. For example, you can enter 192.0.0.0 255.255.255.0 as 192.0.0.0/.24.

The *next-hop-ip-addr* is the IP address of the next-hop router (gateway) for the route.

For a default route, enter 0.0.0.0 0.0.0.0 xxx.xxx.xxx.xxx (use 0 for the *mask-bits* if you specify the address in CIDR format).

If you do not want to specify a next-hop IP address, you can instead specify a port or interface number on the Ruckus device. The *num* parameter is a virtual interface number. The *unit/slot/port* is the port's number of the Ruckus device. If you specify an Ethernet port, the Ruckus device forwards packets destined for the static route's destination network to the specified interface. Conceptually, this feature makes the destination network like a directly connected network, associated with a Ruckus device interface.

NOTE

The port or virtual interface you use for the static route's next hop must have at least one IP address configured on it. The address does not need to be in the same subnet as the destination network.

The **metric** parameter specifies the cost of the route and can be a number from 1 - 16. The default is 1.

NOTE

If you specify 16, RIP considers the metric to be infinite and thus also considers the route to be unreachable.

The **tag num** parameter specifies the tag value of the route. Possible values: 0 - 4294967295. Default: 0.

The **distance num** parameter specifies the administrative distance of the route. When comparing otherwise equal routes to a destination, the Ruckus device prefers lower administrative distances over higher ones, so make sure you use a low value for your default route. Possible values: 1 - 255. Default: 1.

NOTE

The Ruckus device will replace the static route if it receives a route with a lower administrative distance.

The **name string** parameter specifies the name assigned to a route. The static route name is descriptive and an optional feature. It does not affect the selection of static routes.

Configuring a "null" route

You can configure the Ruckus device to drop IP packets to a specific network or host address by configuring a "null" (sometimes called "null0") static route for the address. When the Ruckus device receives a packet destined for the address, the Ruckus device drops the packet instead of forwarding it.

To configure a null static route to drop packets destined for network 209.157.22.x, enter the following commands.

```
device(config)# ip route 209.157.22.0 255.255.255.0 null0
device(config)# write memory
```

Syntax: [no] **ip route** { *ip-addr ip-mask* | *dest-ip-addr/mask-bits* } **null0** [*metric*] [**tag num**] [**distance num**]

To display the maximum value for your device, enter the **show default values** command. The maximum number of static IP routes the system can hold is listed in the ip-static-route row in the System Parameters section of the display. To change the maximum value, use the **system-max ip-static-route** command at the global CONFIG level.

The *ip-addr* parameter specifies the network or host address. The Ruckus device will drop packets that contain this address in the destination field instead of forwarding them.

The *ip-mask* parameter specifies the network mask. Ones are significant bits and zeros allow any value. For example, the mask 255.255.255.0 matches on all hosts within the Class C subnet address specified by *ip-addr*. Alternatively, you can specify the number of bits in the network mask. For example, you can enter 209.157.22.0/24 instead of 209.157.22.0 255.255.255.0.

The **null0** parameter indicates that this is a null route. You must specify this parameter to make this a null route.

The *metric* parameter adds a cost to the route. You can specify from 1 - 16. The default is 1.

The **tag num** parameter specifies the tag value of the route. Possible values: 0 - 4294967295. Default: 0.

The **distance num** parameter configures the administrative distance for the route. You can specify a value from 1 - 255. The default is 1. The value 255 makes the route unusable.

The last three parameters are optional and do not affect the null route, unless you configure the administrative distance to be 255. In this case, the route is not used and the traffic might be forwarded instead of dropped.

Static route next hop resolution

This feature enables the Ruckus device to use routes from a specified protocol to resolve a configured static route. By default this is disabled.

To configure static route next hop resolution with OSPF routes, use the following command.

```
device(config)# ip route next-hop ospf
```

Syntax: [no] ip route next-hop [bgp | ospf | rip]

NOTE

This command can be independently applied on a per-VRF basis.

This command causes the resolution of static route next hop using routes learned from one of the following protocols:

- bgp - both iBGP and eBGP routes are used to resolve static routes.
- ospf
- rip

NOTE

Connected routes are always used to resolve static routes.

Static route recursive lookup

This feature enables the Ruckus device to use static routes to resolve another static route. The recursive static route next hop lookup level can be configured. By default, this feature is disabled.

To configure static route next hop recursive lookup by other static routes, use the following command.

```
device(config)# ip route next-hop-recursion 5
```

Syntax: [no] ip route next-hop-recursion *level*

The *level* available specifies the numbers of level of recursion allowed. Acceptable values are 1-10. The default value is 3.

NOTE

This command can be independently applied on a per-VRF basis.

Static route resolve by default route

This feature enables the Ruckus device to use the default route (0.0.0.0/0) to resolve a static route. By default, this feature is disabled.

Use the following command to configure static route resolve by default route.

```
device(config)# ip route next-hop-enable-default
```

Syntax: [no] ip route next-hop-enable-default

NOTE

This command can be independently applied on a per-VRF basis.

This command works independently with the **ip route next-hop-recursion** and **ip route next-hop** commands. If the default route is a protocol route, that protocol needs to be enabled to resolve static routes using the **ip route next-hop** command in

order for static routes to resolve by this default route. If the default route itself is a static route, you must configure the **ip route next-hop-recursion** command to resolve other static routes by this default route.

Adding a static ARP entry

NOTE

Adding a static ARP entry is supported on FastIron X Series, Brocade FCX Series, ICX 6610 and ICX 6450 devices.

Static entries are useful in cases where you want to pre-configure an entry for a device that is not connected to the Ruckus device, or you want to prevent a particular entry from aging out. The software removes a dynamic entry from the ARP cache if the ARP aging interval expires before the entry is refreshed. Static entries do not age out, regardless of whether the Ruckus device receives an ARP request from the device that has the entry address. The software places a static ARP entry into the ARP cache as soon as you create the entry.

To add a static ARP entry, enter a command such as the following at the global CONFIG level of the CLI.

```
device(config)#arp 10.157.22.3 0000.00bb.cccc ethernet 3
```

This command adds a static ARP entry that maps IP address 10.157.22.3 to MAC address 0000.00bb.cccc. The entry is for a MAC address connected to device port 3.

Syntax: [no] arp *ip-addr mac-addr ethernet port*

The *ip-addr* variable specifies the IP address of the device that has the MAC address of the entry.

The *mac-addr* variable specifies the MAC address of the entry.

The **ethernet** *port* parameter specifies the port number attached to the device that has the MAC address of the entry. Specify the *port* variable in one of the following formats:

The **clear arp** command clears learned ARP entries but does not remove any static ARP entries.

Modifying and displaying Layer 3 system parameter limits

This section shows how to view and configure some of the Layer 3 system parameter limits.

Layer 3 configuration notes

- Changing the system parameters reconfigures the device memory. Whenever you reconfigure the memory on a Ruckus device, you must save the change to the startup-config file, and then reload the software to place the change into effect.
- The Layer 3 system parameter limits for FastIron IPv6 models are automatically adjusted by the system and cannot be manually modified.

FastIron second generation modules

FastIron IPv6 models support the same Layer 3 system parameters that use hardware memory as do FastIron IPv4 models. However, there are some configuration differences between second generation modules and first generation modules. The differences are as follows:

- Number of IP next hops - 6144 maximum and default value.
- Number of multicast output interfaces (clients) - 3072 maximum. This value is fixed in second generation modules and cannot be modified. This system parameter occupies its own hardware memory space.

To display the current settings for the Layer 3 system parameters, use the **show default value** command.

FastIron third generation modules

The default value of next hop entries on FastIron X Series devices with the following third generation modules installed is 16384. This value is predefined and not editable.

- SX-FI48GPP
- SX-FI-2XG
- SX-FI-8XG
- SX-FI-24HF
- SX-FI-24GPP

If the FastIron X Series device is installed with first generation or second generation modules, the system automatically calculates the default value for these modules.

Displaying Layer 3 system parameter limits

To display the Layer 3 system parameter defaults, maximum values, and current values, enter the **show default value** command at any level of the CLI.

The following example shows output on a FastIron X Series with second generation modules.

```
device#show default value
sys log buffers:50          mac age time:300 sec      telnet sessions:5
ip arp age:10 min          bootp relay max hops:4    ip ttl:64 hops
ip addr per intf:24
igmp group memb.:140 sec   igmp query:60 sec
ospf dead:40 sec           ospf hello:10 sec        ospf retrans:5 sec
ospf transit delay:1 sec
System Parameters  Default  Maximum  Current
ip-arp            4000     64000    4000
ip-static-arp     512      1024    512
some lines omitted for brevity...
hw-traffic-condition 50      1024    50
```

The following example shows output on a FastIron X Series with third generation modules.

```
device#show default value
sys log buffers:50          mac age time:300 sec      telnet sessions:5
ip arp age:10 min          bootp relay max hops:4    ip ttl:64 hops
ip addr per intf:24
igmp group memb.:140 sec   igmp query:60 sec
ospf dead:40 sec           ospf hello:10 sec        ospf retrans:5 sec
ospf transit delay:1 sec
System Parameters  Default  Maximum  Current
ip-arp            4000     64000    4000
ip-static-arp     512      1024    512
```

Layer 3 Routing Protocols

Enabling or disabling routing protocols

```
some lines omitted for brevity...
hw-traffic-condition    50          1024      50
```

Enabling or disabling routing protocols

This section describes how to enable or disable routing protocols. For complete configuration information about the routing protocols, refer to the respective chapters in this guide.

The Layer 3 code supports the following protocols:

- BGP4
- IGMP
- IP
- IP multicast (PIM-SM, PIM-DM)
- OSPF
- PIM
- RIPV1 and V2
- VRRP
- VRRP-E
- VSRP
- IPv6 Routing
- IPv6 Multicast

IP routing is enabled by default on devices running Layer 3 code. All other protocols are disabled, so you must enable them to configure and use them.

To enable a protocol on a device running Layer 3 code, enter **router** at the global CONFIG level, followed by the protocol to be enabled. The following example shows how to enable OSPF.

```
device(config)#router ospf
```

Syntax: **router bgp | igmp | ip | ospf | pim | rip | vrrp | vrrp-e | vsrp**

Enabling or disabling Layer 2 switching

By default, Ruckus Layer 3 switches support Layer 2 switching. These devices modify the routing protocols that are not supported on the devices. If you want to disable Layer 2 switching, you can do so globally or on individual ports, depending on the version of software your device is running.

NOTE

Consult your reseller or Ruckus to understand the risks involved before disabling all Layer 2 switching operations.

Configuration notes and feature limitations for Layer 2 switching

- Enabling or disabling Layer 2 switching is supported in Layer 3 software images only.
- FastIron X Series, Brocade FCX Series, and ICX devices support disabling Layer 3 switching at the interface configuration level as well as the global CONFIG level.
- Enabling or disabling Layer 2 switching is not supported on virtual interfaces.

Command syntax for Layer 2 switching

To globally disable Layer 2 switching on a Layer 3 switch, enter commands such as the following.

```
device(config)#route-only
device(config)#exit
device#write memory
device#reload
```

To re-enable Layer 2 switching on a Layer 3 switch, enter the following commands.

```
device(config)#no route-only
device(config)#exit
device#write memory
device#reload
```

Syntax: [no] route-only

To disable Layer 2 switching only on a specific interface, go to the interface configuration level for that interface, and then disable the feature. The following commands show how to disable Layer 2 switching on port 2.

```
device(config)#interface ethernet 2
device(config-if-e1000-2)#route-only
```

Configuring a Layer 3 Link Aggregation Group (LAG)

Configuring a Layer 3 Link Aggregation Group (LAG)

FastIron devices with Layer 3 images support Layer 3 LAGs, which are used for routing and not switching. For details on how to create a LAG, refer to *Link Aggregation* in the *Brocade FastIron Layer 2 Switching Configuration Guide*. Perform the following steps to enable routing on a LAG:

1. In the global configuration mode, run the **interface ethernet** command to enter the interface configuration mode of the primary port of the LAG.

```
Brocade(config)# interface ethernet 4/1/4
```

2. Run the **route-only** command to disable switching and enable routing on the LAG.

```
Brocade(config-if-e1000-4/1/4)# route-only
```

3. Run the **ip address** command to assign an IP address for the LAG.

```
Brocade(config-if-e1000-4/1/4)# ip address 25.0.0.2/24
```

The following example shows the creation and deployment of a dynamic LAG that is used for routing on a FastIron device with Layer 3 image.

```
Brocade(config)# lag "brocade-LAG" dynamic id 55
Brocade(config-lag-brocade-LAG)# ports ethernet 1/1/1 ethernet 2/1/3 ethernet 3/1/4 ethernet 4/1/4
Brocade(config-lag-brocade-LAG)# primary-port 4/1/4
Brocade(config-lag-brocade-LAG)# deploy
Brocade(config-lag-brocade-LAG)# exit
Brocade(config)# interface ethernet 4/1/4
Brocade(config-if-e1000-4/1/4)# route-only
Brocade(config-if-e1000-4/1/4)# ip address 25.0.0.2/24
```


IPv6 Configuration on FastIron X Series, FCX, and ICX Series Switches

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Full Layer 3 IPv6 feature support

The following IPv6 Layer 3 features are supported only with the IPv6 Layer 3 PROM, Software-based Licensing, IPv6-series hardware, and the full Layer 3 image:

- OSPF V3
- RIPng
- IPv6 ICMP redirect messages
- IPv6 route redistribution
- IPv6 over IPv4 tunnels in hardware
- IPv6 Layer 3 forwarding
- BGP4+
- IPv6 Multicast routing
- DHCPv6 Relay Agent

NOTE

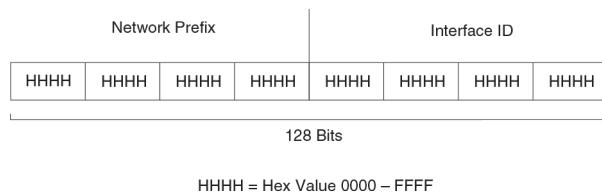
IPv6 static routes and IPv6 unicast routing (multicast routing is not supported) are not supported in the base Layer 3 software images.

IPv6 addressing overview

IPv6 was designed to replace IPv4, the Internet protocol that is most commonly used currently throughout the world. IPv6 increases the number of network address bits from 32 (IPv4) to 128 bits, which provides more than enough unique IP addresses to support all of the network devices on the planet into the future. IPv6 is expected to quickly become the network standard.

An IPv6 address is composed of 8 fields of 16-bit hexadecimal values separated by colons (:). The following figure shows the IPv6 address format.

FIGURE 16 IPv6 address format



As shown in the above figure, HHHH is a 16-bit hexadecimal value, while H is a 4-bit hexadecimal value. The following is an example of an IPv6 address.

2001:0000:0000:0200:002D:D0FF:FE48:4672

Note that this IPv6 address includes hexadecimal fields of zeros. To make the address less cumbersome, you can do the following:

- Omit the leading zeros; for example, 2001:0:0:200:2D:D0FF:FE48:4672.
- Compress the successive groups of zeros at the beginning, middle, or end of an IPv6 address to two colons (::) once per address; for example, 2001::200:2D:D0FF:FE48:4672.

When specifying an IPv6 address in a command syntax, keep the following in mind:

- You can use the two colons (::) only once in the address to represent the longest successive hexadecimal fields of zeros
- The hexadecimal letters in IPv6 addresses are not case-sensitive

As shown in [Figure 16](#), the IPv6 network prefix is composed of the left-most bits of the address. As with an IPv4 address, you can specify the IPv6 prefix using the prefix / prefix-length format, where the following applies.

The prefix parameter is specified as 16-bit hexadecimal values separated by a colon.

The prefix-length parameter is specified as a decimal value that indicates the left-most bits of the IPv6 address.

The following is an example of an IPv6 prefix.

2001:DB8:49EA:D088::/64

IPv6 address types

As with IPv4 addresses, you can assign multiple IPv6 addresses to a switch interface. [IPv6 address types](#) presents the three major types of IPv6 addresses that you can assign to a switch interface.

A major difference between IPv4 and IPv6 addresses is that IPv6 addresses support scope , which describes the topology in which the address may be used as a unique identifier for an interface or set of interfaces.

Unicast and multicast addresses support scoping as follows:

- Unicast addresses support two types of scope: global scope and local scope. In turn, local scope supports site-local addresses and link-local addresses. [IPv6 address types](#) describes global, site-local, and link-local addresses and the topologies in which they are used.
- Multicast addresses support a scope field, which [IPv6 address types](#) describes.

TABLE 30 IPv6 address types

Address type	Description	Address structure
Unicast	An address for a single interface. A packet sent to a unicast address is delivered to the interface identified by the address.	Depends on the type of the unicast address: <ul style="list-style-type: none"> • Aggregatable global address--An address equivalent to a global or public IPv4 address. The address structure is as follows: a fixed prefix of 2000::/3 (001), a 45-bit global routing prefix, a 16-bit subnet ID, and a 64-bit interface ID. • Site-local address--An address used within a site or intranet. (This address is similar to a private IPv4 address.) A site consists of multiple network links. The address structure is as follows: a fixed prefix of FEC0::/10 (1111 1110 11), a 16-bit subnet ID, and a 64-bit interface ID. • Link-local address--An address used between directly connected nodes on a single network link. The address structure is as follows: a fixed prefix of FE80::/10 (1111 1110 10) and a 64-bit interface ID. • IPv4-compatible address--An address used in IPv6 transition mechanisms that tunnel IPv6 packets dynamically over IPv4 infrastructures. The address embeds an IPv4 address in the low-order 32 bits and the high-order 96 bits are zeros. The address structure is as follows: 0:0:0:0:0:A.B.C.D. • Loopback address--An address (0:0:0:0:0:0:1 or ::1) that a switch can use to send an IPv6 packet to itself. You cannot assign a loopback address to a physical interface. • Unspecified address--An address (0:0:0:0:0:0:0 or ::) that a node can use until you configure an IPv6 address for it.
Multicast	An address for a set of interfaces belonging to different nodes. Sending a packet to a multicast address results in the delivery of the packet to all interfaces in the set.	A multicast address has a fixed prefix of FF00::/8 (1111 1111). The next 4 bits define the address as a permanent or temporary address. The next 4 bits define the scope of the address (node, link, site, organization, global).
Anycast	An address for a set of interfaces belonging to different nodes. Sending a packet to an anycast address results in the delivery of the	An anycast address looks similar to a unicast address, because it is allocated from the unicast address space. If you assign a unicast

TABLE 30 IPv6 address types (continued)

Address type	Description	Address structure
	packet to the closest interface identified by the address.	address to multiple interfaces, it is an anycast address. An interface assigned an anycast address must be configured to recognize the address as an anycast address. An anycast address can be assigned to a switch only. An anycast address must not be used as the source address of an IPv6 packet.

A switch automatically configures a link-local unicast address for an interface by using the prefix of FE80::/10 (1111 1110 10) and a 64-bit interface ID. The 128-bit IPv6 address is then subjected to duplicate address detection to ensure that the address is unique on the link. If desired, you can override this automatically configured address by explicitly configuring an address.

NOTE

Brocade FastIron devices support RFC 2526, which requires that within each subnet, the highest 128 interface identifier values reserved for assignment as subnet anycast addresses. Thus, if you assign individual IPv6 addresses within a subnet, the second highest IPv6 address in the subnet does not work.

IPv6 stateless auto-configuration

Ruckus routers use the IPv6 stateless autoconfiguration feature to enable a host on a local link to automatically configure its interfaces with new and globally unique IPv6 addresses associated with its location. The automatic configuration of a host interface is performed without the use of a server, such as a Dynamic Host Configuration Protocol (DHCP) server, or manual configuration.

The automatic configuration of a host interface works in the following way: a switch on a local link periodically sends switch advertisement messages containing network-type information, such as the 64-bit prefix of the local link and the default route, to all nodes on the link. When a host on the link receives the message, it takes the local link prefix from the message and appends a 64-bit interface ID, thereby automatically configuring its interface. (The 64-bit interface ID is derived from the MAC address of the host's NIC.) The 128-bit IPv6 address is then subjected to duplicate address detection to ensure that the address is unique on the link.

The duplicate address detection feature verifies that a unicast IPv6 address is unique before it is assigned to a host interface by the stateless auto configuration feature. Duplicate address detection uses neighbor solicitation messages to verify that a unicast IPv6 address is unique.

NOTE

For the stateless auto configuration feature to work properly, the advertised prefix length in switch advertisement messages must always be 64 bits.

The IPv6 stateless autoconfiguration feature can also automatically reconfigure a host's interfaces if you change the ISP for the host's network. (The host's interfaces must be renumbered with the IPv6 prefix of the new ISP.)

The renumbering occurs in the following way: a switch on a local link periodically sends advertisements updated with the prefix of the new ISP to all nodes on the link. (The advertisements still contain the prefix of the old ISP.) A host can use the addresses created from the new prefix and the existing addresses created from the old prefix on the link. When you are ready for the host to use the new addresses only, you can configure the lifetime parameters appropriately using the **ipv6 nd prefix-advertisement** command. During this transition, the old prefix is removed from the switch advertisements. At this point, only addresses that contain the new prefix are used on the link.

IPv6 CLI command support

[IPv6 CLI command support](#) lists the IPv6 CLI commands supported.

TABLE 31 IPv6 CLI command support

IPv6 command	Description	Switch code	Router code
clear ipv6 cache	Deletes all entries in the dynamic host cache.		X
clear ipv6 mld-snooping	Deletes MLD-snooping-related counters or cache entries.	X	X
clear ipv6 neighbor	Deletes all dynamic entries in the IPv6 neighbor table.	X	X
clear ipv6 ospf	Clears OSPF-related entries.		X
clear ipv6 rip	Clears RIP-related entries.		X
clear ipv6 route	Deletes all dynamic entries in the IPv6 route table.		X
clear ipv6 traffic	Resets all IPv6 packet counters.	X	X
clear ipv6 tunnel	Clears statistics for IPv6 tunnels		X
copy tftp	Downloads a copy of a Ruckus software image from a TFTP server into the system flash using IPv6.	X	X
debug ipv6	Displays IPv6 debug information.	X	X
ipv6 access-class	Configures access control for IPv6 management traffic.	X	X
ipv6 access-list	Configures an IPv6 access control list for IPv6 access control.	X	X
ipv6 address	Configures an IPv6 address on an interface (router) or globally (switch)	X	X
ipv6 debug	Enables IPv6 debugging.	X	X
ipv6 dns domain-name	Configures an IPv6 domain name.	X	X
ipv6 dns server-address	Configures an IPv6 DNS server address.	X	X
ipv6 enable	Enables IPv6 on an interface.	X	X
ipv6 hop-limit	Sets the IPv6 hop limit.		X
ipv6 icmp	Configures IPv6 ICMP parameters		X
Ipv6 load-sharing	Enables IPv6 load sharing		X
Ipv6 mld-snooping	Configures MLD snooping	X	X
ipv6 mtu	Configures the maximum length of an IPv6 packet that can be transmitted on a particular interface.		X
ipv6 nd	Configures neighbor discovery.		X
ipv6 neighbor	Maps a static IPv6 address to a MAC address in the IPv6 neighbor table.		X
ipv6 ospf	Configures OSPF V3 parameters on an interface.		X

TABLE 31 IPv6 CLI command support (continued)

IPv6 command	Description	Switch code	Router code
ipv6 prefix-list	Builds an IPv6 prefix list.		X
ipv6 redirects	Enables the sending of ICMP redirect messages on an interface.		X
ipv6 rip	Configures RIPng parameters on an interface		X
ipv6 route	Configures an IPv6 static route.		X
ipv6 router	Enables an IPv6 routing protocol.		X
ipv6 traffic-filter	Applies an IPv6 ACL to an interface.	X	X
ipv6 unicast-routing	Enables IPv6 unicast routing.		X
log host ipv6	Configures the IPv6 Syslog server.	X	X
ping ipv6	Performs an ICMP for IPv6 echo test.	X	X
show ipv6	Displays some global IPv6 parameters, such IPv6 DNS server address.	X	X
show ipv6 access-list	Displays configured IPv6 access control lists.	X	X
show ipv6 cache	Displays the IPv6 host cache.		X
show ipv6 interface	Displays IPv6 information for an interface.		X
show ipv6 mld-snooping	Displays information about MLD snooping.	X	X
show ipv6 neighbor	Displays the IPv6 neighbor table.	X	X
show ipv6 ospf	Displays information about OSPF V3.		X
show ipv6 prefix-lists	Displays the configured IPv6 prefix lists.		X
show ipv6 rip	Displays information about RIPng.		X
show ipv6 route	Displays IPv6 routes.		X
show ipv6 router	Displays IPv6 local routers.		X
show ipv6 tcp	Displays information about IPv6 TCP sessions.	X	X
show ipv6 traffic	Displays IPv6 packet counters.	X	X
show ipv6 tunnel	Displays information about IPv6 tunnels	X	X
snmp-client ipv6	Restricts SNMP access to a certain IPv6 node.	X	X
snmp-server host ipv6	Specifies the recipient of SNMP notifications.	X	X
telnet	Enables a Telnet connection from the Ruckus device to a remote IPv6 host using the console.	X	X
traceroute ipv6	Traces a path from the Ruckus device to an IPv6 host.	X	X

TABLE 31 IPv6 CLI command support (continued)

IPv6 command	Description	Switch code	Router code
web access-group ipv6	Restricts Web management access to certain IPv6 hosts as determined by IPv6 ACLs.	X	X
web client ipv6	Restricts Web management access to certain IPv6 hosts.	X	X

IPv6 host address on a Layer 2 switch

In a Layer 3 (router) configuration, each port can be configured separately with an IPv6 address. This is accomplished using the interface configuration process that is described in [IPv6 configuration on each router interface](#) on page 161.

There is support for configuring an IPv6 address on the management port as described in [Configuring the management port for an IPv6 automatic address configuration](#) on page 160, and for configuring a system-wide IPv6 address on a Layer 2 switch. Configuration of the system-wide IPv6 address is exactly like configuration of an IPv6 address in router mode, except that the IPv6 configuration is at the Global CONFIG level instead of at the Interface level.

The process for defining the system-wide interface for IPv6 is described in the following sections:

- [Configuring a global or site-local IPv6 address with a manually configured interface ID](#) on page 159
- [Configuring a link-local IPv6 address as a system-wide address for a switch](#) on page 159

NOTE

When configuring an IPv6 host address on a Layer 2 switch that has multiple VLANs, make sure the configuration includes a designated management VLAN that identifies the VLAN to which the global IP address belongs. Refer to "Designated VLAN for Telnet management sessions to a Layer 2 Switch" section in the *FastIron Ethernet Switch Security Configuration Guide*.

Configuring a global or site-local IPv6 address with a manually configured interface ID

To configure a global or site-local IPv6 address with a manually-configured interface ID, such as a system-wide address for a switch, enter a command similar to the following at the Global CONFIG level.

```
device(config)# ipv6 address 2001:DB8:12D:1300:240:D0FF:FE48:4000:1/64
```

Syntax: **ipv6 address** *ipv6-prefix/prefix-length*

You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

You must specify the *prefix-length* parameter in decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter.

Configuring a link-local IPv6 address as a system-wide address for a switch

To enable IPv6 and automatically configure a global interface enter commands such as the following.

```
device(config)#ipv6 enable
```

This command enables IPv6 on the switch and specifies that the interface is assigned an automatically computed link-local address.

Syntax: [no] ipv6 enable

To override a link-local address that is automatically computed for the global interface with a manually configured address, enter a command such as the following.

```
device(config)#ipv6 address FE80::240:D0FF:FE48:4672 link-local
```

This command explicitly configures the link-local address FE80::240:D0FF:FE48:4672 for the global interface.

Syntax: ipv6 address *ipv6-address* link-local

You must specify the *ipv6-address* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

The **link-local** keyword indicates that the router interface should use the manually configured link-local address instead of the automatically computed link-local address.

Configuring the management port for an IPv6 automatic address configuration

You can have the management port configured to automatically obtain an IPv6 address. This process is the same for any other port and is described in detail in the section [Configuring a global or site-local IPv6 address on an interface](#) on page 161

Configuring basic IPv6 connectivity on a Layer 3 switch

To configure basic IPv6 connectivity on a Ruckus Layer 3 Switch, you must do the following:

- Enable IPv6 routing globally on the switch
- Configure an IPv6 address or explicitly enable IPv6 on each router interface over which you plan to forward IPv6 traffic
- Configure IPv4 and IPv6 protocol stacks. (This step is mandatory only if you want a router interface to send and receive both IPv4 and IPv6 traffic.)

All other configuration tasks in this chapter are optional.

Enabling IPv6 routing

By default, IPv6 routing is disabled. To enable the forwarding of IPv6 traffic globally on the Layer 3 switch, enter the following command.

```
device(config)#ipv6 unicast-routing
```

Syntax: [no] ipv6 unicast-routing

To disable the forwarding of IPv6 traffic globally on the Ruckus device, enter the **no** form of this command.

IPv6 configuration on each router interface

To forward IPv6 traffic on a router interface, the interface must have an IPv6 address, or IPv6 must be explicitly enabled. By default, an IPv6 address is not configured on a router interface.

If you choose to configure a global or site-local IPv6 address for an interface, IPv6 is also enabled on the interface. Further, when you configure a global or site-local IPv6 address, you must decide on one of the following in the low-order 64 bits:

- A manually configured interface ID.
- An automatically computed EUI-64 interface ID.

If you prefer to assign a link-local IPv6 address to the interface, you must explicitly enable IPv6 on the interface, which causes a link-local address to be automatically computed for the interface. If preferred, you can override the automatically configured link-local address with an address that you manually configure.

This section provides the following information:

- Configuring a global or site-local address with a manually configured or automatically computed interface ID for an interface.
- Automatically or manually configuring a link-local address for an interface.
- Configuring IPv6 anycast addresses

Configuring a global or site-local IPv6 address on an interface

Configuring a global or site-local IPv6 address on an interface does the following:

- Automatically configures an interface ID (a link-local address), if specified.
- Enables IPv6 on that interface.

Additionally, the configured interface automatically joins the following required multicast groups for that link:

- Solicited-node multicast group FF02:0:0:0:1:FF00::/104 for each unicast address assigned to the interface.
- Solicited-node for subnet anycast address for each unicast assigned address
- Solicited-node for anycast address FF02:0:0:0:1:FF00::0000
- All-nodes link-local multicast group FF02::1
- All-routers link-local multicast group FF02::2

The neighbor discovery feature sends messages to these multicast groups. For more information, refer to [IPv6 neighbor discovery configuration](#) on page 172.

Configuring a global or site-local IPv6 address with a manually configured interface ID

To configure a global or site-local IPv6 address, including a manually configured interface ID, for an interface, enter commands such as the following.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 address 2001:DB8:12D:1300:240:D0FF:
FE48:4672:/64
```

These commands configure the global prefix 2001:DB8:12d:1300::/64 and the interface ID ::240:D0FF:FE48:4672, and enable IPv6 on Ethernet interface 1/3/1.

Syntax: **ipv6 address** *ipv6-prefix/prefix-length*

You must specify the ipv6-prefix parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

IPv6 Configuration on FastIron X Series, FCX, and ICX Series Switches

Configuring basic IPv6 connectivity on a Layer 3 switch

You must specify the prefix-length parameter as a decimal value. A slash mark (/) must follow the ipv6-prefix parameter and precede the prefix-length parameter.

To configure a /122 address on a VE enter commands similar to the following.

```
device(config-vlan-11)#int ve11
device(config-vif-11)#ipv6 add 2001:DB8::1/122
device(config-vif-11)#sh ipv6 int
Routing Protocols : R - RIP O - OSPF
Interface      Status      Routing   Global Unicast Address
VE 11          up/up       2001:DB8::1/122
device(config-vif-11)#sh ipv6 route
IPv6 Routing Table - 1 entries:
Type Codes: C - Connected, S - Static, R - RIP, O - OSPF, B - BGP
OSPF Sub Type Codes: O - Intra, Oi - Inter, O1 - Type1 external, O2 - Type2 external
Type IPv6 Prefix           Next Hop Router           Interface Dis/Metric
C  2001:DB8::/122          ::                         ve 11      0/0
```

Configuring a global IPv6 address with an automatically computed EUI-64 interface ID

To configure a global IPv6 address with an automatically computed EUI-64 interface ID in the low-order 64-bits, enter commands such as the following.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 address 2001:DB8:12D:1300::/64 eui-64
```

These commands configure the global prefix 2001:DB8:12d:1300::/64 and an interface ID, and enable IPv6 on Ethernet interface 1/3/1.

Syntax: **ipv6 address ipv6-prefix/prefix-length eui-64**

You must specify the ipv6-prefix parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

You must specify the prefix-length parameter as a decimal value. A slash mark (/) must follow the ipv6-prefix parameter and precede the prefix-length parameter.

The **eui-64** keyword configures the global address with an EUI-64 interface ID in the low-order 64 bits. The interface ID is automatically constructed in IEEE EUI-64 format using the interface's MAC address.

Enabling IPv6 on an interface

You can enable IPv6 at the interface level.

1. Enter global configuration mode.

```
device# configure terminal
```

2. Enter interface configuration mode.

```
device(config)# interface ethernet 3/1
```

3. Enable IPv6 for the interface.

```
device(config-if-e1000-3/1)# ipv6 enable
```

The following example enables IPv6 for an Ethernet interface.

```
device# configure terminal
device(config)# interface ethernet 3/1
device(config-if-e1000-3/1)# ipv6 enable
```

NOTE

In the example above, the interface is assigned an automatically computed link-local address. When configuring VLANs that share a common tagged interface with a physical or Virtual Ethernet (VE) interface, Ruckus recommends that you override the automatically computed link-local address with a manually configured unique address for the interface. If the interface uses the automatically computed address, which in the case of physical and VE interfaces is derived from a global MAC address, all physical and VE interfaces will have the same MAC address. To override a link-local address that is automatically computed for an interface with a manually configured address, refer to [Configuring a link-local IPv6 address on an interface](#) on page 163.

Configuring a link-local IPv6 address on an interface

You can configure link-local IPv6 addresses at the interface level.

1. Enter global configuration mode.

```
device# configure terminal
```

2. Enter interface configuration mode.

```
device(config)# interface ethernet 3/1
```

3. Configure a link-local IPv6 address for the interface.

```
device(config-if-e1000-3/1)# ipv6 address FE80::240:D0FF:FE48:4672 link-local
```

The following example explicitly configures a link-local IPv6 address for an Ethernet interface.

```
device# configure terminal
device(config)# interface ethernet 3/1
device(config-if-e1000-3/1)# ipv6 address FE80::240:D0FF:FE48:4672 link-local
```

Configuring an IPv6 anycast address on an interface

In IPv6, an anycast address is an address for a set of interfaces belonging to different nodes. Sending a packet to an anycast address results in the delivery of the packet to the closest interface configured with the anycast address.

An anycast address looks similar to a unicast address, because it is allocated from the unicast address space. If you assign an IPv6 unicast address to multiple interfaces, it is an anycast address. On the Ruckus device, you configure an interface assigned an anycast address to recognize the address as an anycast address.

For example, the following commands configure an anycast address on interface 1/2/1.

```
device(config)# int e 1/2/1
device(config-if-e1000-1/2/1)# ipv6 address 2001:DB8::/64 anycast
```

Syntax: **ipv6 address** *ipv6-prefix/prefix-length* [**anycast**]

IPv6 anycast addresses are described in detail in RFC 1884. Refer to RFC 2461 for a description of how the IPv6 Neighbor Discovery mechanism handles anycast addresses.

Configuring IPv4 and IPv6 protocol stacks

One situation in which you must configure a router to run both IPv4 and IPv6 protocol stacks is if it is deployed as an endpoint for an IPv6 over IPv4 tunnel.

Each router interface that will send and receive both IPv4 and IPv6 traffic must be configured with an IPv4 address and an IPv6 address. (An alternative to configuring a router interface with an IPv6 address is to explicitly enable IPv6 using the **ipv6 enable** command. For more information about using this command, refer to the *Brocade FastIron Command Reference*).

To configure a router interface to support both the IPv4 and IPv6 protocol stacks, use commands such as the following.

```
device(config)#ipv6 unicast-routing
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ip address 10.168.1.1 255.255.255.0
device(config-if-e1000-1/3/1)#ipv6 address 2001:DB8:12d:1300::/64 eui-64
```

These commands globally enable IPv6 routing and configure an IPv4 address and an IPv6 address for Ethernet interface 1/3/1.

Syntax: [no] **ipv6 unicast-routing**

To disable IPv6 traffic globally on the router, enter the **no** form of this command.

Syntax: **ip address ip-address sub-net-mask [secondary]**

You must specify the ip-address parameter using 8-bit values in dotted decimal notation.

You can specify the sub-net-mask parameter in either dotted decimal notation or as a decimal value preceded by a slash mark (/).

The **secondary** keyword specifies that the configured address is a secondary IPv4 address.

To remove the IPv4 address from the interface, enter the **no** form of this command.

Syntax: **ipv6 address ipv6-prefix /prefix-length [eui-64]**

This syntax specifies a global or site-local IPv6 address. For information about configuring a link-local IPv6 address, refer to refer to [Configuring a link-local IPv6 address on an interface](#) on page 163.

You must specify the ipv6-prefix parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

You must specify the prefix-length parameter as a decimal value. A slash mark (/) must follow the ipv6-prefix parameter and precede the prefix-length parameter.

The **eui-64** keyword configures the global address with an EUI-64 interface ID in the low-order 64 bits. The interface ID is automatically constructed in IEEE EUI-64 format using the interface's MAC address. If you do not specify the **eui-64** keyword, you must manually configure the 64-bit interface ID as well as the 64-bit network prefix. For more information about manually configuring an interface ID, refer to [Configuring a global or site-local IPv6 address on an interface](#) on page 161.

IPv6 management (IPv6 host support)

You can configure a FastIron X Series, FCX, or ICX switch to serve as an IPv6 host in an IPv6 network. An **IPv6 host** has IPv6 addresses on its interfaces, but does not have full IPv6 routing enabled on it.

This section describes the IPv6 host features supported on FastIron X Series devices.

Configuring IPv6 management ACLs

When you enter the `ipv6 access-list` command, the Brocade device enters the IPv6 Access List configuration level, where you can access several commands for configuring IPv6 ACL entries. After configuring the ACL entries, you can apply them to network management access features such as Telnet, SSH, Web, and SNMP.

NOTE

Unlike IPv4, there is no distinction between standard and extended ACLs in IPv6.

```
FastIron(config)#ipv6 access-list netw
FastIron(config-ipv6-access-list-netw) #
```

Syntax: [no] **ipv6 access-list** *ACL-name*

The *ACL-name* variable specifies a name for the IPv6 ACL. An IPv6 ACL name cannot start with a numeral, for example, 1access. Also, an IPv4 ACL and an IPv6 ACL cannot share the same name.

Restricting SNMP access to an IPv6 node

You can restrict SNMP access to the device to the IPv6 host whose IP address you specify. To do so, enter a command such as the following.

```
device(config)#snmp-client ipv6 2001:DB8:89::23
```

Syntax: **snmp-client ipv6** *ipv6-address*

The *ipv6-address* you specify must be in hexadecimal format using 16-bit values between colons as documented in RFC 2373.

Specifying an IPv6 SNMP trap receiver

You can specify an IPv6 host as a trap receiver to ensure that all SNMP traps sent by the device will go to the same SNMP trap receiver or set of receivers, typically one or more host devices on the network. To do so, enter a command such as the following.

```
device(config)#snmp-server host ipv6 2001:DB8:89::13
```

Syntax: **snmp-server host ipv6** *ipv6-address*

The *ipv6-address* you specify must be in hexadecimal format using 16-bit values between colons as documented in RFC 2373.

Configuring SNMP V3 over IPv6

Ruckus FastIron X Series, FCX, and ICX devices support IPv6 for SNMP version 3. For more information about how to configure SNMP, refer to *FastIron Ethernet Switch Security Configuration Guide*.

Secure Shell, SCP, and IPv6

Secure Shell (SSH) is a mechanism that allows secure remote access to management functions on the Ruckus device. SSH provides a function similar to Telnet. You can log in to and configure the Ruckus device using a publicly or commercially available SSH client program, just as you can with Telnet. However, unlike Telnet, which provides no security, SSH provides a secure, encrypted connection to the Ruckus device.

To open an SSH session between an IPv6 host running an SSH client program and the Ruckus device, open the SSH client program and specify the IPv6 address of the device. For more information about configuring SSH on the Ruckus device, refer to "SSH2 and SCP" chapter in the *FastIron Ethernet Switch Security Configuration Guide*.

IPv6 Telnet

Telnet sessions can be established between a Ruckus device to a remote IPv6 host, and from a remote IPv6 host to the Ruckus device using IPv6 addresses.

The **telnet** command establishes a Telnet connection from a Ruckus device to a remote IPv6 host using the console. Up to five read-access Telnet sessions are supported on the router at one time. Write-access through Telnet is limited to one session, and only one outgoing Telnet session is supported on the router at one time. To see the number of open Telnet sessions at any time, enter the **show telnet** command.

To establish a Telnet connection to a remote host with the IPv6 address of 2001:DB8:3de2:c37::6, enter the following command.

```
device#telnet 2001:DB8:3de2:c37::6
```

Syntax: **telnet** *ipv6-address* [*port-number* | **outgoing-interface** *ethernet port* | **ve** *number*]

The *ipv6-address* parameter specifies the address of a remote host. You must specify this address in hexadecimal using 16-bit values between colons as documented in RFC 2373.

The *port-number* parameter specifies the port number on which the Ruckus device establishes the Telnet connection. You can specify a value between 1 - 65535. If you do not specify a port number, the Ruckus device establishes the Telnet connection on port 23.

If the IPv6 address you specify is a link-local address, you must specify the **outgoing-interface** *ethernet port* | **ve** *number* parameter. This parameter identifies the interface that must be used to reach the remote host. If you specify an Ethernet interface, you must also specify the port number associated with the interface. If you specify a VE interface, also specify the VE number.

Establishing a Telnet session from an IPv6 host

To establish a Telnet session from an IPv6 host to the Ruckus device, open your Telnet application and specify the IPv6 address of the Layer 3 Switch.

IPv6 traceroute

NOTE

This section describes the **/IPv6traceroute** command. For details about **/IPv4 traceroute**, refer to *FastIron Ethernet Switch Administration Guide*.

The **traceroute** command allows you to trace a path from the Ruckus device to an IPv6 host.

The CLI displays trace route information for each hop as soon as the information is received. Traceroute requests display all responses to a minimum TTL of 1 second and a maximum TTL of 30 seconds. In addition, if there are multiple equal-cost routes to the destination, the Ruckus device displays up to three responses.

For example, to trace the path from the Ruckus device to a host with an IPv6 address of 2001:DB8:349e:a384::34, enter the following command:

```
device#traceroute ipv6 2001:DB8:349e:a384::34
```

Syntax: **traceroute** **ipv6** *ipv6-address*

The *ipv6-address* parameter specifies the address of a host. You must specify this address in hexadecimal using 16-bit values between colons as documented in RFC 2373.

IPv6 Web management using HTTP and HTTPS

When you have an IPv6 management station connected to a switch with an IPv6 address applied to the management port, you can manage the switch from a Web browser by entering one of the following in the browser address field.

http://[<ipv6 address>]

or

https://[<ipv6 address>]

NOTE

You must enclose the IPv6 address with square brackets [] in order for the Web browser to work.

Restricting Web management access

You can restrict Web management access to include only management functions on a Brocade device that is acting as an IPv6 host, or restrict access so that the Brocade host can be reached by a specified IPv6 device.

Restricting Web management access by specifying an IPv6 ACL

You can specify an IPv6 ACL that restricts Web management access to management functions on the device that is acting as the IPv6 host.

Example

```
Brocade(config)# access-list 12 deny host 2000:2383:e0bb::2/128 log
Brocade(config)# access-list 12 deny 30ff:3782::ff89/128 log
Brocade(config)# access-list 12 deny 3000:4828::fe19/128 log
Brocade(config)# access-list 12 permit any
Brocade(config)# web access-group ipv6 12
```

Syntax: **web access-group ipv6 *ipv6-ACL-name***

where *ipv6-ACL-name* is a valid IPv6 ACL.

Restricting Web management access to an IPv6 host

You can restrict Web management access to the device to the IPv6 host whose IP address you specify. No other device except the one with the specified IPv6 address can access the Web Management Interface.

Example

```
Brocade(config)#web client ipv6 3000:2383:e0bb::2/128
```

Syntax: **web client ipv6 *ipv6-address***

the *ipv6-address* you specify must be in hexadecimal format using 16-bit values between colons as documented in RFC 2373.

Configuring name-to-IPv6 address resolution using IPv6 DNS resolver

The Domain Name Server (DNS) resolver feature lets you use a host name to perform Telnet and ping commands. You can also define a DNS domain on a Ruckus device and thereby recognize all hosts within that domain. After you define a domain name, the Ruckus device automatically appends the appropriate domain to the host and forwards it to the domain name server.

For example, if the domain "newyork.com" is defined on a Ruckus device, and you want to initiate a ping to host "NYC01" on that domain, you need to reference only the host name in the command instead of the host name and its domain name. For example, you could enter either of the following commands to initiate the ping.

```
device#ping ipv6 nyc01
device#ping ipv6 nyc01.newyork.com
```

Defining an IPv6 DNS entry

IPv6 defines new DNS record types to resolve queries for domain names to IPv6 addresses, as well as IPv6 addresses to domain names. Ruckus devices running IPv6 software support AAAA DNS records, which are defined in RFC 1886.

AAAA DNS records are analogous to the A DNS records used with IPv4. They store a complete IPv6 address in each record. AAAA records have a type value of 28.

To define an IPv6 DNS server address, enter command such as the following:

```
device(config)#ipv6 dns server-address 2001:DB8::1
```

Syntax: [no] **ipv6 dns server-address** *ipv6-addr* [*ipv6-addr*] [*ipv6-addr*] [*ipv6-addr*]

The *ipv6 dns server-address* parameter sets IPv6 DNS server addresses.

As an example, in a configuration where ftp6.company.net.com is a server with an IPv6 protocol stack, when a user pings ftp6.company.net.com, the Ruckus device attempts to resolve the AAAA DNS record. In addition, if the DNS server does not have an IPv6 address, as long as it is able to resolve AAAA records, it can still respond to DNS queries.

Pinging an IPv6 address

NOTE

This section describes the *IPv6 ping* command. For details about *IPv4 ping*, refer to the *FastIron Ethernet Switch Layer 3 Routing Configuration Guide*.

The **ping** command allows you to verify the connectivity from a Ruckus device to an IPv6 device by performing an ICMP for IPv6 echo test.

For example, to ping a device with the IPv6 address of 2001:DB8:847f:a385:34dd::45 from the Ruckus device, enter the following command.

```
device#ping ipv6 2001:DB8:847f:a385:34dd::45
```

Syntax: **ping** **ipv6** *ipv6-address* [**outgoing-interface** [*port* | **venumber**]] [**source** *ipv6-address*] [**count** *number*] [**timeout** *milliseconds*] [**ttl** *number*] [**size** *bytes*] [**quiet**] [**numeric**] [**no-fragment**] [**verify**] [**data** *1-to-4-byte-hex*] [**brief**]

- The *ipv6-address* parameter specifies the address of the router. You must specify this address in hexadecimal using 16-bit values between colons as documented in RFC 2373.

- The **outgoing-interface** keyword specifies a physical interface over which you can verify connectivity. If you specify a physical interface, such as an Ethernet interface, you must also specify the port number of the interface. If you specify a virtual interface, such as a VE, you must specify the number associated with the VE.
- The **source** ipv6-address parameter specifies an IPv6 address to be used as the origin of the ping packets.
- The **count** number parameter specifies how many ping packets the router sends. You can specify from 1 - 4294967296. The default is 1.
- The **timeout** milliseconds parameter specifies how many milliseconds the router waits for a reply from the pinged device. You can specify a timeout from 1 - 4294967296 milliseconds. The default is 5000 (5 seconds).
- The **ttl** number parameter specifies the maximum number of hops. You can specify a TTL from 1 - 255. The default is 64.
- The **size** bytes parameter specifies the size of the ICMP data portion of the packet. This is the payload and does not include the header. You can specify from 0 - 10000. The default is 16.
- The **no-fragment** keyword turns on the "do not fragment" bit in the IPv6 header of the ping packet. This option is disabled by default.
- The **quiet** keyword hides informational messages such as a summary of the ping parameters sent to the device, and instead only displays messages indicating the success or failure of the ping. This option is disabled by default.
- The **verify** keyword verifies that the data in the echo packet (the reply packet) is the same as the data in the echo request (the ping). By default the device does not verify the data.
- The **data** 1 - 4 byte hex parameter lets you specify a specific data pattern for the payload instead of the default data pattern, "abcd", in the packet's data payload. The pattern repeats itself throughout the ICMP message (payload) portion of the packet.

NOTE

For parameters that require a numeric value, the CLI does not check that the value you enter is within the allowed range. Instead, if you do exceed the range for a numeric value, the software rounds the value to the nearest valid value.

- The **brief** keyword causes ping test characters to be displayed. The following ping test characters are supported.

! Indicates that a reply was received.

. Indicates that the network server timed out while waiting for a reply.

U Indicates that a destination unreachable error PDU was received.

I Indicates that the user interrupted ping.

Configuring an IPv6 Syslog server

To enable IPv6 logging, specify an IPv6 Syslog server. Enter a command such as the following.

```
device(config)#log host ipv6 2000:2383:e0bb::4/128
```

Syntax: **log host ipv6** *ipv6-address* [*udp-port-num*]

The *ipv6-address* must be in hexadecimal using 16-bit values between colons as documented in RFC 2373.

The *udp-port-num* optional parameter specifies the UDP application port used for the Syslog facility.

Viewing IPv6 SNMP server addresses

Some of the **show** commands display IPv6 addresses for IPv6 SNMP servers. The following shows an example output for the **show snmp server** command.

```
device#show snmp server

    Contact:
    Location:
Community(ro): ......

Traps
    Warm/Cold start: Enable
        Link up: Enable
        Link down: Enable
        Authentication: Enable
Locked address violation: Enable
Power supply failure: Enable
    Fan failure: Enable
Temperature warning: Enable
    STP new root: Enable
STP topology change: Enable
    vsrp: Enable

Total Trap-Receiver Entries: 4

Trap-Receiver IP-Address          Port-Number Community
1      10.147.201.100
     162      .....
2      2001:DB8::200
     162      .....
3      10.147.202.100
     162      .....
4      2001:DB8::200
     162      .....
```

Disabling router advertisement and solicitation messages

Router advertisement and solicitation messages enable a node on a link to discover the routers on the same link. By default, router advertisement and solicitation messages are permitted on the device. To disable these messages, configure an IPv6 access control list that denies them. The following shows an example configuration.

```
device(config)#ipv6 access-list rtradvert
device(config)#deny icmp any any router-advertisement
device(config)#deny icmp any any router-solicitation
device(config)#permit ipv6 any any
```

Disabling IPv6 on a Layer 2 switch

IPv6 is enabled by default in the Layer 2 switch code. If desired, you can disable IPv6 on a global basis on a device running the switch code. To do so, enter the following command at the Global CONFIG level of the CLI.

```
device(config)#no ipv6 enable
```

Syntax: no ipv6 enable

To re-enable IPv6 after it has been disabled, enter **ipv6 enable**.

NOTE

IPv6 is disabled by default in the router code and must be configured on each interface that will support IPv6.

IPv6 ICMP feature configuration

As with the Internet Control Message Protocol (ICMP) for IPv4, ICMP for IPv6 provides error and informational messages. Implementation of the stateless auto configuration, neighbor discovery, and path MTU discovery features use ICMP messages.

This section explains how to configure following IPv6 ICMP features:

- ICMP rate limiting
- ICMP redirects

Configuring ICMP rate limiting

You can limit the rate at which IPv6 ICMP error messages are sent out on a network. IPv6 ICMP implements a token bucket algorithm.

To illustrate how this algorithm works, imagine a virtual bucket that contains a number of tokens. Each token represents the ability to send one ICMP error message. Tokens are placed in the bucket at a specified interval until the maximum number of tokens allowed in the bucket is reached. For each error message that ICMP sends, a token is removed from the bucket. If ICMP generates a series of error messages, messages can be sent until the bucket is empty. If the bucket is empty of tokens, error messages cannot be sent until a new token is placed in the bucket.

You can adjust the following elements related to the token bucket algorithm:

- The interval at which tokens are added to the bucket. The default is 100 milliseconds.
- The maximum number of tokens in the bucket. The default is 10 tokens.

For example, to adjust the interval to 1000 milliseconds and the number of tokens to 100 tokens, enter the following command.

```
device(config)# ipv6 icmp error-interval 1000 100
```

Syntax: **ipv6 icmp error-interval** *interval* [*number-of-tokens*]

The interval in milliseconds at which tokens are placed in the bucket can range from 0 - 2147483647. The maximum number of tokens stored in the bucket can range from 1 - 200.

NOTE

If you retain the default interval value or explicitly set the value to 100 milliseconds, output from the **show run** command does not include the setting of the **ipv6 icmp error-interval** command because the setting is the default. Also, if you configure the interval value to a number that does not evenly divide into 100000 (100 milliseconds), the system rounds up the value to a next higher value that does divide evenly into 100000. For example, if you specify an interval value of 150, the system rounds up the value to 200.

ICMP rate limiting is enabled by default. To disable ICMP rate limiting, set the interval to zero.

Enabling IPv6 ICMP redirect messages

You can enable a Layer 3 switch to send an IPv6 ICMP redirect message to a neighboring host to inform it of a better first-hop router on a path to a destination. By default, the sending of IPv6 ICMP redirect messages by a Layer 3 switch is disabled. (For more information about how ICMP redirect messages are implemented for IPv6, refer to [IPv6 neighbor discovery configuration](#) on page 172.)

NOTE

This feature is supported on Virtual Ethernet (VE) interfaces only.

For example, to enable the sending of IPv6 ICMP redirect messages on VE 2, enter the following commands.

```
device(config)#interface ve2
device(config-vif-2)#ipv6 redirects
```

To disable the sending of IPv6 ICMP redirect messages after it has been enabled on VE 2, enter the following commands.

```
device(config)#interface ve2
device(config-vif-2)#no ipv6 redirects
```

Syntax: [no] ipv6 redirects

Use the **show ipv6 interface** command to verify that the sending of IPv6 ICMP redirect messages is enabled on a particular interface.

IPv6 neighbor discovery configuration

The neighbor discovery feature for IPv6 uses IPv6 ICMP messages to do the following tasks:

- Determine the link-layer address of a neighbor on the same link.
- Verify that a neighbor is reachable.
- Track neighbor routers.

An IPv6 host is required to listen for and recognize the following addresses that identify itself:

- Link-local address.
- Assigned unicast address.
- Loopback address.
- All-nodes multicast address.
- Solicited-node multicast address.
- Multicast address to all other groups to which it belongs.

You can adjust the following IPv6 neighbor discovery features:

- Neighbor solicitation messages for duplicate address detection.
- Router advertisement messages:
 - Interval between router advertisement messages.
 - Value that indicates a router is advertised as a default router (for use by all nodes on a given link).
 - Prefixes advertised in router advertisement messages.
 - Flags for host stateful autoconfiguration.
- Amount of time during which an IPv6 node considers a remote node reachable (for use by all nodes on a given link).

IPv6 neighbor discovery configuration notes

NOTE

For all solicitation and advertisement messages, Ruckus uses seconds as the unit of measure instead of milliseconds.

- If you add a port to a port-based VLAN, and the port has IPv6 neighbor discovery configuration, the system will clean up the neighbor discovery configuration from the port and display the following message on the console.

ND6 port config on the new member ports removed

- Neighbor discovery is not supported on tunnel interfaces.

Neighbor solicitation and advertisement messages

Neighbor solicitation and advertisement messages enable a node to determine the link-layer address of another node (neighbor) on the same link. (This function is similar to the function provided by the Address Resolution Protocol [ARP] in IPv4.) For example, node 1 on a link wants to determine the link-layer address of node 2 on the same link. To do so, node 1, the source node, multicasts a neighbor solicitation message. The neighbor solicitation message, which has a value of 135 in the Type field of the ICMP packet header, contains the following information:

- Source address: IPv6 address of node 1 interface that sends the message.
- Destination address: solicited-node multicast address (FF02:0:0:0:1:FF00::/104) that corresponds the IPv6 address of node 2.
- Link-layer address of node 1.
- A query for the link-layer address of node 2.

After receiving the neighbor solicitation message from node 1, node 2 replies by sending a neighbor advertisement message, which has a value of 136 in the Type field of the ICMP packet header. The neighbor solicitation message contains the following information:

- Source address: IPv6 address of the node 2 interface that sends the message.
- Destination address: IPv6 address of node 1.
- Link-layer address of node 2.

After node 1 receives the neighbor advertisement message from node 2, nodes 1 and 2 can now exchange packets on the link.

After the link-layer address of node 2 is determined, node 1 can send neighbor solicitation messages to node 2 to verify that it is reachable. Also, nodes 1, 2, or any other node on the same link can send a neighbor advertisement message to the all-nodes multicast address (FF02::1) if there is a change in their link-layer address.

Router advertisement and solicitation messages

Router advertisement and solicitation messages enable a node on a link to discover the routers on the same link.

Each configured router interface on a link sends out a router advertisement message, which has a value of 134 in the Type field of the ICMP packet header, periodically to the all-nodes link-local multicast address (FF02::1).

A configured router interface can also send a router advertisement message in response to a router solicitation message from a node on the same link. This message is sent to the unicast IPv6 address of the node that sent the router solicitation message.

At system startup, a host on a link sends a router solicitation message to the all-routers multicast address (FF01). Sending a router solicitation message, which has a value of 133 in the Type field of the ICMP packet header, enables the host to automatically configure its IPv6 address immediately instead of awaiting the next periodic router advertisement message.

Because a host at system startup typically does not have a unicast IPv6 address, the source address in the router solicitation message is usually the unspecified IPv6 address (0:0:0:0:0:0). If the host has a unicast IPv6 address, the source address is the unicast IPv6 address of the host interface sending the router solicitation message.

Entering the **ipv6 unicast-routing** command automatically enables the sending of router advertisement messages on all configured router Ethernet interfaces. You can configure several router advertisement message parameters. For information about disabling the sending of router advertisement messages and the router advertisement parameters that you can configure, refer to [Enabling and disabling IPv6 router advertisements](#) on page 177 and [Setting IPv6 router advertisement parameters](#) on page 175.

Neighbor redirect messages

After forwarding a packet, by default, a router can send a neighbor redirect message to a host to inform it of a better first-hop router. The host receiving the neighbor redirect message will then readdress the packet to the better router.

A router sends a neighbor redirect message only for unicast packets, only to the originating node, and to be processed by the node.

A neighbor redirect message has a value of 137 in the Type field of the ICMP packet header.

Setting neighbor solicitation parameters for duplicate address detection

Although the stateless auto configuration feature assigns the 64-bit interface ID portion of an IPv6 address using the MAC address of the host's NIC, duplicate MAC addresses can occur. Therefore, the duplicate address detection feature verifies that a unicast IPv6 address is unique before it is assigned to a host interface by the stateless auto configuration feature. Duplicate address detection verifies that a unicast IPv6 address is unique.

If duplicate address detection identifies a duplicate unicast IPv6 address, the address is not used. If the duplicate address is the link-local address of the host interface, the interface stops processing IPv6 packets.

NOTE

Duplicate Address Detection (DAD) is not currently supported with IPv6 tunnels. Make sure tunnel endpoints do not have duplicate IP addresses.

You can configure the following neighbor solicitation message parameters that affect duplicate address detection while it verifies that a tentative unicast IPv6 address is unique:

- The number of consecutive neighbor solicitation messages that duplicate address detection sends on an interface. By default, duplicate address detection sends three neighbor solicitation messages without any follow-up messages.
- The interval in seconds at which duplicate address detection sends a neighbor solicitation message on an interface. By default, duplicate address detection sends a neighbor solicitation message every 1000 milliseconds.

For example, to change the number of neighbor solicitation messages sent on Ethernet interface 1/3/1 to two and the interval between the transmission of the two messages to 9 seconds, enter the following commands.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 nd dad attempt 2
device(config-if-e1000-1/3/1)#ipv6 nd ns-interval 9000
```

Syntax: [no] **ipv6 nd dad attempt** *number*

Syntax: [no] **ipv6 nd ns-interval** *number*

For the number of neighbor solicitation messages, specify a number from 0 - 255. The default is 3. Configuring a value of 0 disables duplicate address detection processing on the specified interface. To restore the number of messages to the default value, use the **no** form of this command.

For the interval between neighbor solicitation messages and the value for the retrans timer in router advertisements, specify a number from 0 - 4294967295 milliseconds. The default value for the interval between neighbor solicitation messages is 1000 milliseconds. The default value for the retrans timer is 0. Ruckus does not recommend very short intervals in normal IPv6 operation. When a non-default value is configured, the configured time is both advertised and used by the router itself. To restore the default interval, use the **no** form of this command.

Setting IPv6 router advertisement parameters

You can adjust the following parameters for router advertisement messages:

- The interval (in seconds) at which an interface sends router advertisement messages. By default, an interface sends a router advertisement message every 200 seconds.
- The "router lifetime" value, which is included in router advertisements sent from a particular interface. The value (in seconds) indicates if the router is advertised as a default router on this interface. If you set the value of this parameter to 0, the router is not advertised as a default router on an interface. If you set this parameter to a value that is not 0, the router is advertised as a default router on this interface. By default, the router lifetime value included in router advertisement messages sent from an interface is 1800 seconds.
- The hop limit to be advertised in the router advertisement.

When adjusting these parameter settings, Ruckus recommends that the interval between router advertisement transmission be less than or equal to the router lifetime value if the router is advertised as a default router. For example, to adjust the interval of router advertisements to 300 seconds and the router lifetime value to 1900 seconds on Ethernet interface 1/3/1, enter the following commands.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 nd ra-interval 300
device(config-if-e1000-1/3/1)#ipv6 nd ra-lifetime 1900
device(config-if-e1000-1/3/1)#ipv6 nd ra-hop-limit 1
```

Here is another example with a specified range.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 nd ra-interval range 33 55
device(config-if-e1000-1/3/1)#ipv6 nd ra-lifetime 1900
device(config-if-e1000-1/3/1)#ipv6 nd ra-hop-limit 1
```

Syntax: [no] **ipv6 nd ra-interval** *number | min-range-value max-range-value*

Syntax: [no] **ipv6 nd ra-lifetime** *number*

Syntax: **ipv6 nd ra-hop-limit** *number*

number is a value from 0 - 255. The default is 64.

The **ipv6 nd ra-interval** *number* can be a value between 3 - 1800 seconds. The default is 200 seconds. The actual RA interval will be from .5 to 1.5 times the configured or default value. For example, in the above configuration, for **ipv6 nd ra-interval 300**, the range would be 150 - 450. To restore the default interval of 200 seconds, use the no form of the command.

The **ipv6 nd ra-interval range** *min range value max range value* command lets you specify a range of values instead of a single value.

The *min-range-value* specifies the minimum number of seconds allowed between sending unsolicited multicast router advertisements from the interface. The default is 0.33 times the *max-range-value* if the *max-range-value* is greater than or equal

to 9 seconds. Otherwise, the default is the value specified by the max-range-value . The min-range-value can be a number between -3 - (.75 x max range value).

The max-range-value parameter specifies the maximum number of seconds allowed between sending unsolicited multicast router advertisements from the interface. This number can be between 4 - 1800 seconds and must be greater than the min-range-value x 1.33. The default is 600 seconds.

The **ipv6 nd ra-lifetime** number is a value between 0 - 9000 seconds. To restore the router lifetime value of 1800 seconds, use the **no** form of the command.

The **ipv6 nd ra-hop-limit** number is a value from 0 - 255. The default is 64.

NOTE

By default, router advertisements will always have the MTU option. To suppress the MTU option, use the following command at the Interface level of the CLI: **ipv6 nd suppress-mtu-option** .

Prefixes advertised in IPv6 router advertisement messages

By default, router advertisement messages include prefixes configured as addresses on router interfaces using the **ipv6 address** command. You can use the **ipv6 nd prefix-advertisement** command to control exactly which prefixes are included in router advertisement messages. Along with which prefixes the router advertisement messages contain, you can also specify the following parameters:

- **Valid lifetime** --(Mandatory) The time interval (in seconds) in which the specified prefix is advertised as valid. The default is 2592000 seconds (30 days). When the timer expires, the prefix is no longer considered to be valid.
- **Preferred lifetime** --(Mandatory) The time interval (in seconds) in which the specified prefix is advertised as preferred. The default is 604800 seconds (7 days). When the timer expires, the prefix is no longer considered to be preferred.
- **Onlink flag** --(Optional) If this flag is set, the specified prefix is assigned to the link upon which it is advertised. Nodes sending traffic to addresses that contain the specified prefix consider the destination to be reachable on the local link.
- **Autoconfiguration flag** --(Optional) If this flag is set, the stateless auto configuration feature can use the specified prefix in the automatic configuration of 128-bit IPv6 addresses for hosts on the local link, provided the specified prefix is aggregatable, as specified in RFC 2374.

For example, to advertise the prefix 2001:DB8:a487:7365::/64 in router advertisement messages sent out on Ethernet interface 1/3/1 with a valid lifetime of 1000 seconds, a preferred lifetime of 800 seconds, and the Onlink and Autoconfig flags set, enter the following commands.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 nd prefix-advertisement 2001:DB8:a487:7365::/64 1000 800 onlink
autoconfig
```

Syntax: [no] ipv6 nd prefix-advertisement *ipv6-prefix/prefix-length valid-lifetime preferred-lifetime [autoconfig] [onlink]*

You must specify the **ipv6-prefix** parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

You must specify the **prefix-length** parameter as a decimal value. A slash mark (/) must follow the **ipv6-prefix** parameter and precede the **prefix-length** parameter.

The valid lifetime and preferred lifetime is a numerical value between 0 - 4294967295 seconds. The default valid lifetime is 2592000 seconds (30 days), while the default preferred lifetime is 604800 seconds (7 days).

To remove a prefix from the router advertisement messages sent from a particular interface, use the **no** form of this command.

Setting flags in IPv6 router advertisement messages

An IPv6 router advertisement message can include the following flags:

- Managed Address Configuration--This flag indicates to hosts on a local link if they should use the stateful autoconfiguration feature to get IPv6 addresses for their interfaces. If the flag is set, the hosts use stateful autoconfiguration to get addresses as well as non-IPv6-address information. If the flag is not set, the hosts do not use stateful autoconfiguration to get addresses and if the hosts can get non-IPv6-address information from stateful autoconfiguration is determined by the setting of the Other Stateful Configuration flag.
- Other Stateful Configuration--This flag indicates to hosts on a local link if they can get non-IPv6 address autoconfiguration information. If the flag is set, the hosts can use stateful autoconfiguration to get non-IPv6-address information.

NOTE

When determining if hosts can use stateful autoconfiguration to get non-IPv6-address information, a set Managed Address Configuration flag overrides an unset Other Stateful Configuration flag. In this situation, the hosts can obtain nonaddress information. However, if the Managed Address Configuration flag is not set and the Other Stateful Configuration flag is set, then the setting of the Other Stateful Configuration flag is used.

By default, the Managed Address Configuration and Other Stateful Configuration flags are not set in router advertisement messages. For example, to set these flags in router advertisement messages sent from Ethernet interface 1/3/1, enter the following commands.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 nd managed-config-flag
device(config-if-e1000-1/3/1)#ipv6 nd other-config-flag
```

Syntax: [no] ipv6 nd managed-config-flag

Syntax: [no] ipv6 nd other-config-flag

To remove either flag from router advertisement messages sent on an interface, use the **no** form of the respective command.

Enabling and disabling IPv6 router advertisements

If IPv6 unicast routing is enabled on an Ethernet interface, by default, this interface sends IPv6 router advertisement messages. However, by default, non-LAN interface types, for example, tunnel interfaces, do not send router advertisement messages.

To disable the sending of router advertisement messages on an Ethernet interface, enter commands such as the following.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 nd suppress-ra
```

To enable the sending of router advertisement messages on a tunnel interface, enter commands such as the following.

```
device(config)#interface tunnel 1
device(config-tunif-1)#no ipv6 nd suppress-ra
```

Syntax: [no] ipv6 nd suppress-ra

IPv6 router advertisement preference support

IPv6 router advertisement (RA) preference enables IPv6 RA messages to communicate default router preferences from IPv6 routers to IPv6 hosts in network topologies where the host has multiple routers on its Default Router List. This improves the ability of the IPv6 hosts to select an appropriate router for an off-link destination.

Configuring IPv6 RA preference

Configuring IPv6 RA preference

If IPv6 unicast routing is enabled on an Ethernet interface, by default, this interface sends IPv6 router advertisement messages. The IPv6 router sets the preference field based on the configured value on IPv6 RA and sends it periodically to the IPv6 host or as a response to the router solicitations.

To configure IPv6 RA preference for the IPv6 router, use the **ipv6 nd router-preference** in the interface configuration mode.

The following example shows the router preference configured for interface 1/2/3 with the preference value "low".

```
device(config)#interface ethernet 1/2/3
device(config-if-e1000-1/2/3)#ipv6 nd router-preference low
```

Configuring reachable time for remote IPv6 nodes

You can configure the duration (in seconds) that a router considers a remote IPv6 node reachable. By default, a router interface uses the value of 30 seconds.

The router advertisement messages sent by a router interface include the amount of time specified by the **ipv6 nd reachable-time** command so that nodes on a link use the same reachable time duration. By default, the messages include a default value of 0.

Ruckus does not recommend configuring a short reachable time duration, because a short duration causes the IPv6 network devices to process the information at a greater frequency.

For example, to configure the reachable time of 40 seconds for Ethernet interface 1/3/1, enter the following commands.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 nd reachable-time 40
```

Syntax: [no] **ipv6 nd reachable-time** *seconds*

For the *seconds* variable, specify a number from 0 through 3600 seconds. To restore the default time, use the **no** form of this command.

NOTE

The actual reachable time will be from 0.5 to 1.5 times the configured or default value.

IPv6 MTU

The IPv6 maximum transmission unit (MTU) is the maximum length of an IPv6 packet that can be transmitted on a particular interface. If an IPv6 packet is longer than an MTU, the host that originated the packet fragments the packet and transmits its contents in multiple packets that are shorter than the configured MTU.

By default, in non-jumbo mode, the default and maximum Ethernet MTU size is 1500 bytes. When jumbo mode is enabled, the default Ethernet MTU size is 9216. The maximum Ethernet MTU size is 10200 for Brocade ICX 6610 devices, 10178 for Brocade ICX 6450 devices, and 10218 for other devices.

Configuration notes and feature limitations for IPv6 MTU

- The IPv6 MTU functionality is applicable to VEs and physical IP interfaces. It applies to traffic routed between networks.

- For ICX 7250, ICX 7450, and ICX 7750 devices, the IPv4 and IPv6 MTU values are the same. Modifying one also changes the value of the other.
- For ICX 7250, ICX 7450, and ICX 7750 devices, the minimum IPv4 and IPv6 MTU values for both physical and virtual interfaces are 1280.
- You cannot use IPv6 MTU to set Layer 2 maximum frame sizes per interface. Enabling global jumbo mode causes all interfaces to accept Layer 2 frames.

Changing the IPv6 MTU

You can configure the IPv6 MTU on individual interfaces. For example, to configure the MTU on Ethernet interface 1/3/1 as 1280 bytes, enter the following commands.

```
device(config)#interface ethernet 1/3/1
device(config-if-e1000-1/3/1)#ipv6 mtu 1280
```

Syntax: [no] **ipv6 mtu** *bytes*

For *bytes*, specify a value between 1280 - 1500, or 1280 - 10218 if jumbo mode is enabled. For ICX 6610 and ICX 6450 devices, you can specify a value between 1280 and 10200. If a non-default value is configured for an interface, router advertisements include an MTU option.

NOTE

IPv6 MTU cannot be configured globally. It is supported only on devices running Layer 3 software.

Static neighbor entries configuration

In some special cases, a neighbor cannot be reached using the neighbor discovery feature. In this situation, you can add a static entry to the IPv6 neighbor discovery cache, which causes a neighbor to be reachable at all times without using neighbor discovery. (A static entry in the IPv6 neighbor discovery cache functions like a static ARP entry in IPv4.)

NOTE

A port that has a statically assigned IPv6 entry cannot be added to a VLAN.

NOTE

Static neighbor configurations will be cleared on secondary ports when a LAG is formed.

For example, to add a static entry for a neighbor with the IPv6 address 2001:DB8:2678:47b and link-layer address 0000.002b.8641 that is reachable through Ethernet interface 1/3/1, enter the **ipv6 neighbor** command.

```
device(config)# ipv6 neighbor 2001:DB8:2678:47b ethernet 1/3/1 0000.002b.8641
```

Syntax: [no] **ipv6 neighbor** *ipv6-address* **ether***net port | ve**e-number* [**ether***net port*] *link-layer-address*

The *ipv6-address* parameter specifies the address of the neighbor.

The **ether***net | ve* parameter specifies the interface through which to reach a neighbor. If you specify an Ethernet interface, specify the port number of the Ethernet interface. If you specify a VE, specify the VE number and then the Ethernet port numbers associated with the VE. The link-layer address is a 48-bit hardware address of the neighbor.

If you attempt to add an entry that already exists in the neighbor discovery cache, the software changes the already existing entry to a static entry.

To remove a static IPv6 entry from the IPv6 neighbor discovery cache, use the **no** form of this command.

Limiting the number of hops an IPv6 packet can traverse

By default, the maximum number of hops an IPv6 packet can traverse is 64. You can change this value to between 0 - 255 hops. For example, to change the maximum number of hops to 70, enter the following command.

```
device(config)#ipv6 hop-limit 70
```

Syntax: [no] **ipv6 hop-limit** *number*

Use the **no** form of the command to restore the default value.

hop-limit 0 will transmit packets with default (64) hop limit.

number can be from 0 - 255.

IPv6 source routing security enhancements

The IPv6 specification (RFC 2460) specifies support for IPv6 source-routed packets using a type 0 Routing extension header, requiring device and host to process the type 0 routing extension header. However, this requirement may leave a network open to a DoS attack.

A security enhancement disables sending IPv6 source-routed packets to IPv6 devices. (This enhancement conforms to RFC 5095.)

By default, when the router drops a source-routed packet, it sends an ICMP Parameter Problem (type 4), Header Error (code 0) message to the packet's source address, pointing to the unrecognized routing type. To disable these ICMP error messages, enter the following command:

```
device(config)# no ipv6 icmp source-route
```

Syntax: [no] **ipv6 icmp source-route**

Use the **ipv6 icmp source-route** form of the command to enable the ICMP error messages.

TCAM space on FCX device configuration

FCX devices store routing information for IPv4 and IPv6 and GRE tunnel information in the same TCAM table. You can configure the amount of TCAM space to allocate for IPv4 routing information and GRE tunnels. The remaining space is allocated automatically for IPv6 routing information.

FCX devices have TCAM space to store 16,000 IPv4 route entries. Each IPv6 route entry and GRE tunnel use as much storage space as four IPv4 route entries. The default, maximum, and minimum allocation values for each type of data are shown in [TCAM space on FCX device configuration](#).

TABLE 32 TCAM space allocation on FCX and ICX devices (except ICX 6450)

	Default	Maximum	Minimum
IPv4 route entries	12000	15168	4096
IPv6 route entries	908	2884	68
GRE tunnels	16	64	16

Allocating TCAM space for IPv4 routing information

For example, to allocate 13,512 IPv4 route entries, enter the following command:

```
device(config)# system-max ip-route 13512
```

Syntax: **system-max ip-route routes**

The routes parameter specifies how many IPv4 route entries get allocated. The command output shows the new space allocations for IPv4 and IPv6. You must save the running configuration to the startup configuration and reload the device for the changes to take effect.

After the device reloads, the space allocated for IPv4 and IPv6 routing information appears in the device running configuration in this format:

```
system-max ip-route 13512
system-max ip6-route 514
```

NOTE

If you disable IPv6 routing, the TCAM space allocations do not change. If you want to allocate the maximum possible space for IPv4 routing information, you must configure the TCAM space manually.

Allocating TCAM space for GRE tunnel information

For example, to allocate space for 64 GRE tunnels, enter the following command at the Privileged EXEC level:

```
device#system-max gre-tunnels 64
```

Syntax: **system-max gre-tunnels tunnels**

The tunnels parameter specifies the number of GRE tunnels to allocate.

Clearing global IPv6 information

You can clear the following global IPv6 information:

- Entries from the IPv6 cache.
- Entries from the IPv6 neighbor table.
- IPv6 routes from the IPv6 route table.
- IPv6 traffic statistics.

Clearing the IPv6 cache

You can remove all entries from the IPv6 cache or specify an entry based on the following:

- IPv6 prefix.
- IPv6 address.
- Interface type.

For example, to remove entries for IPv6 address 2000:e0ff::1, enter the following command at the Privileged EXEC level or any of the Config levels of the CLI.

```
device#clear ipv6 cache 2000:e0ff::1
```

Syntax: **clear ipv6 cache** [*ipv6-prefix/prefix-length* | *ipv6-address* | **ethernet** *port* | **tunnel** *number* | **ve** *number* | **vrf** *vrf-name*]

You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373. You must specify the *prefix-length* parameter as a decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter.

You must specify the *ipv6-address* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

The **ethernet** | **tunnel** | **ve** | **vrf** parameter specifies the interfaces for which you can remove cache entries. If you specify an Ethernet interface, also specify the port number associated with the interface. If you specify a VE, VRF, or tunnel interface, also specify the VE, VRF name, or tunnel number, respectively.

Clearing IPv6 neighbor information

You can remove all entries from the IPv6 neighbor table or specify an entry based on the following:

- IPv6 prefix
- IPv6 address
- Interface type

For example, to remove entries for Ethernet interface 1/3/1, enter the following command at the Privileged EXEC level or any of the CONFIG levels of the CLI.

```
device#clear ipv6 neighbor ethernet 1/3/1
```

Syntax: **clear ipv6 neighbor** [*ipv6-prefix/prefix-length* | *ipv6-address* | **ethernet** *port* | **ve** *number* | **vrf** *vrf-name*]

You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373. You must specify the *prefix-length* parameter as a decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter.

You must specify the *ipv6-address* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

The **ethernet** | **ve** | **vrf** parameter specifies the interfaces for which you can remove cache entries. If you specify an Ethernet interface, also specify the port number associated with the interface. If you specify a VRF or VE, also specify the VRF name or VE number respectively.

Clearing IPv6 routes from the IPv6 route table

You can clear all IPv6 routes or only those routes associated with a particular IPv6 prefix from the IPv6 route table and reset the routes.

For example, to clear IPv6 routes associated with the prefix 2000:7838::/32, enter the following command at the Privileged EXEC level or any of the Config levels of the CLI.

```
device#clear ipv6 route 2000:7838::/32
```

Syntax: **clear ipv6 route** [*ipv6-prefix/prefix-length* | **vrf** *vrf-name*]

The *ipv6-prefix / prefix-length* parameter clears routes associated with a particular IPv6 prefix. You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373. You must specify the *prefix-length* parameter as a decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter. If you specify a VRF parameter, specify the VRF name.

Clearing IPv6 traffic statistics

To clear all IPv6 traffic statistics (reset all fields to zero), enter the following command at the Privileged EXEC level or any of the Config levels of the CLI.

```
device(config)#clear ipv6 traffic
```

Syntax: **clear ipv6 traffic**

Displaying global IPv6 information

You can display output for the following global IPv6 parameters:

- IPv6 cache
- IPv6 interfaces
- IPv6 neighbors
- IPv6 route table
- Local IPv6 routers
- IPv6 TCP connections and the status of individual connections
- IPv6 traffic statistics

Displaying IPv6 cache information

The IPv6 cache contains an IPv6 host table that has indices to the next hop gateway and the router interface on which the route was learned.

To display IPv6 cache information, enter the following command at any CLI level.

```
device# show ipv6 cache
Total number of cache entries: 10
  IPv6 Address           Next Hop          Port
 1  2001:DB8::2           LOCAL            tunnel 2
 2  2001:DB8::106         LOCAL            ethe 1/3/2
 3  2001:DB8::110         DIRECT           ethe 1/3/2
 4  2001:DB8:46a::1       LOCAL            ethe 1/3/2
 5  2001:DB8::2e0:52ff:fe99:9737 LOCAL            ethe 1/3/2
 6  2001:DB8::ffff:ffff:ffff LOCAL           loopback 2
 7  2001:DB8::c0a8:46a    LOCAL            tunnel 2
 8  2001:DB8::c0a8:46a    LOCAL            tunnel 6
 9  2001:DB8::1           LOCAL           loopback 2
10  2001:DB8::2e0:52ff:fe99:9700 LOCAL            ethe 1/3/1
```

Syntax: **show ipv6 cache [index-number | ipv6-prefix/prefix-length | ipv6-address | ethernet unit / slot / port | vnumber | tunnel number]**

The *index-number* parameter restricts the display to the entry for the specified index number and subsequent entries.

The *ipv6-prefix/prefix-length* parameter restricts the display to the entries for the specified IPv6 prefix. You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373. You must specify the *prefix-length* parameter as a decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter.

The **ethernet | ve | tunnel** parameter restricts the display to the entries for the specified interface. The *ipv6-address* parameter restricts the display to the entries for the specified IPv6 address. You must specify this parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

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Displaying global IPv6 information

If you specify an Ethernet interface, also specify the *unit / slot / port* number associated with the interface. If you specify a VE interface, also specify the VE number. If you specify a tunnel interface, also specify the tunnel number.

This display shows the following information.

TABLE 33 IPv6 cache information fields

Field	Description
Total number of cache entries	The number of entries in the cache table.
IPv6 Address	The host IPv6 address.
Next Hop	The next hop, which can be one of the following: <ul style="list-style-type: none"> • Direct - The next hop is directly connected to the router. • Local - The next hop is originated on this router. • ipv6 address - The IPv6 address of the next hop.
Port	The port on which the entry was learned.

Displaying IPv6 interface information

To display IPv6 interface information, enter the following command at any CLI level.

```
device#show ipv6 interface
Routing Protocols : R - RIP O - OSPF
Interface      Status      Routing      Global Unicast Address
Ethernet 1/3/3   down/down    R
Ethernet 1/3/5   down/down
Ethernet 1/3/17  up/up       2017::c017:101/64
Ethernet 1/3/19  up/up       2019::c019:101/64
VE 4           down/down
VE 14          up/up       2024::c060:101/64
Loopback 1     up/up       ::1/128
Loopback 2     up/up       2005::303:303/128
Loopback 3     up/up
```

Syntax: **show ipv6 interface [interface [unit / slot / port | number]]**

The interface parameter displays detailed information for a specified interface. For the interface, you can specify the **Ethernet**, **loopback**, **tunnel**, or **VE** keywords. If you specify an Ethernet interface, also specify *unit / slot / port*. If you specify a loopback, tunnel, or VE interface, also specify the number associated with the interface.

This display shows the following information.

TABLE 34 General IPv6 interface information fields

Field	Description
Routing protocols	A one-letter code that represents a routing protocol that can be enabled on an interface.
Interface	The interface type, and the port number or number of the interface.
Status	The status of the interface. The entry in the Status field will be either "up/up" or "down/down".
Routing	The routing protocols enabled on the interface.
Global Unicast Address	The global unicast address of the interface.

To display detailed information for a specific interface, enter a command such as the following at any CLI level.

```
device#show ipv6 interface ethernet 1/3/1
Interface Ethernet 1/3/1 is up, line protocol is up
  IPv6 is enabled, link-local address is fe80::2e0:52ff:fe99:97
```

```

Global unicast address(es):
Joined group address(es):
  ff02::9
  ff02::1:ff99:9700
  ff02::2
  ff02::1
MTU is 1500 bytes
ICMP redirects are enabled
ND DAD is enabled, number of DAD attempts: 3
ND reachable time is 30 seconds
ND advertised reachable time is 0 seconds
ND retransmit interval is 1 seconds
ND advertised retransmit interval is 0 seconds
ND router advertisements are sent every 200 seconds
ND router advertisements live for 1800 seconds
No Inbound Access List Set
No Outbound Access List Set
RIP enabled

```

This display shows the following information.

TABLE 35 Detailed IPv6 interface information fields

Field	Description
Interface/line protocol status	The status of interface and line protocol. If you have disabled the interface with the disable command, the status will be "administratively down". Otherwise, the status is either "up" or "down".
IPv6 status/link-local address	The status of IPv6. The status is either "enabled" or "disabled". Displays the link-local address, if one is configured for the interface.
Global unicast address(es)	Displays the global unicast address(es), if one or more are configured for the interface.
Joined group address(es)	The multicast address(es) that a router interface listens for and recognizes.
MTU	The setting of the maximum transmission unit (MTU) configured for the IPv6 interface. The MTU is the maximum length an IPv6 packet can have to be transmitted on the interface. If an IPv6 packet is longer than an MTU, the host that originated the packet fragments the packet and transmits its contents in multiple packets that are shorter than the configured MTU.
ICMP	The setting of the ICMP redirect parameter for the interface.
ND	The setting of the various neighbor discovery parameters for the interface.
Access List	The inbound and outbound access control lists applied to the interface.
Routing protocols	The routing protocols enabled on the interface.

Displaying IPv6 neighbor information

You can display the IPv6 neighbor table, which contains an entry for each IPv6 neighbor with which the router exchanges IPv6 packets.

To display the IPv6 neighbor table, enter the following command at any CLI level.

```

device(config)# show ipv6 neighbor
Total number of Neighbor entries: 3
IPv6 Address          LinkLayer-Addr  State      Age    Port      vlan  IsR
2001:DB8::55           0000.0002.0002  *REACH    0      e 1/3/11   -     0
2000:4::110            0000.0091.bb37  REACH    20     e 1/3/1

```

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Displaying global IPv6 information

```
fe80::2e0:52ff:fe91:bb37 0000.0091.bb37  DELAY      1      e 1/3/2   4      1
fe80::2e0:52ff:fe91:bb40 0000.0091.bb40  STALE     5930    e 1/3/3   5      1
```

Syntax: **show ipv6 neighbor** [*ipv6-prefix/prefix-length* | *ipv6-address* | *interface* [*unit / slot / port* | *number*]]

The *ipv6-prefix / prefix-length* parameters restrict the display to the entries for the specified IPv6 prefix. You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373. You must specify the *prefix-length* parameter as a decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter.

The *ipv6-address* parameter restricts the display to the entries for the specified IPv6 address. You must specify this parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

The *interface* parameter restricts the display to the entries for the specified router interface. For this parameter, you can specify the **ether** or **ve** keywords. If you specify an Ethernet interface, also specify *unit / slot / port*. If you specify a VE interface, also specify the VE number.

This display shows the following information.

TABLE 36 IPv6 neighbor information fields

Field	Description
Total number of neighbor entries	The total number of entries in the IPv6 neighbor table.
IPv6 Address	The 128-bit IPv6 address of the neighbor.
Link-Layer Address	The 48-bit interface ID of the neighbor.
State	<p>The current state of the neighbor. Possible states are as follows:</p> <ul style="list-style-type: none"> • INCOMPLETE - Address resolution of the entry is being performed. • *REACH - The static forward path to the neighbor is functioning properly. • REACH - The forward path to the neighbor is functioning properly. • STALE - This entry has remained unused for the maximum interval. While stale, no action takes place until a packet is sent. • DELAY - This entry has remained unused for the maximum interval, and a packet was sent before another interval elapsed. • PROBE - Neighbor solicitation are transmitted until a reachability confirmation is received.
Age	The number of seconds the entry has remained unused. If this value remains unused for the number of seconds specified by the ipv6 nd reachable-time command (the default is 30 seconds), the entry is removed from the table.
Port	The physical port on which the entry was learned.
vlan	The VLAN on which the entry was learned.
IsR	Determines if the neighbor is a router or host: 0 - Indicates that the neighbor is a host. 1 - Indicates that the neighbor is a router.

Displaying the IPv6 route table

To display the IPv6 route table, enter the following command at any CLI level.

```
device# show ipv6 route
IPv6 Routing Table - 7 entries:
Type Codes: C - Connected, S - Static, R - RIP, O - OSPF, B - BGP
OSPF Sub Type Codes: O - Intra, Oi - Inter, O1 - Type1 external, O2 - Type2 external
Type   IPv6 Prefix          Next Hop Router      Interface    Dis/Metric
C     2000:4::/64           ::                  eth1/3/2    0/0
S     2001:DB8::/16          ::                  tunnel 6    1/1
S     2001:DB8:1234::/32     ::                  tunnel 6    1/1
C     2001:DB8:46a::/64      ::                  eth1/3/2    0/0
C     2001:DB8::1/128        ::                  loopback 2  0/0
O     2001:DB8::2/128        fe80::2e0:52ff:fe91:bb37  eth1/3/2    110/1
C     2001:DB8::/64          ::                  tunnel 2    0/0
```

Syntax: **show ipv6 route** [*ipv6-address* | *ipv6-prefix/prefix-length* | **bgp** | **connect** | **ospf** | **rip** | **static** | **summary**]

The *ipv6-address* parameter restricts the display to the entries for the specified IPv6 address. You must specify the *ipv6-address* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

The *ipv6-prefix / prefix-length* parameters restrict the display to the entries for the specified IPv6 prefix. You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373. You must specify the *prefix-length* parameter as a decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter.

The **bgp** keyword restricts the display to entries for BGP4 routes.

The **connect** keyword restricts the display to entries for directly connected interface IPv6 routes.

The **ospf** keyword restricts the display to entries for OSPFv3 routes.

The **rip** keyword restricts the display to entries for RIPng routes.

The **static** keyword restricts the display to entries for static IPv6 routes.

The **summary** keyword displays a summary of the prefixes and different route types.

The following table lists the information displayed by the **show ipv6 route** command.

TABLE 37 IPv6 route table fields

Field	Description
Number of entries	The number of entries in the IPv6 route table.
Type	The route type, which can be one of the following: <ul style="list-style-type: none"> • C - The destination is directly connected to the router. • S - The route is a static route. • R - The route is learned from RIPng. • O - The route is learned from OSPFv3. • B - The route is learned from BGP4.
IPv6 Prefix	The destination network of the route.
Next-Hop Router	The next-hop router.
Interface	The interface through which this router sends packets to reach the route's destination.
Dis/Metric	The route's administrative distance and metric value.

To display a summary of the IPv6 route table, enter the following command at any CLI level.

```
device#show ipv6 route summary
IPv6 Routing Table - 7 entries:
 4 connected, 2 static, 0 RIP, 1 OSPF, 0 BGP
 Number of prefixes:
 /16: 1 /32: 1 /64: 3 /128: 2
```

The following table lists the information displayed by the **show ipv6 route summary** command.

TABLE 38 IPv6 route table summary fields

Field	Description
Number of entries	The number of entries in the IPv6 route table.
Number of route types	The number of entries for each route type.
Number of prefixes	A summary of prefixes in the IPv6 route table, sorted by prefix length.

Displaying local IPv6 routers

The Ruckus device can function as an IPv6 host, instead of an IPv6 router, if you configure IPv6 addresses on its interfaces but do not enable IPv6 routing using the **ipv6 unicast-routing** command.

From the IPv6 host, you can display information about IPv6 routers to which the host is connected. The host learns about the routers through their router advertisement messages. To display information about the IPv6 routers connected to an IPv6 host, enter the following command at any CLI level.

```
device#show ipv6 router
Router fe80::2e0:80ff:fe46:3431 on Ethernet 50, last update 0 min
Hops 64, Lifetime 1800 sec
Reachable time 0 msec, Retransmit time 0 msec
```

Syntax: show ipv6 router

If you configure your Ruckus device to function as an IPv6 router (you configure IPv6 addresses on its interfaces and enable IPv6 routing using the **ipv6 unicast-routing** command) and you enter the **show ipv6 router command**, you will receive the following output.

```
No IPv6 router in table
```

Meaningful output for this command is generated for Ruckus devices configured to function as IPv6 hosts only.

This display shows the following information.

TABLE 39 IPv6 local router information fields

Field	Description
Router ipv6 address on interface port	The IPv6 address for a particular router interface.
Last update	The amount of elapsed time (in minutes) between the current and previous updates received from a router.
Hops	The default value that should be included in the Hop Count field of the IPv6 header for outgoing IPv6 packets. The hops value applies to the router for which you are displaying information and should be followed by IPv6 hosts attached to the router. A value of 0 indicates that the router leaves this field unspecified.
Lifetime	The amount of time (in seconds) that the router is useful as the default router.
Reachable time	The amount of time (in milliseconds) that a router assumes a neighbor is reachable after receiving a reachability confirmation. The

TABLE 39 IPv6 local router information fields (continued)

Field	Description
	reachable time value applies to the router for which you are displaying information and should be followed by IPv6 hosts attached to the router. A value of 0 indicates that the router leaves this field unspecified.
Retransmit time	The amount of time (in milliseconds) between retransmissions of neighbor solicitation messages. The retransmit time value applies to the router for which you are displaying information and should be followed by IPv6 hosts attached to the router. A value of 0 indicates that the router leaves this field unspecified.

Displaying IPv6 TCP information

You can display the following IPv6 TCP information:

- General information about each TCP connection on the router, including the percentage of free memory for each of the internal TCP buffers.
- Detailed information about a specified TCP connection.

To display general information about each TCP connection on the router, enter the following command at any CLI level.

```
device#show ipv6 tcp connections
Local IP address:port <-> Remote IP address:port TCP state
10.168.182.110:23 <-> 10.168.8.186:4933 ESTABLISHED
10.168.182.110:8218 <-> 10.168.182.106:179 ESTABLISHED
10.168.182.110:8039 <-> 10.168.2.119:179 SYN-SENT
10.168.182.110:8159 <-> 10.168.2.102:179 SYN-SENT
2000:4::110:179 <-> 2000:4::106:8222 ESTABLISHED (1440)
Total 5 TCP connections
TCP MEMORY USAGE PERCENTAGE
FREE TCP = 98 percent
FREE TCP QUEUE BUFFER = 99 percent
FREE TCP SEND BUFFER = 97 percent
FREE TCP RECEIVE BUFFER = 100 percent
FREE TCP OUT OF SEQUENCE BUFFER = 100 percent
```

Syntax: show ipv6 tcp connections

This display shows the following information.

TABLE 40 General IPv6 TCP connection fields

Field	Description
Local IP address:port	The IPv4 or IPv6 address and port number of the local router interface over which the TCP connection occurs.
Remote IP address:port	The IPv4 or IPv6 address and port number of the remote router interface over which the TCP connection occurs.
TCP state	The state of the TCP connection. Possible states include the following: <ul style="list-style-type: none"> LISTEN - Waiting for a connection request. SYN-SENT - Waiting for a matching connection request after having sent a connection request. SYN-RECEIVED - Waiting for a confirming connection request acknowledgment after having both received and sent a connection request. ESTABLISHED - Data can be sent and received over the connection. This is the normal operational state of the connection.

TABLE 40 General IPv6 TCP connection fields (continued)

Field	Description
	<ul style="list-style-type: none"> • FIN-WAIT-1 - Waiting for a connection termination request from the remote TCP, or an acknowledgment of the connection termination request previously sent. • FIN-WAIT-2 - Waiting for a connection termination request from the remote TCP. • CLOSE-WAIT - Waiting for a connection termination request from the local user. • CLOSING - Waiting for a connection termination request acknowledgment from the remote TCP. • LAST-ACK - Waiting for an acknowledgment of the connection termination request previously sent to the remote TCP (which includes an acknowledgment of its connection termination request). • TIME-WAIT - Waiting for enough time to pass to be sure the remote TCP received the acknowledgment of its connection termination request. • CLOSED - There is no connection state.
FREE TCP = percentage	The percentage of free TCP control block (TCP) space.
FREE TCP QUEUE BUFFER = percentage	The percentage of free TCP queue buffer space.
FREE TCP SEND BUFFER = percentage	The percentage of free TCP send buffer space.
FREE TCP RECEIVE BUFFER = percentage	The percentage of free TCP receive buffer space.
FREE TCP OUT OF SEQUENCE BUFFER = percentage	The percentage of free TCP out of sequence buffer space.

To display detailed information about a specified TCP connection, enter a command such as the following at any CLI level.

```
device#show ipv6 tcp status 2000:4::110 179 2000:4::106 8222
TCP: TCP = 0x217fc300
TCP: 2000:4::110:179 <-> 2000:4::106:8222: state: ESTABLISHED Port: 1
  Send: initial sequence number = 242365900
  Send: first unacknowledged sequence number = 242434080
  Send: current send pointer = 242434080
  Send: next sequence number to send = 242434080
  Send: remote received window = 16384
  Send: total unacknowledged sequence number = 0
  Send: total used buffers 0
  Receive: initial incoming sequence number = 740437769
  Receive: expected incoming sequence number = 740507227
  Receive: received window = 16384
  Receive: bytes in receive queue = 0
  Receive: congestion window = 1459
```

Syntax: **show ipv6 tcp status** *local-ip-address local-port-number remote-ip-address remote-port-number*

The *local-ip-address* parameter can be the IPv4 or IPv6 address of the local interface over which the TCP connection is taking place.

The *local-port-number* parameter is the local port number over which a TCP connection is taking place.

The *remote-ip-address* parameter can be the IPv4 or IPv6 address of the remote interface over which the TCP connection is taking place.

The *remote-port-number* parameter is the local port number over which a TCP connection is taking place.

This display shows the following information.

TABLE 41 Specific IPv6 TCP connection fields

Field	Description
TCP = location	The location of the TCP.
local-ip-address local-port-number remote-ip-address remote-port-number state port	This field provides a general summary of the following: <ul style="list-style-type: none"> The local IPv4 or IPv6 address and port number. The remote IPv4 or IPv6 address and port number. The state of the TCP connection. For information on possible states, refer to Displaying IPv6 TCP information. The port numbers of the local interface.
Send: initial sequence number = number	The initial sequence number sent by the local router.
Send: first unacknowledged sequence number = number	The first unacknowledged sequence number sent by the local router.
Send: current send pointer = number	The current send pointer.
Send: next sequence number to send = number	The next sequence number sent by the local router.
Send: remote received window = number	The size of the remote received window.
Send: total unacknowledged sequence number = number	The total number of unacknowledged sequence numbers sent by the local router.
Send: total used buffers number	The total number of buffers used by the local router in setting up the TCP connection.
Receive: initial incoming sequence number = number	The initial incoming sequence number received by the local router.
Receive: expected incoming sequence number = number	The incoming sequence number expected by the local router.
Receive: received window = number	The size of the local router's receive window.
Receive: bytes in receive queue = number	The number of bytes in the local router's receive queue.
Receive: congestion window = number	The size of the local router's receive congestion window.

Displaying IPv6 traffic statistics

To display IPv6 traffic statistics, enter the following command at any CLI level.

```
device#show ipv6 traffic
IP6 Statistics
 36947 received, 66818 sent, 0 forwarded, 36867 delivered, 0 rawout
 0 bad vers, 23 bad scope, 0 bad options, 0 too many hdr
 0 no route, 0 can not forward, 0 redirect sent
 0 frag recv, 0 frag dropped, 0 frag timeout, 0 frag overflow
 0 reassembled, 0 fragmented, 0 ofragments, 0 can not frag
 0 too short, 0 too small, 11 not member
 0 no buffer, 66819 allocated, 21769 freed
 0 forward cache hit, 46 forward cache miss
ICMP6 Statistics
Received:
 0 dest unreach, 0 pkt too big, 0 time exceeded, 0 param prob
 2 echo req, 1 echo reply, 0 mem query, 0 mem report, 0 mem red
 0 router soli, 2393 router adv, 106 nei soli, 3700 nei adv, 0 redirect
 0 bad code, 0 too short, 0 bad checksum, 0 bad len
 0 reflect, 0 nd toomany opt, 0 badhopcount
Sent:
 0 dest unreach, 0 pkt too big, 0 time exceeded, 0 param prob
 1 echo req, 2 echo reply, 0 mem query, 0 mem report, 0 mem red
 0 router soli, 2423 router adv, 3754 nei soli, 102 nei adv, 0 redirect
 0 error, 0 can not send error, 0 too freq
Sent Errors:
 0 unreach no route, 0 admin, 0 beyond scope, 0 address, 0 no port
 0 pkt too big, 0 time exceed transit, 0 time exceed reassembly
 0 param problem header, 0 nextheader, 0 option, 0 redirect, 0 unknown
UDP Statistics
 470 received, 7851 sent, 6 no port, 0 input errors
TCP Statistics
```

IPv6 Configuration on FastIron X Series, FCX, and ICX Series Switches

Displaying global IPv6 information

```
57913 active opens, 0 passive opens, 57882 failed attempts
159 active resets, 0 passive resets, 0 input errors
565189 in segments, 618152 out segments, 171337 retransmission
```

Syntax: show ipv6 traffic

This show ipv6 traffic command displays the following information.

Field	Description
IPv6 statistics	
received	The total number of IPv6 packets received by the router.
sent	The total number of IPv6 packets originated and sent by the router.
forwarded	The total number of IPv6 packets received by the router and forwarded to other routers.
delivered	The total number of IPv6 packets delivered to the upper layer protocol.
rawout	This information is used by Ruckus Technical Support.
bad vers	The number of IPv6 packets dropped by the router because the version number is not 6.
bad scope	The number of IPv6 packets dropped by the router because of a bad address scope.
bad options	The number of IPv6 packets dropped by the router because of bad options.
too many hdr	The number of IPv6 packets dropped by the router because the packets had too many headers.
no route	The number of IPv6 packets dropped by the router because there was no route.
can not forward	The number of IPv6 packets the router could not forward to another router.
redirect sent	This information is used by Ruckus Technical Support.
frag recv	The number of fragments received by the router.
frag dropped	The number of fragments dropped by the router.
frag timeout	The number of fragment timeouts that occurred.
frag overflow	The number of fragment overflows that occurred.
reassembled	The number of fragmented IPv6 packets that the router reassembled.
fragmented	The number of IPv6 packets fragmented by the router to accommodate the MTU of this router or of another device.
ofragments	The number of output fragments generated by the router.
can not frag	The number of IPv6 packets the router could not fragment.
too short	The number of IPv6 packets dropped because they are too short.
too small	The number of IPv6 packets dropped because they do not have enough data.
not member	The number of IPv6 packets dropped because the recipient is not a member of a multicast group.
no buffer	The number of IPv6 packets dropped because there is no buffer available.
forward cache miss	The number of IPv6 packets received for which there is no corresponding cache entry.
ICMP6 statistics	

Field	Description
Some ICMP statistics apply to both Received and Sent, some apply to Received only, some apply to Sent only, and some apply to Sent Errors only.	
Applies to received and sent	
dest unreach	The number of Destination Unreachable messages sent or received by the router.
pkt too big	The number of Packet Too Big messages sent or received by the router.
time exceeded	The number of Time Exceeded messages sent or received by the router.
param prob	The number of Parameter Problem messages sent or received by the router.
echo req	The number of Echo Request messages sent or received by the router.
echo reply	The number of Echo Reply messages sent or received by the router.
mem query	The number of Group Membership Query messages sent or received by the router.
mem report	The number of Membership Report messages sent or received by the router.
mem red	The number of Membership Reduction messages sent or received by the router.
router soli	The number of Router Solicitation messages sent or received by the router.
router adv	The number of Router Advertisement messages sent or received by the router.
nei soli	The number of Neighbor Solicitation messages sent or received by the router.
nei adv	The number of Router Advertisement messages sent or received by the router.
redirect	The number of redirect messages sent or received by the router.
Applies to received only	
bad code	The number of Bad Code messages received by the router.
too short	The number of Too Short messages received by the router.
bad checksum	The number of Bad Checksum messages received by the router.
bad len	The number of Bad Length messages received by the router.
nd toomany opt	The number of Neighbor Discovery Too Many Options messages received by the router.
badhopcount	The number of Bad Hop Count messages received by the router.
Applies to sent only	
error	The number of Error messages sent by the router.
can not send error	The number of times the node encountered errors in ICMP error messages.
too freq	The number of times the node has exceeded the frequency of sending error messages.
Applies to sent errors only	
unreach no route	The number of Unreachable No Route errors sent by the router.
admin	The number of Admin errors sent by the router.
beyond scope	The number of Beyond Scope errors sent by the router.
address	The number of Address errors sent by the router.

Field	Description
no port	The number of No Port errors sent by the router.
pkt too big	The number of Packet Too Big errors sent by the router.
time exceed transit	The number of Time Exceed Transit errors sent by the router.
time exceed reassembly	The number of Time Exceed Reassembly errors sent by the router.
param problem header	The number of Parameter Problem Header errors sent by the router.
nextheader	The number of Next Header errors sent by the router.
option	The number of Option errors sent by the router.
redirect	The number of Redirect errors sent by the router.
unknown	The number of Unknown errors sent by the router.
UDP statistics	
received	The number of UDP packets received by the router.
sent	The number of UDP packets sent by the router.
no port	The number of UDP packets dropped because the packet did not contain a valid UDP port number.
input errors	This information is used by Ruckus Technical Support.
TCP statistics	
active opens	The number of TCP connections opened by the router by sending a TCP SYN to another device.
passive opens	The number of TCP connections opened by the router in response to connection requests (TCP SYNs) received from other devices.
failed attempts	This information is used by Ruckus Technical Support.
active resets	The number of TCP connections the router reset by sending a TCP RESET message to the device at the other end of the connection.
passive resets	The number of TCP connections the router reset because the device at the other end of the connection sent a TCP RESET message.
input errors	This information is used by Ruckus Technical Support.
in segments	The number of TCP segments received by the router.
out segments	The number of TCP segments sent by the router.
retransmission	The number of segments that the router retransmitted because the retransmission timer for the segment had expired before the device at the other end of the connection had acknowledged receipt of the segment.

DHCP relay agent for IPv6

A client locates a DHCP server using a reserved, link-scoped multicast address. Direct communication between the client and server requires that they are attached by the same link. In some situations where ease-of-management, economy, and scalability are concerns, you can allow a DHCPv6 client to send a message to a DHCP server using a DHCPv6 relay agent.

A DHCPv6 relay agent, which may reside on the client link, but is transparent to the client, relays messages between the client and the server. Multiple DHCPv6 relay agents can exist between the client and server. DHCPv6 relay agents can also receive relay-forward messages from other relay agents; these messages are forwarded to the DHCP server specified as the destination.

When the relay agent receives a message, it creates a new relay-forward message, inserts the original DHCPv6 message, and sends the relay-forward message as the DHCP server.

Configuring DHCP for IPv6 relay agent

To enable the DHCPv6 relay agent function and specify the relay destination (the DHCP server) address on an interface, enter the following command at the interface level:

```
device(config)# interface ethernet 1/2/3
device(config-if-e10000-1/2/3)#ipv6 dhcp-relay destination 2001::2
device(config-if-e10000-1/2/3)#ipv6 dhcp-relay destination fe80::224:38ff:febb:e3c0 outgoing-interface
ethernet 1/2/5
```

Syntax: [no] ipv6 dhcp-relay destination *ipv6-address* [**outgoing-interface *interface-type port-num*]**

Specify the *ipv6-address* as a destination address to which client messages are forwarded and which enables DHCPv6 relay service on the interface. You can configure up to 16 relay destination addresses on an interface. The **outgoing-interface** parameter is used when the destination relay address is a link-local or multicast address. Specify the *interface-type* as ethernet interface, tunnel interface, or VE interface. Specify the *port-num* as the port number.

Use the **no** version of the command to remove a DHCPv6 relay agent from the interface.

Enabling the interface-ID on the DHCPv6 relay agent messages

The interface-id parameter on the DHCPv6 relay forward message is used to identify the interface on which the client message is received. By default, this parameter is included only when the client message is received with the link-local source address.

To include the interface-id parameter on the DHCPv6 relay agent messages, enter the **ipv6 dhcp-relay include-options** command at the interface level.

```
device(config-if-eth-1/2/3)# ipv6 dhcp-relay include-options interface-id
```

Syntax: [no] ipv6 dhcp-relay include-options *interface-id*

Displaying DHCPv6 relay agent information

The **show ipv6 dhcp-relay** command displays the DHCPv6 relay agent information configured on the device:

```
device(config)#show ipv6 dhcp-relay
Current DHCPv6 relay agent state: Enabled
DHCPv6 enabled interface(s): e 1/2/3
DHCPv6 Relay Agent Statistics:
  Total DHCPv6 Packets, Received:0, Transmitted:0
  Received DHCPv6 Packets: RELEASE:0,RELAY_FORWARD:0,RELAY_REPLY:0
                            OtherServertoClient:0,OtherClinettoServer:0
```

Syntax: show ipv6 dhcp-relay

Displaying the DHCPv6 Relay configured destinations

Enter the **show ipv6 dhcp-relay destinations** command to display information about the dhcpcv6 relay agent configured destinations.

```
device#show ipv6 dhcp-relay destinations
DHCPv6 Relay Destinations:
Interface e 1/2/3:
  Destination          OutgoingInterface
  2001::2                NA
  fe80::224:38ff:febb:e3c0    e 1/2/5
```

Syntax: show ipv6 dhcp-relay destination

[Displaying the DHCPv6 Relay configured destinations](#) describes the fields from the output of show ipv6 dhcp-relay destinations command.

TABLE 42 DHCPv6 relay configured destination information

Field	Description
DHCPv6 relay destination	The DHCPv6 relay agent configured destination information
Interface	The interface specified (ethernet, tunnel, or VE interface)
Destination	The configured destination IPv6 address.
OutgoingInterface	The interface on which packets are relayed if the destination relay address is a local link or multicast address.

Displaying the DHCPv6 Relay information for an interface

Enter the show ipv6 dhcp-relay interface command to display the DHCPv6 relay information for a specific interface.

```
device#show ipv6 dhcp-relay interface ethernet 1/2/3
DHCPv6 Relay Information for interface e 1/2/3:
Destinations:
  Destination          OutgoingInterface
  2001::2                NA
  fe80::224:38ff:febb:e3c0      e 1/2/5
Options:
  Interface-Id: Yes
```

Syntax: show ipv6 dhcp-relay interface *interface-type port-num*

Specify the interface-type as ethernet interface, tunnel interface, or VE interface. Specify the port-num as the port number.

The following table describes the fields from the output of the **show ipv6 dhcp-relay interface** command.

TABLE 43 DHCPv6 relay information for an interface

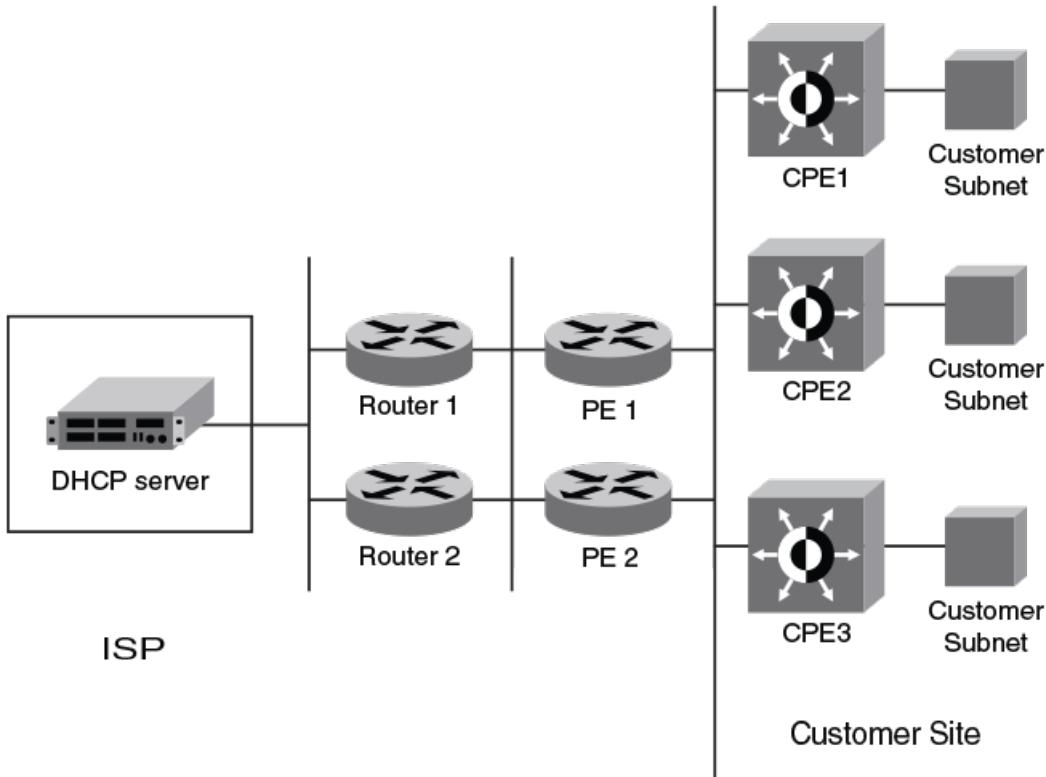
Field	Description
DHCPv6 Relay Information for interface <i>interface-type port-num</i>	The DHCPv6 relay information for the specific interface.
Destination	The configured destination IPv6 address.
OutgoingInterface	The interface on which the packet will be relayed if the destination relay address is a link local or multicast address.
Options	The current information about the DHCPv6 relay options for the interface
Interface-Id	The interface ID option indicating if the option is used or not.

DHCPv6 Relay Agent Prefix Delegation Notification

DHCPv6 Relay Agent Prefix Delegation Notification feature allows a DHCPv6 server to dynamically delegate IPv6 prefixes to a DHCPv6 client using the DHCPv6 Prefix Delegation (PD) option. DHCPv6 prefix delegation enables an Internet service provider (ISP) to automate the process of assigning prefixes to a customer premises equipment (CPE) network. The CPE then assigns IPv6 subnets from the delegated IPv6 prefix to its downstream customer interfaces.

This feature description is shown in [Figure 17](#).

FIGURE 17 DHCPv6 Relay Agent Prefix Delegation Notification



A route is added to the IPv6 route table on the provider edge router (PE) for the delegated prefix to be delegated to requesting routers. The DHCP server chooses a prefix for delegation and responds with it to the CPEs to the external network and to enable the correct forwarding of the IPv6 packets for the delegated IPv6 prefix. Adding the delegated prefix to the IPv6 route table ensures that the unicast Reverse Path Forwarding (uRPF) works correctly.

Since the PE is also a DHCPv6 relay agent (it relays DHCPv6 messages between the CPE and the DHCP server), it examines all DHCPv6 messages relayed between the CPE and the DHCP server and gathers information about a delegated prefix and then manages the advertisement of this delegated prefix to the external network.

DHCPv6 Relay Agent Prefix Delegation Notification limitations

The following limitations apply to the DHCPv6 Relay Agent Prefix Delegation Notification.

- The PD notification fails when the DHCPv6 messages between a DHCPv6 server and a DHCPv6 client containing the PD option are not relayed via the DHCPv6 relay agent.
- If the delegated prefix is released or renewed by the client at the time when the DHCPv6 relay agent is down or rebooting, then this release or renewal of the delegated prefix will not be detected by the relay agent. In such a condition, there could be stale static routes in the routing table. You must clear the stale routes.
- If there is no sufficient disk space on a flash disk, then the system may not store all the delegated prefixes in the IPv6 route table.
- The DHCPv6 PD flash operation will depend on the NTP clock synchronization. During system boot up, if the NTP is configured, the flash operation (dhcp6_delegated_prefixes_data flash file read/write) is delayed till the NTP is

synchronized. The NTP synchronization is needed for the correct updation of prefix age. If the NTP is not configured, then the DHCP prefix delegation will still read the flash, but the prefix age may not be correct.

Upgrade and downgrade considerations

- When a router is upgraded to the version of software that supports this feature, the saved information about delegated prefixes will be examined and if the delegated prefix lifetime is not expired, then the prefix will be added to the IPv6 static route table.
- When a router is downgraded to the version of software that does not support this feature, the saved information about delegated prefixes is retained and it cannot be used.

Configuring DHCPv6 Relay Agent Prefix Delegation Notification

To set the number of delegated prefixes that can be learned at the global system level, use the **ipv6 dhcp-relay maximum-delegated-prefixes** command.

By default, the DHCPv6 Relay Agent Prefix Delegation Notification is enabled when the DHCPv6 relay agent feature is enabled on an interface. User can disable the DHCPv6 Relay Agent Prefix Delegation Notification at the system or the interface level by setting **ipv6 dhcp-relay maximum-delegated-prefixes** to 0 at the system or interface level as required.

NOTE

Make sure that there is enough free space in the flash memory to save information about delegated prefixes in flash on both the Active and Standby management processor

```
device(config)# ipv6 dhcp-relay maximum-delegated-prefixes 500
```

The *value* parameter is used to limit the maximum number of prefixes that can be learned at the global level. The range is from 0 to 512. The default value is 500.

Syntax: [no] **ipv6 dhcp-relay maximum-delegated-prefixes value**

The *value* parameter is used to limit the maximum number of prefixes that can be learned at the global level. The range is from 0 to 512. The default value is 500.

Use the **no ipv6 dhcp-relay maximum-delegated-prefixes** command to set the parameter to the default value of the specified platform. Refer to [Enabling DHCPv6 Relay Agent Prefix Delegation notification on an interface](#) on page 198 for more information.

NOTE

The DHCPv6 prefix delegation default for ICX 7750 is 50.

Enabling DHCPv6 Relay Agent Prefix Delegation notification on an interface

To set the number of delegated prefixes that can be learned at the interface level, use the **ipv6 dhcp-relay maximum-delegated-prefixes** command. This command limits the maximum number of prefixes that can be learned on the interface.

```
device(config-if-eth 1/2/1)# ipv6 dhcp-relay maximum-delegated-prefixes 100
```

Syntax: [no] **ipv6 dhcp-relay maximum-delegated-prefixes value**

The *value* parameter is used to limit the maximum number of prefixes that can be delegated. The range is from 0 to 512. The default value is 100. The sum of all the delegated prefixes that can be learned at the interface level is limited by the system max.

Use the **no ipv6 dhcp-relay maximum-delegated-prefixes** command to set the parameter to the default value of the specified platform.

Assigning the administrative distance to DHCPv6 static routes

To assign the administrative distance to DHCPv6 static routes installed in IPv6 route table for the delegated prefixes on the interface, use the **ipv6 dhcp-relay distance** command at the interface level. The administrative distance value has to be set so that it does not replace the same IPv6 static route configured by the user.

```
device(config-if-eth-1/2/1)# ipv6 dhcp-relay distance 25
```

Syntax: [no] **ipv6 dhcp-relay distance** *value*

The *value* parameter is used to assign the administrative distance to DHCPv6 static routes on the interface. The range is from 1 to 255. The default value is 10. If the value is set to 255, then the delegated prefixes for this interface will not be installed in the IPv6 static route table.

Use the **no ipv6 dhcp-relay distance** command to set the parameter to a default value of 10.

Displaying the DHCPv6 Relay Agent Prefix Delegation Notification information

Enter the **show ipv6 dhcp-relay delegated-prefixes** command to display information about the delegated prefixes.

```
device# show ipv6 dhcp-relay delegated-prefixes interface ethernet 1/1/45
```

Prefix	Client	Interface	ExpireTime
fc00:2000:6:7:1::/96	fe80::210:94ff:fe00:e	1/1/45	29d23h53m0s

Syntax: **show ipv6 dhcp-relay delegated-prefixes vrf** *vrf-name* { { *X:X:X/X/M* | **client-id** *client ipv6 address* | **interface** *interface-id* } }

The **vrf** *vrf-name* parameter is used to display the DHCPv6 delegated prefixes for a specific VRF.

The *X:X:X/X/M* parameter is used to display the specified delegated prefix information.

The **client-id** *client ipv6 address* parameter is used to display the delegated prefix for the specific client.

The **interface** *interface-id* parameter is used to display delegated prefixes for the specified outgoing interface.

Table 44 describes the fields from the output of **show ipv6 dhcp-relay delegated-prefixes** command.

TABLE 44 Output from the show ipv6 dhcp-relay delegated-prefixes command

Field	Description
IPv6 Prefix	The IPv6 prefix delegated to the client.
Client	The IPv6 address of the client.
Interface	The interface on which the DHCPv6 messages are relayed to the client.
ExpireTime	The remaining lifetime of the delegated prefix.

Displaying the DHCPv6 Relay configured destinations

Enter the **show ipv6 dhcp-relay destinations** command to display information about the delegated prefixes' configured destinations for a specific interface.

```
device#show ipv6 dhcp-relay destinations
DHCPv6 Relay Destinations:
Interface ve 100:
  Destination          OutgoingInterface
  2001:db8:1::39        NA
Interface ve 101:
  Destination          OutgoingInterface
  
```

```
2001:db8:1::39          NA
Interface ve 102:
  Destination           OutgoingInterface
  2001:db8:1::39          NA
```

Syntax: show ipv6 dhcp-relay destinations

[Table 45](#) describes the fields from the output of **show ipv6 dhcp-relay destinations** command.

TABLE 45 Output from the **show ipv6 dhcp-relay destinations** command

Field	Description
Destination	The configured destination IPv6 address.
OutgoingInterface	The interface on which packets will be relayed if the destination relay address is local link or multicast.

Displaying the DHCPv6 Relay Agent options

Enter the **show ipv6 dhcp-relay options** command to display information about the relay options available to the prefixed delegates for a specific interface.

```
device# show ipv6 dhcp-relay options
DHCPv6 Relay Options Information:
  Interface      Interface-Id      Remote-Id
  ve 100          No                No
  ve 101          Yes               No
  ve 102          No                Yes
```

Syntax: show ipv6 dhcp-relay options

[Table 46](#) describes the fields from the output of **show ipv6 dhcp-relay options** command.

TABLE 46 Output from the **show ipv6 dhcp-relay options** command

Field	Description
Interface	The interface name.
Interface-Id	The interface ID option. Yes or No indicates if the option is used or not.
Remote-Id	The remote ID option. Yes or No indicates if the option is used or not.

Displaying the DHCPv6 Relay prefix delegation information

Enter the **show ipv6 dhcp-relay prefix-delegation-information** command to display additional information about the DHCPv6 prefix delegation.

```
device# show ipv6 dhcp-relay prefix-delegation-information
DHCPv6 Relay Prefix Delegation Notification Information:
  Interface    Current    Maximum    AdminDistance
  ve 100       20         20000      10
  ve 101       4000       20000      10
  ve 102       0          20000      10
  ve 103       0          20000      10
  ve 104       0          20000      10
  ve 105       0          20000      10
```

Syntax: show ipv6 dhcp-relay prefix-delegation-information

[Table 47](#) describes the fields from the output of the **show ipv6 dhcp-relay prefix-delegation-information** command.

TABLE 47 Output from the show ipv6 dhcp-relay prefix-delegation-information command

Field	Description
Interface	The interface name.
Current	The number of delegated prefixes currently learned on the interface.
Maximum	The maximum number of delegated prefixes that can be learned on the interface.
AdminDistance	The current administrative distance used for prefixes learned on this interface when added to the IPv6 static route table.

Displaying the DHCPv6 Relay information for an interface

Enter the **show ipv6 dhcp-relay interface** command to display DHCPv6 relay information for a specific interface.

```
device#show ipv6 dhcp-relay interface ve 100
DHCPv6 Relay Information for interface ve 100:
Destinations:
  Destination          OutgoingInterface
  2001:db8:1::39        NA
Options:
  Interface-Id: No    Remote-Id:No
Prefix Delegation Notification:
  Current:0 Maximum:20000 AdminDistance:10
```

Syntax: **show ipv6 dhcp-relay interface** *interface type*

The *interface type* is interface type such as ethernet, POS (Point of Service), or VE and the specific port number.

Table 48 describes the fields from the output of the **show ipv6 dhcp-relay interface** command.

TABLE 48 Output from the show ipv6 dhcp-relay interface command

Field	Description
Destinations	The DHCPv6 relay destination configured on the interface. <ul style="list-style-type: none"> Destination : The configured destination IPv6 address. OutgoingInterface : The interface on which packet will be relayed if the destination relay address is link local or multicast.
Options	The current information about DHCPv6 relay options for the interface. <ul style="list-style-type: none"> Interface-Id : The interface ID option indicating if the option is used or not. Remote-Id : The remote ID option indicating if the option is used or not.
Prefix Delegation Notification	This current information about the DHCPv6 Prefix Delegation for the interface. <ul style="list-style-type: none"> Interface: The name of the interface. Current - The number of delegated prefixes currently learned on the interface. Maximum - The maximum number of delegated prefixes that can be learned on the interface. AdminDistance - The administrative distance used for prefixes learned on the specific interface when added to IPv6 Static Route table.

Clearing the DHCPv6 delegated prefixes

To clear the DHCPv6 delegated prefixes for specific VRFs, use the **clear ipv6 dhcp-relay delegated-prefixes** command at the privilege level.

```
device# clear ipv6 dhcp-relay delegated-prefixes vrf VRF1
```

Syntax: **clear ipv6 dhcp-relay delegated-prefixes { vrf vrf-name } { X:X::X:X/M | all | interface interface-id }**

The **vrf vrf-name** parameter is used to clear the DHCPv6 delegated prefixes for a specific VRF. If this parameter is not provided, then the information for the default VRF is cleared.

The **X:X::X:X/M** parameter is used to clear the specified delegated prefix and remove the corresponding route permanently from the router.

The **all** parameter is used to clear all the delegated prefixes and remove the corresponding routes permanently from the router for the VRF.

The **interface interface-id** parameter is used to clear all the delegated prefixes and remove the corresponding routes permanently from the router for the specified outgoing interface.

Clearing the DHCPv6 packet counters

To clear all DHCPv6 packet counters, use the **clear ipv6 dhcp-relay statistics** command at the privilege level.

```
device# clear ipv6 dhcp-relay statistics
```

Syntax: **clear ipv6 dhcp-relay statistics**

RIP

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RIP overview

Routing Information Protocol (RIP) is an IP route exchange protocol that uses a distance vector (a number representing distance) to measure the cost of a given route. The cost is a distance vector because the cost often is equivalent to the number of router hops between the Ruckus device and the destination network.

A Ruckus device can receive multiple paths to a destination. The software evaluates the paths, selects the best path, and saves the path in the IP route table as the route to the destination. Typically, the best path is the path with the fewest hops. A hop is another router through which packets must travel to reach the destination. If a RIP update is received from another router that contains a path with fewer hops than the path stored in the Ruckus device route table, the older route is replaced with the newer one. The new path is then included in the updates sent to other RIP routers, including Ruckus devices.

RIP routers, including Ruckus devices, also can modify a route cost, generally by adding to it, to bias the selection of a route for a given destination. In this case, the actual number of router hops may be the same, but the route has an administratively higher cost and is thus less likely to be used than other, lower-cost routes.

A RIP route can have a maximum cost of 15. Any destination with a higher cost is considered unreachable. Although limiting to larger networks, the low maximum hop count prevents endless loops in the network.

Ruckus devices support the following RIP versions:

- Version 1 (v1)
- Version 2 (v2, the default)
- V1 compatible with v2

RIP parameters and defaults

You can configure global RIP parameters for the protocol and interface RIP parameters on those interfaces that send and receive RIP information.

RIP global parameters

TABLE 49 RIP global parameters

Parameter	Description	Default
RIP state	The global state of the protocol.	Disabled

RIP

RIP parameters and defaults

TABLE 49 RIP global parameters (continued)

Parameter	Description	Default
	<p>NOTE You also must enable the protocol on individual interfaces. Globally enabling the protocol does not allow interfaces to send and receive RIP information.</p>	
Administrative distance	<p>The administrative distance is a numeric value assigned to each type of route on the device.</p> <p>When the device is selecting from among multiple routes (sometimes of different origins) to the same destination, the device compares the administrative distances of the routes and selects the route with the lowest administrative distance.</p> <p>This parameter applies to routes originated by RIP. The administrative distance stays with a route when it is redistributed into other routing protocols.</p>	120
Redistribution	RIP can redistribute routes from other routing protocols such as OSPF and BGP4 into RIP. A redistributed route is one that a router learns through another protocol, and then distributes into RIP.	Disabled
Redistribution metric	<p>RIP assigns a RIP metric (cost) to each external route redistributed from another routing protocol into RIP.</p> <p>An external route is a route with at least one hop (packets must travel through at least one other router to reach the destination). This parameter applies to routes that are redistributed from other protocols into RIP.</p>	1
Update Interval	How often the router sends route updates to its RIP neighbors.	30 seconds
Learning default routes	<p>The device can learn default routes from its RIP neighbors.</p> <p>NOTE You also can enable or disable this parameter on an individual interface basis.</p>	Disabled
Advertising and learning with specific neighbors	The device learns and advertises RIP routes with all its neighbors by default. You can prevent the device from advertising routes to specific neighbors or learning routes from specific neighbors.	Learning and advertising permitted for all neighbors

RIP interface parameters

TABLE 50 RIP interface parameters

Parameter	Description	Default
RIP state and version	The state of the protocol and the version that is supported on the interface. The version can be one of the following: <ul style="list-style-type: none"> • Version 1 only • Version 2 only • Version 1, but also compatible with version 2 NOTE You also must enable RIP globally.	Disabled
Metric	A numeric cost the device adds to RIP routes learned on the interface. This parameter applies only to RIP routes.	1
Learning default routes	Locally overrides the global setting.	Disabled
Loop prevention	The method a device uses to prevent routing loops caused by advertising a route on the same interface as the one on which the device learned the route. <ul style="list-style-type: none"> • Split horizon - The device does not advertise a route on the same interface as the one on which the device learned the route. • Poison reverse - The device assigns a cost of 16 ("infinite" or "unreachable") to a route before advertising it on the same interface as the one on which the device learned the route. NOTE Enabling poison reverse disables split horizon on the interface.	Split horizon
Advertising and learning specific routes	You can control the routes that a device learns or advertises.	The device learns and advertises all RIP routes on all interfaces.

Configuring RIP parameters

Enabling RIP

RIP is disabled by default. To enable RIP, you must enable it globally and also on individual interfaces on which you want to advertise RIP. Globally enabling the protocol does not enable it on individual interfaces. When you enable RIP on a port, you also must specify the version (version 1 only, version 2 only, or version 1 compatible with version 2).

To enable RIP globally, enter the **router rip** command.

```
device(config)# router rip
```

Syntax: **[no] router rip**

RIP

Configuring RIP parameters

After globally enabling the protocol, you must enable it on individual interfaces. You can enable the protocol on physical interfaces as well as virtual routing interfaces. To enable RIP on an interface, enter commands such as the following.

```
device(config)# interface ethernet 1/1/1
device(config-if-e1000-1/1/1)# ip rip v1-only
```

Syntax: [no] ip rip {v1-only | v1-compatible-v2 | v2-only}

Configuring route costs

By default, a Ruckus device port increases the cost of a RIP route that is learned on the port. The Ruckus device increases the cost by adding one to the route metric before storing the route.

You can change the amount that an individual port adds to the metric of RIP routes learned on the port.

To increase the metric for learned routes, enter the **ip rip metric-offset** command.

```
device(config-if-e1000-1/1/1)# ip rip metric-offset 5 in
```

In the above example, the **ip rip metric-offset** command configures the port to add 5 to the cost of each route it learns.

Syntax: [no] ip rip metric-offset num {in | out}

The *num* variable specifies a range from 1 through 16.

NOTE

RIP considers a route with a metric of 16 to be unreachable. You can prevent the device from using a specific port for routes learned though that port by setting its metric to 16.

The **in** keyword applies to routes the port learns from RIP neighbors.

The **out** keyword applies to routes the port advertises to its RIP neighbors.

Changing the administrative distance

By default, the Ruckus device assigns the default RIP administrative distance (120) to RIP routes. When comparing routes based on administrative distance, the Ruckus device selects the route with the lower distance. You can change the administrative distance for RIP routes.

To change the administrative distance for RIP routes, enter the **distance** command.

```
device(config-rip-router)# distance 140
```

In the above example, the **distance** command changes the administrative distance to 140 for all RIP routes.

Syntax: [no] distance *number*

The *number* variable specifies a range from 1 through 255.

Configuring redistribution

You can configure the Ruckus device to redistribute routes learned through Open Shortest Path First (OSPF) or Border Gateway Protocol version 4 (BGP4), connected into RIP, or static routes. When you redistribute a route from one of these other protocols into RIP, the Ruckus device can use RIP to advertise the route to its RIP neighbors.

To configure redistribution, perform the following tasks.

1. Configure redistribution filters (optional). You can configure filters to permit or deny redistribution for a route based on its origin (OSPF, BGP4, and so on), the destination network address, and the route's metric. You also can configure a filter to set the metric based on these criteria.
2. Change the default redistribution metric (optional). The Ruckus device assigns a RIP metric of 1 to each redistributed route by default. You can change the default metric to a value up to 15.
3. Enable redistribution.

NOTE

Do not enable redistribution until you configure the other redistribution parameters.

Configuring redistribution filters

RIP redistribution filters apply to all interfaces. Use route maps to define how you want to deny or permit redistribution.

NOTE

The default redistribution action is permit, even after you configure and apply redistribution filters to the virtual routing interface. If you want to tightly control redistribution, apply a filter to deny all routes as the last filter (the filter with the highest ID), and then apply filters to allow specific routes.

A route map is a named set of match conditions and parameter settings that the Ruckus device can use to modify route attributes and to control redistribution of the routes into other protocols. A route map consists of a sequence of up to 50 instances. The Ruckus device evaluates a route according to a route map's instances in ascending numerical order. The route is first compared against instance 1, then against instance 2, and so on. If a match is found, the Ruckus device stops evaluating the route against the route map instances.

Route maps can contain match statements and set statements. Each route map contains a permit or deny action for routes that match the match statements:

- If the route map contains a permit action, a route that matches a match statement is permitted; otherwise, the route is denied.
- If the route map contains a deny action, a route that matches a match statement is denied.
- If a route does not match any match statements in the route map, the route is denied. This is the default action. To change the default action, configure the last match statement in the last instance of the route map to "permit any any".
- If there is no match statement, the route is considered to be a match.
- For route maps that contain address filters, AS-path filters, or community filters, if the action specified by a filter conflicts with the action specified by the route map, the route map's action takes precedence over the individual filter's action.

If the route map contains set statements, routes that are permitted by the route map's match statements are modified according to the set statements.

In RIP, the match statements are based on prefix lists and access control lists. Set statements are based on tag values and metric values.

To configure redistribution filters, enter the following command.

```
device(config-rip-router) # redistribute connected route-map routemap1
```

Syntax: [no] redistribute {connected | bgp | ospf | static [metric value | route-map name]}

The **connected** keyword applies redistribution to connected types.

The **bgp** keyword applies redistribution to BGP4 routes.

The **ospf** keyword applies redistribution to OSPF routes.

The **static** keyword applies redistribution to IP static routes.

The **metric value** parameter sets the RIP metric value from 1 through 15 that will be applied to the routes imported into RIP.

The **route-map name** parameter indicates the route map's name.

Matching based on RIP protocol type

The **match** option has been added to the **route-map** command that allows statically configured routes or the routes learned from the IGP protocol RIP.

To configure the route map to match to RIP, enter the **match protocol rip** command.

```
device(config-routemap test)# match protocol rip
```

Syntax: [no] **match protocol rip**

Changing the default redistribution metric

When the Ruckus device redistributes a route into RIP, the software assigns a RIP metric (cost) to the route. By default, the software assigns a metric of 1 to each route that is redistributed into RIP. You can increase the metric that the Ruckus device assigns, up to 15.

To change the RIP metric the Ruckus device assigns to redistributed routes, enter a command such as the following.

```
device(config-rip-router)# default-metric 10
```

This command assigns a RIP metric of 10 to each route that is redistributed into RIP.

Syntax: [no] **default-metric 1-15**

Configuring route learning and advertising parameters

By default, a Ruckus device learns routes from all its RIP neighbors and advertises RIP routes to those neighbors.

You can configure the following learning and advertising parameters:

- Update interval - The update interval specifies how often the device sends RIP route advertisements to its neighbors. You can change the interval to a value from 3 through 65535 seconds. The default is 30 seconds.
- Learning and advertising of RIP default routes - The Ruckus device can learn and advertise RIP default routes. You can disable learning and advertising of default routes on a global or individual interface basis.
- Learning of standard RIP routes - By default, the Ruckus device can learn RIP routes from all its RIP neighbors. You can configure RIP neighbor filters to explicitly permit or deny learning from specific neighbors.

Changing the update interval for route advertisements

The update interval specifies how often the device sends route advertisements to its RIP neighbors. You can specify an interval from 3 through 21,845 seconds. The default is 30 seconds.

To change the RIP update interval, enter the **update-time** command.

```
device(config-rip-router)# update-time 120
```

This command configures the device to send RIP updates every 120 seconds.

Syntax: `update-time value`

Enabling learning of RIP default routes

By default, the Ruckus device does not learn default RIP routes. You can enable learning of RIP default routes on a global or interface basis.

To enable learning of default RIP routes on a global basis, enter the following command.

```
device(config-rip-router) # learn-default
```

Syntax: `[no] learn-default`

To enable learning of default RIP routes on an interface, enter the `ip rip learn-default` command.

```
device(config)# interface ethernet 1/1/1
device(config-if-e1000-1/1/1) # ip rip learn-default
```

Syntax: `[no] ip rip learn-default`

Configuring a RIP neighbor filter

By default, a Ruckus device learns RIP routes from all its RIP neighbors. Neighbor filters allow you to specify the neighbor routers from which the Ruckus device can receive RIP routes. Neighbor filters apply globally to all ports.

To configure a RIP neighbor filters, enter the **neighbor** command.

```
device(config-rip-router) # neighbor 1 deny any
```

This command configures the Ruckus device so that the device does not learn any RIP routes from any RIP neighbors.

Syntax: `[no] neighbor filter-num {permit | deny} {source-ip-address | any}`

The following commands configure the Ruckus device to learn routes from all neighbors except 10.70.12.104. Once you define a RIP neighbor filter, the default action changes from learning all routes from all neighbors to denying all routes from all neighbors except the ones you explicitly permit. Thus, to deny learning from a specific neighbor but allow all other neighbors, you must add a filter that allows learning from all neighbors. Make sure you add the filter to permit all neighbors as the last filter (the one with the highest filter number). Otherwise, the software can match on the permit all filter before a filter that denies a specific neighbor, and learn routes from that neighbor.

```
device(config-rip-router) # neighbor 2 deny 10.70.12.104
device(config-rip-router) # neighbor 64 permit any
```

Changing the route loop prevention method

RIP uses the following methods to prevent routing loops:

- Split horizon - The device does not advertise a route on the same interface as the one on which the Ruckus device learned the route. This is the default.
- Poison reverse - The device assigns a cost of 16 ("infinite" or "unreachable") to a route before advertising it on the same interface as the one on which the Ruckus device learned the route.

These loop prevention methods are configurable on a global basis as well as on an individual interface basis. One of the methods is always in effect on an interface enabled for RIP. Thus, if you disable one method, the other method is enabled.

NOTE

These methods are in addition to RIP's maximum valid route cost of 15.

RIP

Configuring RIP parameters

To disable poison reverse and enable split horizon on a global basis, enter the following command.

```
device(config-rip-router) # no poison-reverse
```

Syntax: [no] poison-reverse

To disable poison reverse and enable split horizon on an interface, enter commands such as the following.

```
device(config)#interface ethernet 1/1/1
device(config-if-e1000-1/1/1) # no ip rip poison-reverse
```

Syntax: [no] ip rip poison-reverse

To disable split horizon and enable poison reverse on an interface, enter commands such as the following.

```
device(config)#interface ethernet 1/1/1
device(config-if-e1000-1/1/1) # ip rip poison-reverse
```

You can configure the Ruckus device to avoid routing loops by advertising local RIP routes with a cost of 16 ("infinite" or "unreachable") when these routes go down.

```
device(config-rip-router) # poison-local-routes
```

Syntax: [no] poison-local-routes

Suppressing RIP route advertisement on a VRRP or VRRPE backup interface

NOTE

This section applies only if you configure the device for Virtual Router Redundancy Protocol (VRRP) or VRRP Extended (VRRPE).

Normally, a VRRP or VRRPE Backup includes route information for the virtual IP address (the backed up interface) in RIP advertisements. As a result, other routers receive multiple paths for the backed up interface and might sometimes unsuccessfully use the path to the Backup rather than the path to the Master.

You can prevent the backups from advertising route information for the backed up interface by enabling suppression of the advertisements.

To suppress RIP advertisements for the backed up interface, enter the following commands.

```
device(config)# router rip
device(config-rip-router) # use-vrrp-path
```

Syntax: [no] use-vrrp-path

The syntax is the same for VRRP and VRRP-E.

Configuring RIP route filters using prefix-lists and route maps

You can configure prefix lists to permit or deny specific routes, then apply them globally or to individual interfaces and specify whether the lists apply to learned routes (in) or advertised routes (out).

You can configure route maps to permit or deny specific routes, then apply a route map to an interface, and specify whether the map applies to learned routes (in) or advertised routes (out).

NOTE

A route is defined by the destination's IP address and network mask.

NOTE

By default, routes that do not match a prefix list are learned or advertised. To prevent a route from being learned or advertised, you must configure a prefix list to deny the route.

To configure a prefix list, enter commands such as the following.

```
device(config)# ip prefix-list list1 permit 10.53.4.1 255.255.255.0
device(config)# ip prefix-list list2 permit 10.53.5.1 255.255.255.0
device(config)# ip prefix-list list3 permit 10.53.6.1 255.255.255.0
device(config)# ip prefix-list list4 deny 10.53.7.1 255.255.255.0
```

The prefix lists permit routes to three networks, and deny the route to one network.

Because the default action is permit, all other routes (routes not explicitly permitted or denied by the filters) can be learned or advertised.

Syntax: [no] ip prefix-list name {permit | deny} {source-ip-address | any source-mask | any}

To apply a prefix list at the global level of RIP, enter commands such as the following.

```
device(config-rip-router)# prefix-list list1 in
```

Syntax: no prefix-list name {in | out}

To apply prefix lists to a RIP interface, enter commands such as the following.

```
device(config-if-e1000-1/1/2)# ip rip prefix-list list2 in
device(config-if-e1000-1/1/2)# ip rip prefix-list list3 out
```

Syntax: no ip rip prefix-list name {in | out}

In is for Inbound filtering. It applies the prefix list to routes the Ruckus device learns from its neighbor on the interface.

Out is for Outbound filtering. It applies the prefix list to routes the Ruckus device advertises to its neighbor on the interface.

The commands apply RIP list2 route filters to all routes learned from the RIP neighbor on the port and applies the lists to all routes advertised on the port.

To configure a route-map, enter commands such as the following.

```
device(config)#access-list 21 deny 160.1.0.0 0.0.255.255
device(config)#access-list 21 permit any
device(config)# route-map routemap1 permit 21
device(config-route-map routemap1)# match ip address 21
device(config)# route-map routemap2 permit 22
```

The route-map permit routes to two networks, and denies the route to one network.

Syntax: [no] route-map map-name {permit | deny} num

To apply a route map to a RIP interface, enter commands such as the following.

```
device(config-if-e1000-1/1/2)# ip rip route-map map1 in
```

Syntax: [no] ip rip route-map name {in | out}

The **route-map** can be a prefix list or an ACL. Setting this command can change the metric.

In applies the route map to routes the Ruckus device learns from its neighbor on the interface.

Out applies the route map to routes the Ruckus device advertises to its neighbor on the interface.

The commands apply route map map1 as route filters to routes learned from the RIP neighbor on the port.

Setting RIP timers

You can set basic update timers for the RIP protocol. The protocol must be enabled in order to set the timers. The **timers** command specifies how often RIP update messages are sent.

To set the timers, enter the following commands.

```
device(config) router rip
device(config-rip-router)# timer 30 180 180 120
```

Syntax: [no] **timers** *update-timer* *timeout-timer* *hold-down-timer* *garbage-collection-timer*

The *update-timer* parameter sets the amount of time between RIP routing updates. The possible value ranges from 3 - 21845. The default is 30 seconds.

The *timeout-timer* parameter sets the amount of time after which a route is considered unreachable. The possible value ranges from 9 - 65535. The default is 180 seconds.

The *hold-down-timer* parameter sets the amount of time during which information about other paths is ignored. The possible value ranges from 0 - 65535. The default is 180 seconds.

The *garbage-collection-timer* sets the amount of time after which a route is removed from the rip routing table. The possible value ranges from 0 - 65535. The default is 120 seconds.

Displaying RIP Information

To display RIP filters, enter the following command at any CLI level.

```
device# show ip rip
RIP Summary
  Default port 520
    Administrative distance is 120
    Updates every 30 seconds, expire after 180
    Holddown lasts 180 seconds, garbage collect after 120
    Last broadcast 29, Next Update 27
    Need trigger update 0, Next trigger broadcast 1
    Minimum update interval 25, Max update Offset 5
    Split horizon is on; poison reverse is off
    Import metric 1
    Prefix List, Inbound : block_223
    Prefix List, Outbound : block_223
    Route-map, Inbound : Not set
    Route-map, Outbound : Not set
    Redistribute: CONNECTED Metric : 0 Routemap : Not Set

  No Neighbors are configured in RIP Neighbor Filter Table
```

Syntax: **show ip rip**

TABLE 51 CLI display of neighbor filter information

Field.	Definition
RIP Summary area	Shows the current configuration of RIP on the device.
Static metric	Shows the static metric configuration. ".not defined" means the route map has not been distributed.
OSPF metric	Shows what OSPF route map has been applied.
Neighbor Filter Table area	
Index	The filter number. You assign this number when you configure the filter.

TABLE 51 CLI display of neighbor filter information (continued)

Field.	Definition
Action	The action the Ruckus device takes for RIP route packets to or from the specified neighbor: <ul style="list-style-type: none"> deny - If the filter is applied to an interface's outbound filter group, the filter prevents the Ruckus device from advertising RIP routes to the specified neighbor on that interface. If the filter is applied to an interface's inbound filter group, the filter prevents the Ruckus device from receiving RIP updates from the specified neighbor. permit - If the filter is applied to an interface's outbound filter group, the filter allows the Ruckus device to advertise RIP routes to the specified neighbor on that interface. If the filter is applied to an interface's inbound filter group, the filter allows the Ruckus device to receive RIP updates from the specified neighbor.
Neighbor IP Address	The IP address of the RIP neighbor.

To display RIP filters for a specific interface, enter the following command.

```
device# show ip rip interface ethernet 1/1/1
Interface e 1/1/1
RIP Mode : Version2 Running: TRUE
  Route summarization disabled
  Split horizon is on; poison reverse is off
  Default routes not accepted
  Metric-offset, Inbound 1
  Metric-offset, Outbound 0
  Prefix List, Inbound : Not set
    Prefix List, Outbound : Not set
  Route-map, Inbound : Not set
  Route-map, Outbound : Not set
  RIP Sent/Receive packet statistics:
    Sent : Request 2 Response 34047
    Received : Total 123473 Request 1 Response 123472 UnRecognised 0
  RIP Error packet statistics:
    Rejected 0 Version 0 RespFormat 0 AddrFamily 0
    Metric 0 ReqFormat 0
```

Syntax: **show ip rip interface *jfName***

To display RIP route information, enter the following command.

```
device# show ip rip route
RIP Routing Table - 474 entries:
1.1.1.1/32, from 169.254.30.1, e 1/1/23 (820)
  RIP, metric 4, tag 0, timers: aging 13
1.1.2.1/32, from 169.254.50.1, e 1/3/1 (482)
  RIP, metric 3, tag 0, timers: aging 42
1.1.6.1/32, from 169.254.100.1, ve 101 (413)
  RIP, metric 2, tag 0, timers: aging 42
169.254.40.0/24, from 192.168.1.2, e 1/1/1 (1894)
  RIP, metric 3, tag 0, timers: aging 14
169.254.50.0/24, from 192.168.1.2, e 1/1/1 (1895)
  RIP, metric 4, tag 0, timers: aging 14
169.254.100.0/24, from 192.168.1.2, e 1/1/1 (2040)
  RIP, metric 2, tag 0, timers: aging 14
169.254.101.0/30, from 192.168.1.2, e 1/1/1 (2105)
223.229.32.0/31, from 169.254.50.1, e 1/3/1 (818)
  RIP, metric 2, tag 0, timers: aging 21
```

Syntax: **show ip rip route**

RIP

Displaying CPU utilization statistics

To display current running configuration for interface 1/1/1, enter the following command.

```
device# show running-config interface ethernet 1/1/1
interface ethernet 1/1/1
enable
ip ospf area 0
ip ospf priority 0
ip rip v2-only
ip address 10.1.1.2/24
ipv6 address 2000::1/32
ipv6 enable
!
```

To display current running configuration for ve 10, enter the following command.

```
device# show running-config interface ve 10
interface ve 10
ip ospf area 2
ip rip v1-compatible-v2
ip rip poison-reverse
ip address 10.1.0.1/24
ipv6 address 2001:db8:1::14/64
!
```

To display current running configuration for ve 20, enter the following command.

```
device# show running-config interface ve 20
interface ve 20
ip ospf area 1
ip rip v1-only
ip rip poison-reverse
ip address 10.2.0.1/24
!
```

Displaying CPU utilization statistics

You can display CPU utilization statistics for RIP and other IP protocols. To display CPU utilization statistics for RIP, enter the **show cpu-utilization tasks** command at any level of the CLI.

```
device#show cpu-utilization tasks
Current total CPU utilization = 89%
... Usage average for all tasks in the last 1 second ...
=====
Name          %
idle          11
con           0
mon           0
flash          0
dbg            0
boot           0
main           0
stkKeepAliveTsk  0
keygen          0
itc            0
poeFwd fsm    0
tmr            0
scp            0
appl          89
snms           0
rtm            0
rtm6           0
rip             0
bgp             0
bgp io          0
(Output truncated)
```

Syntax: show cpu-utilization tasks

The command lists the usage statistics for the previous five-second, one-minute, five-minute, and fifteen-minute intervals.

RIPng

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RIPng Overview

Routing Information Protocol (RIP) is an IP route exchange protocol that uses a distance vector (a number representing a distance) to measure the cost of a given route. RIP uses a hop count as its cost or metric.

IPv6 RIP, known as Routing Information Protocol Next Generation or RIPng , functions similarly to IPv4 RIP version 2. RIPng supports IPv6 addresses and prefixes.

In addition, some new commands that are specific to RIPng have been implemented. This chapter describes the commands that are specific to RIPng. This section does not describe commands that apply to both IPv4 RIP and RIPng.

RIPng maintains a Routing Information Database (RIB), which is a local route table. The local RIB contains the lowest-cost IPv6 routes learned from other RIP routers. In turn, RIPng attempts to add routes from its local RIB into the main IPv6 route table.

NOTE

Brocade IPv6 devices support up to 10,000 RIPng routes. ICX 6650 IPv6 devices support up to 2000 RIPng routes.

Configuring RIPng

To configure RIPng, you must enable RIPng globally on the Ruckus device and on individual device interfaces. The following configuration tasks are optional:

- Change the default settings of RIPng timers
- Configure how the Ruckus device learns and advertises routes
- Configure which routes are redistributed into RIPng from other sources
- Configure how the Ruckus device distributes routes through RIPng
- Configure poison reverse parameters

Enabling RIPng

Before configuring the device to run RIPng, you must do the following:

- Enable the forwarding of IPv6 traffic on the device using the **ipv6 unicast-routing** command.
- Enable IPv6 on each interface over which you plan to enable RIPng. You enable IPv6 on an interface by configuring an IPv6 address or explicitly enabling IPv6 on that interface.

By default, RIPng is disabled. To enable RIPng, you must enable it globally on the Ruckus device and also on individual device interfaces.

NOTE

Enabling RIPng globally on the Ruckus device does not enable it on individual device interfaces.

RIPng

Configuring RIPng

To enable RIPng globally, enter the following command.

```
device(config-rip-router)#ipv6 router rip  
device(config-ripng-router)#[/pre]
```

After you enter this command, the device enters the RIPng configuration level, where you can access several commands that allow you to configure RIPng.

Syntax: [no] ipv6 router rip

To disable RIPng globally, use the **no** form of this command.

After enabling RIPng globally, you must enable it on individual Ruckus device interfaces. You can enable it on physical as well as virtual routing interfaces. For example, to enable RIPng on Ethernet interface 1/3/1, enter the following commands.

```
device(config)# interface ethernet 1/3/1  
device(config-if-e100-1/3/1)# ipv6 rip enable
```

Syntax: [no] ipv6 rip enable

To disable RIPng on an individual device interface, use the **no** form of this command.

Configuring RIPng timers

TABLE 52 RIPng timers

Timer	Description	Default
Update	Amount of time (in seconds) between RIPng routing updates.	30 seconds.
Timeout	Amount of time (in seconds) after which a route is considered unreachable.	180 seconds.
Hold-down	Amount of time (in seconds) during which information about other paths is ignored.	180 seconds.
Garbage-collection	Amount of time (in seconds) after which a route is removed from the routing table.	120 seconds.

You can adjust these timers for RIPng. Before doing so, keep the following caveats in mind:

- If you adjust these RIPng timers, Ruckus strongly recommends setting the same timer values for all routers and access servers in the network.
- Setting the update timer to a shorter interval can cause the devices to spend excessive time updating the IPv6 route table.
- Ruckus recommends setting the timeout timer value to at least three times the value of the update timer.
- Ruckus recommends a shorter hold-down timer interval, because a longer interval can cause delays in RIPng convergence.

The following example sets updates to be advertised every 45 seconds. If a route is not heard from in 135 seconds, the route is declared unusable. Further information is suppressed for an additional 10 seconds. Assuming no updates, the route is flushed from the routing table 20 seconds after the end of the hold-down period.

```
device(config)# ipv6 router rip  
device(config-ripng-router)# timers 45 135 10 20
```

Syntax: [no] timers *update-timer* *timeout-timer* *hold-down-timer* *garbage-collection-timer*

Possible values for the timers are as follows:

- Update timer: 3 through 65535 seconds.
- Timeout timer: 9 through 65535 seconds.
- Hold-down timer: 9 through 65535 seconds.
- Garbage-collection timer: 9 through 65535 seconds.

NOTE

You must enter a value for each timer, even if you want to retain the current setting of a particular timer.

To return to the default values of the RIPng timers, use the **no** form of this command.

Configuring route learning and advertising parameters

You can configure the following learning and advertising parameters:

- Learning and advertising of RIPng default routes.
- Advertising of IPv6 address summaries.
- Metric of routes learned and advertised on a Ruckus device interface.

Configuring default route learning and advertising

By default, the device does not learn IPv6 default routes (::/0). You can originate default routes into RIPng, which causes individual Ruckus device interfaces to include the default routes in their updates. When configuring the origination of the default routes, you can also do the following:

- Suppress all other routes from the updates.
- Include all other routes in the updates.

For example, to originate default routes in RIPng and suppress all other routes in updates sent from Ethernet interface 1/3/1, enter the following commands.

```
device(config)# interface ethernet 1/3/1
device(config-if-e100-1/3/1)# ipv6 rip default-information only
```

To originate IPv6 default routes and include all other routes in updates sent from Ethernet interface 1/3/1, enter the following commands.

```
device(config)# interface ethernet 1/3/1
device(config-if-e100-1/3/1)# ipv6 rip default-information originate
```

Syntax: [no] ipv6 rip default-information { only | originate }

The **only** keyword originates the default routes and suppresses all other routes from the updates.

The **originate** keyword originates the default routes and includes all other routes in the updates.

To remove the explicit default routes from RIPng and suppress advertisement of these routes, use the **no** form of this command.

Advertising IPv6 address summaries

You can configure RIPng to advertise a summary of IPv6 addresses from a Ruckus device interface and to specify an IPv6 prefix that summarizes the routes.

If a route's prefix length matches the value specified in the **ipv6 rip summary-address** command, RIPng advertises the prefix specified in the **ipv6 rip summary-address** command instead of the original route.

For example, to advertise the summarized prefix 2001:db8::/36 instead of the IPv6 address 2001:db8:0:adff:8935:e838:78:e0ff with a prefix length of 64 bits from Ethernet interface 1/3/1, enter the following commands.

```
device(config)# interface ethernet 1/3/1
device(config-if-e100-1/3/1)# ipv6 address 2001:db8:0:adff:8935:e838:78:e0ff /64
device(config-if-e100-1/3/1)# ipv6 rip summary-address 2001:db8::/36
```

Syntax: [no] **ipv6 rip summary-address** *ipv6-prefix/prefix-length*

You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

You must specify the *prefix-length* parameter as a decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter.

To stop the advertising of the summarized IPv6 prefix, use the **no** form of this command.

Changing the metric of routes learned and advertised on an interface

A device interface increases the metric of an incoming RIPng route it learns by an offset (the default is one). The device then places the route in the route table. When the device sends an update, it advertises the route with the metric plus the default offset of zero in an outgoing update message.

You can change the metric offset an individual interface adds to a route learned by the interface or advertised by the interface. For example, to change the metric offset for incoming routes learned by Ethernet interface 1/3/1 to one and the metric offset for outgoing routes advertised by the interface to three, enter the following commands.

```
device(config)# interface ethernet 1/3/1
device(config-if-e100-1/3/1)# ipv6 rip metric-offset 2
device(config-if-e100-1/3/1)# ipv6 rip metric-offset out 3
```

In this example, if Ethernet interface 1/3/1 learns about an incoming route, it will increase the incoming metric by two. If the interface 1/3/1 advertises an outgoing route, it will increase the metric offset by 3 as specified in the example. Configuring the default metric (1 for incoming, 0 for outgoing) will be allowed but will not be visible in the **show run** output for the interface.

Syntax: [no] **ipv6 rip metric-offset** *1-16*

Syntax: [no] **ipv6 rip metric-offset out** *0-15*

To return the metric offset to its default value, use the **no** form of this command.

Redistributing routes into RIPng

You can configure the Ruckus device to redistribute routes from the following sources into RIPng:

- IPv6 static routes
- Directly connected IPv6 networks
- BGP4+
- OSPFv3

When you redistribute a route from BGP4+ or OSPFv3 into RIPng, the device can use RIPng to advertise the route to its RIPng neighbors.

When configuring the Ruckus device to redistribute routes, such as BGP4+ routes, you can optionally specify a metric for the redistributed routes. If you do not explicitly configure a metric, the default metric value of one is used.

For example, to redistribute OSPFv3 routes into RIPng, enter the following command.

```
device(config)# ipv6 router rip
device(config-ripng-router)# redistribute ospf
```

Syntax: [no] **redistribute{ bgp | connected | ospf | static [metric number] }**

For the metric, specify a numerical value that is consistent with RIPng.

Controlling distribution of routes through RIPng

You can create a prefix list and then apply it to RIPng routing updates that are received or sent on a device interface. Performing this task allows you to control the distribution of routes through RIPng.

For example, to permit the inclusion of routes with the prefix 2001:db8::/32 in RIPng routing updates sent from Ethernet interface 1/3/1, enter the following commands.

```
device(config)# ipv6 prefix-list routesfor2001 permit 2001:db8::/32
device(config)# ipv6 router rip
device(config-ripng-router)# distribute-list prefix-list routesfor2001 out
```

To deny prefix lengths greater than 64 bits in routes that have the prefix 2001:db8::/64 and allow all other routes received on tunnel interface 1/3/1, enter the following commands.

```
device(config)# ipv6 prefix-list 2001routes deny 2001:db8::/64 le 128
device(config)# ipv6 prefix-list 2001routes permit ::/0 ge 0 le 128
device(config)# ipv6 router rip
device(config-ripng-router)# distribute-list prefix-list 2001routes in
```

Syntax: [no] **distribute-list prefix-list name { in | out }**

The name parameter indicates the name of the prefix list generated using the **ipv6 prefix-list** command.

The **in** keyword indicates that the prefix list is applied to incoming routing updates on the specified interface.

The **out** keyword indicates that the prefix list is applied to outgoing routing updates on the specified interface.

To remove the distribution list, use the **no** form of this command.

Configuring poison reverse parameters

By default, poison reverse is disabled on a RIPng Ruckus device. If poison reverse is enabled, RIPng advertises routes it learns from a particular interface over that same interface with a metric of 16, which means that the route is unreachable.

Enabling poison reverse on the RIPng Ruckus device disables split-horizon and vice versa. By default, split horizon will be enabled.

To enable poison reverse on the RIPng Ruckus device, enter the following commands.

```
device(config)# ipv6 router rip
device(config-ripng-router)# poison-reverse
```

Syntax:[no] **poison-reverse**

To disable poison-reverse, use the **no** form of this command.

By default, if a RIPng interface goes down, the Ruckus device does not send a triggered update for the interface's IPv6 networks.

RIPng

Clearing RIPng routes from IPv6 route table

To better handle this situation, you can configure a RIPng Ruckus device to send a triggered update containing the local routes of the disabled interface with an unreachable metric of 16 to the other RIPng routers in the routing domain. You can enable the sending of a triggered update by entering the following commands.

```
device(config)# ipv6 router rip
device(config-ripng-router)# poison-local-routes
```

Syntax: [no] poison-local-routes

To disable the sending of a triggered update, use the **no** form of this command.

Clearing RIPng routes from IPv6 route table

To clear all RIPng routes from the RIPng route table and the IPv6 main route table and reset the routes, enter the following command at the Privileged EXEC level or any of the Config levels of the CLI.

```
device# clear ipv6 rip route
```

Syntax: clear ipv6 rip route

Displaying RIPng information

You can display the following RIPng information:

- RIPng configuration
- RIPng routing table

Displaying RIPng configuration

To display RIPng configuration information, enter the **show ipv6 rip** command at any CLI level.

```
device# show ipv6 rip
IPv6 rip enabled, port 521
    Administrative distance is 120
    Updates every 30 seconds, expire after 180
    Holddown lasts 180 seconds, garbage collect after 120
    Split horizon is on; poison reverse is off
    Default routes are not generated
    Periodic updates 5022, trigger updates 10
    Distribute List, Inbound : Not set
    Distribute List, Outbound : Not set
    Redistribute: CONNECTED
```

Syntax: show ipv6 rip

TABLE 53 show ipv6 rip output descriptions

Field	Description
IPv6 RIP status/port	The status of RIPng on the device. Possible status is "enabled" or "disabled."
	The UDP port number over which RIPng is enabled.
Administrative distance	The setting of the administrative distance for RIPng.
Updates/expiration	The settings of the RIPng update and timeout timers.
Holddown/garbage collection	The settings of the RIPng hold-down and garbage-collection timers.

TABLE 53 show ipv6 rip output descriptions (continued)

Field	Description
Split horizon/poison reverse	The status of the RIPng split horizon and poison reverse features. Possible status is "on" or "off."
Default routes	The status of RIPng default routes.
Periodic updates/trigger updates	The number of periodic updates and triggered updates sent by the RIPng Ruckus device.
Distribution lists	The inbound and outbound distribution lists applied to RIPng.
Redistribution	The types of IPv6 routes redistributed into RIPng. The types can include the following: <ul style="list-style-type: none"> • STATIC - IPv6 static routes are redistributed into RIPng. • CONNECTED - Directly connected IPv6 networks are redistributed into RIPng. • BGP - BGP4+ routes are redistributed into RIPng. • OSPF - OSPFv3 routes are redistributed into RIPng.

Displaying RIPng routing table

To display the RIPng routing table, enter the following command at any CLI level.

```
device# show ipv6 rip route
IPv6 RIP Routing Table - 4 entries:
ada::1:1:1:2/128, from fe80::224:38ff:fe8f:3000, e 1/3/4
    RIP, metric 2, tag 0, timers: aging 17
2001:db8::/64, from fe80::224:38ff:fe8f:3000, e 1/3/4
    RIP, metric 3, tag 0, timers: aging 17
bebe::1:1:1:4/128, from ::, null (0)
    CONNECTED, metric 1, tag 0, timers: none
cccc::1:1:1:3/128, from fe80::768e:f8ff:fe94:2da, e 2/1/23
    RIP, metric 2, tag 0, timers: aging 50
```

Syntax: **show ipv6 rip route [ipv6-prefix/prefix-length | ipv6-address]**

The *ipv6-prefix/prefix-length* parameters restrict the display to the entries for the specified IPv6 prefix. You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373. You must specify the *prefix-length* parameter as a decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter.

The *ipv6-address* parameter restricts the display to the entries for the specified IPv6 address. You must specify this parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

TABLE 54 show ipv6 rip route output descriptions

Field	Description
IPv6 RIP Routing Table entries	The total number of entries in the RIPng routing table.
<i>ipv6-prefix /prefix-length</i>	The IPv6 prefix and prefix length.
<i>ipv6-address</i>	The IPv6 address.
Next-hop router	The next-hop router for this Ruckus device. If :: appears, the route is originated locally.
Interface	The interface name. If "null" appears, the interface is originated locally.
Source of route	The source of the route information. The source can be one of the following: <ul style="list-style-type: none"> • RIP - routes learned by RIPng.

RIPng

Displaying RIPng information

TABLE 54 show ipv6 rip route output descriptions (continued)

Field	Description
	<ul style="list-style-type: none">• CONNECTED - IPv6 routes redistributed from directly connected networks.• STATIC - IPv6 static routes are redistributed into RIPng.• BGP - BGP4+ routes are redistributed into RIPng.• OSPF - OSPFv3 routes are redistributed into RIPng.
Metric <i>number</i>	The cost of the route. The <i>number</i> parameter indicates the number of hops to the destination.
Tag <i>number</i>	The tag value of the route.
Timers	Indicates if the hold-down timer or the garbage-collection timer is set.

OSPFv2

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OSPF overview

OSPF is a link-state routing protocol. The protocol uses link-state advertisements (LSA) to update neighboring routers regarding its interfaces and information on those interfaces. The router floods these LSAs to all neighboring routers to update them regarding the interfaces. Each router maintains an identical database that describes its area topology to help a router determine the shortest path between it and any neighboring router.

The Ruckus device supports the following types of LSAs, which are described in RFC 2328 and 3101:

- Router link
- Network link
- Summary link
- Autonomous system (AS) summary link
- AS external link
- Not-So-Stubby Area (NSSA) external link
- Grace LSAs

OSPF is built upon a hierarchy of network components. The highest level of the hierarchy is the Autonomous System (AS). An autonomous system is defined as a number of networks, all of which share the same routing and administration characteristics.

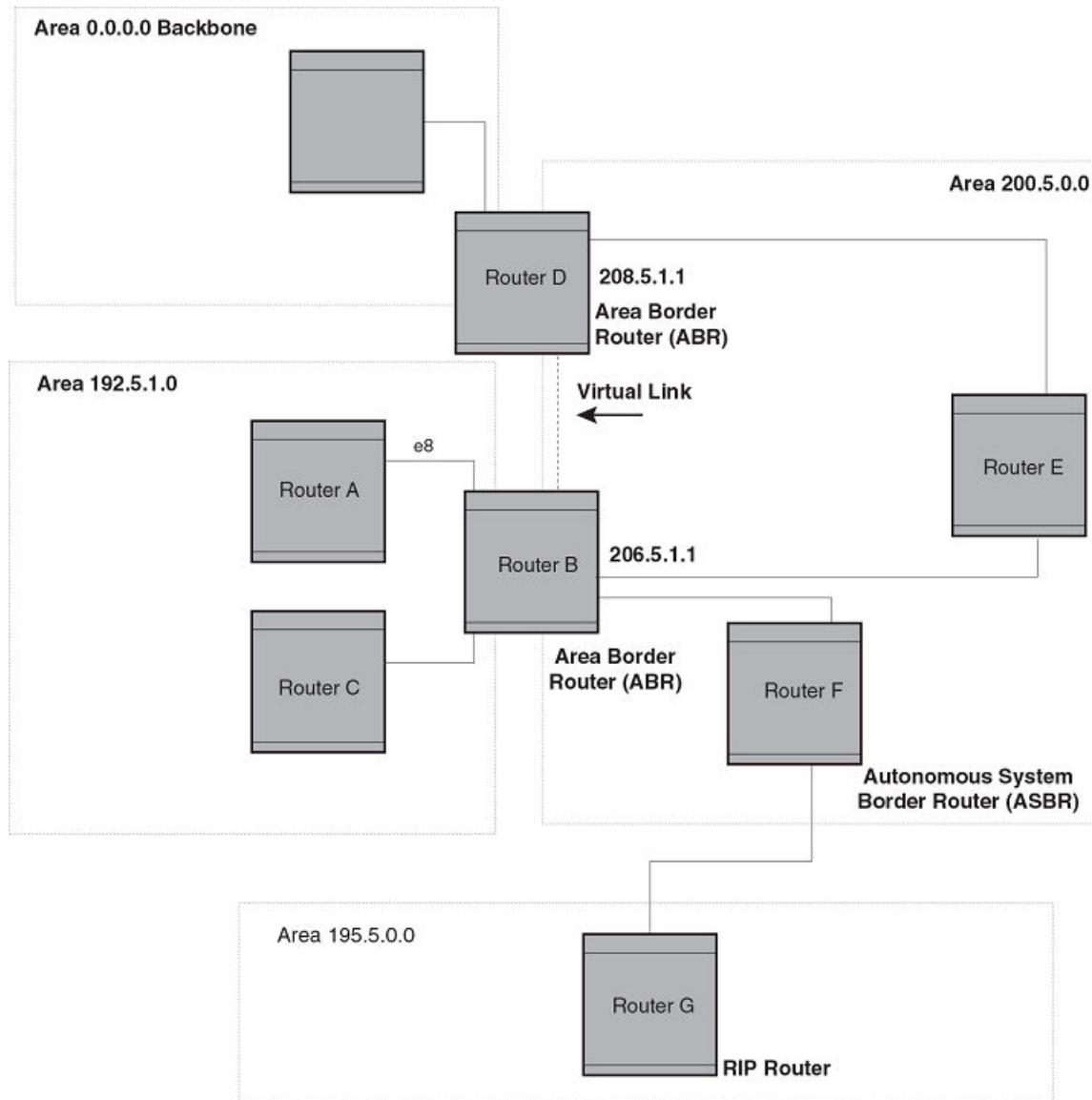
An AS can be divided into multiple areas. Each area represents a collection of contiguous networks and hosts. Areas limit the area to which link-state advertisements are broadcast, thereby limiting the amount of flooding that occurs within the network. An area is represented in OSPF by either an IP address or a number.

You can further limit the broadcast area of flooding by defining an area range. The area range allows you to assign an aggregate value to a range of IP addresses. This aggregate value becomes the address that is advertised instead all of the individual addresses it represents being advertised. You can assign up to 32 ranges in an OSPF area.

An OSPF router can be a member of multiple areas. Routers with membership in multiple areas are known as Area Border Routers (ABRs). Each ABR maintains a separate topological database for each area the router is in. Each topological database contains all of the LSA databases for each router within a given area. The routers within the same area have identical topological databases. The ABR is responsible for forwarding routing information or changes between its border areas.

An Autonomous System Boundary Router (ASBR) is a router that is running multiple protocols and serves as a gateway to routers outside an area and those operating with different protocols. The ASBR is able to import and translate different protocol routes into OSPF through a process known as redistribution .

FIGURE 18 OSPF operating in a network



OSPF point-to-point links

In an OSPF point-to-point network, where a direct Layer 3 connection exists between a single pair of OSPF routers, there is no need for Designated and Backup Designated Routers, as is the case in OSPF multi-access networks. Without the need for Designated and Backup Designated routers, a point-to-point network establishes adjacency and converges faster. The neighboring routers become adjacent whenever they can communicate directly. In contrast, in broadcast and non-broadcast multi-access (NBMA) networks, the Designated Router and Backup Designated Router become adjacent to all other routers attached to the network.

Designated routers in multi-access networks

In a network that has multiple routers attached, OSPF elects one router to serve as the designated router (DR) and another router on the segment to act as the backup designated router (BDR). This arrangement minimizes the amount of repetitive information that is forwarded on the network by forwarding all messages to the designated router and backup designated routers responsible for forwarding the updates throughout the network.

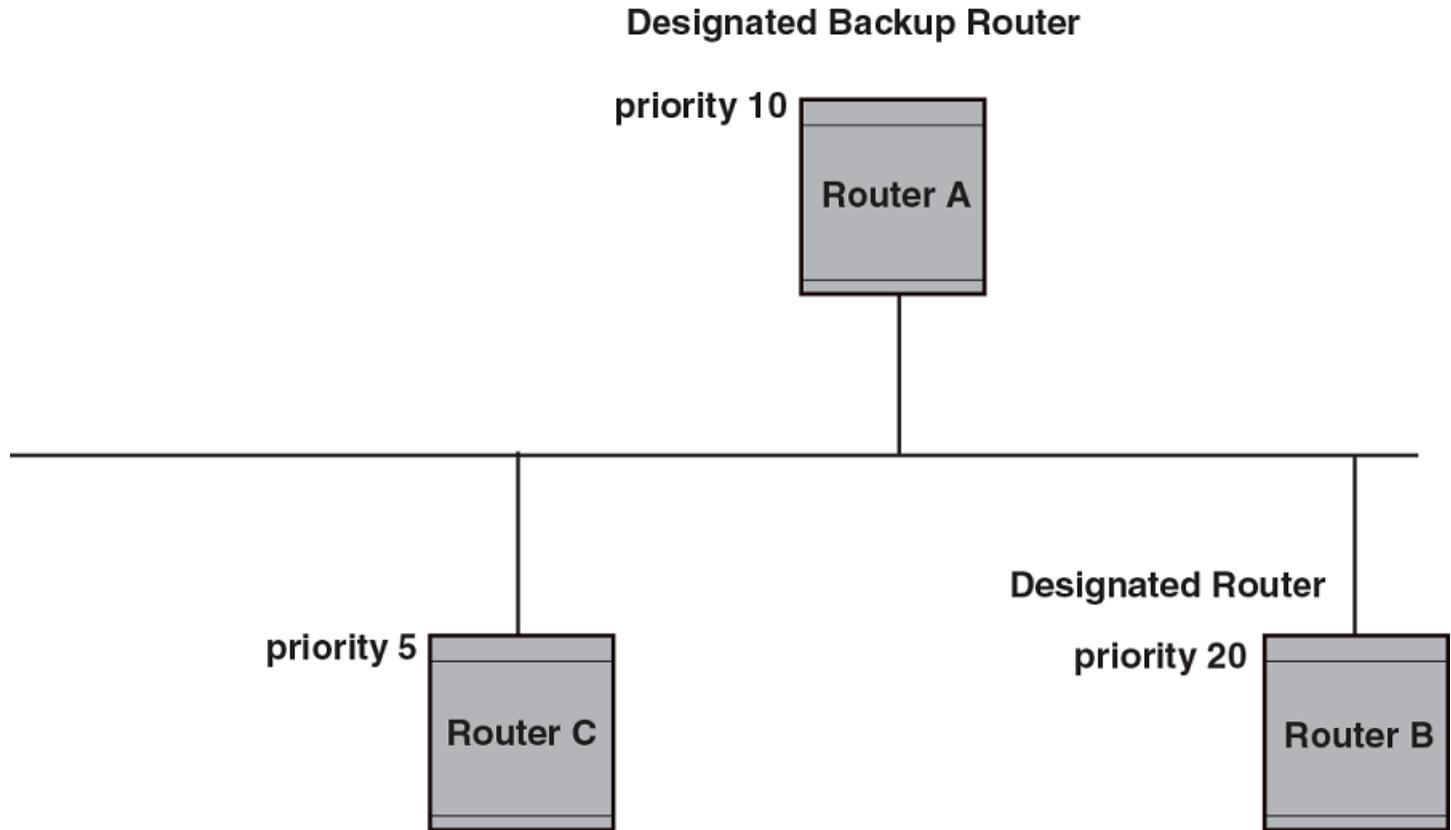
Designated router election in multi-access networks

In a network with no designated router and no backup designated router, the neighboring router with the highest priority is elected as the DR, and the router with the next largest priority is elected as the BDR.

OSPFv2

Designated router election in multi-access networks

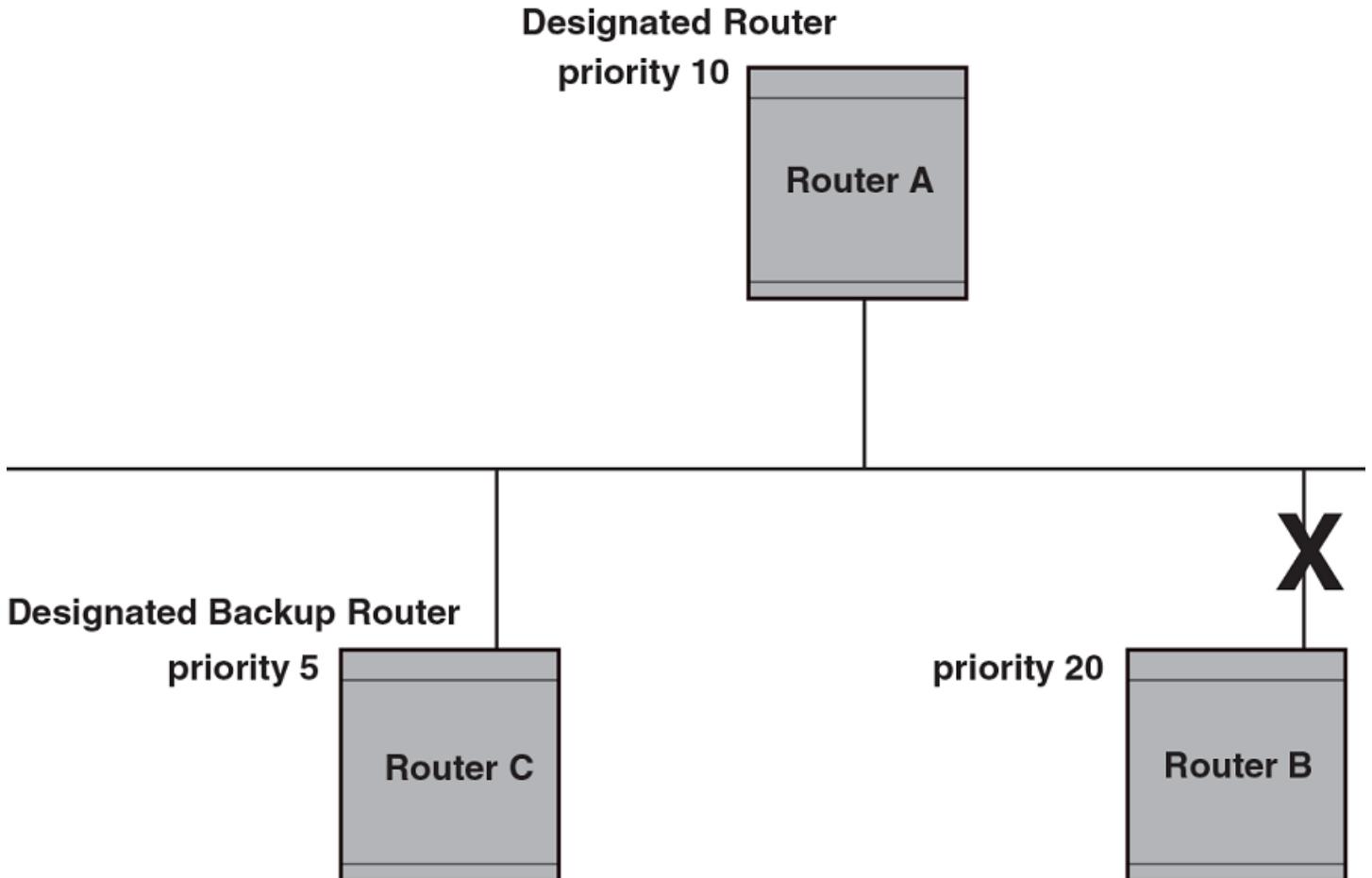
FIGURE 19 Designated and backup router election



If the DR goes off-line, the BDR automatically becomes the DR. The router with the next highest priority becomes the new BDR.

NOTE

Priority is a configurable option at the interface level. You can use this parameter to help bias one router as the DR.

FIGURE 20 Backup designated router becomes designated router

If two neighbors share the same priority, the router with the highest router ID is designated as the DR. The router with the next highest router ID is designated as the BDR.

NOTE

By default, the Ruckus device's router ID is the IP address configured on the lowest numbered loopback interface. If the device does not have a loopback interface, the default router ID is the lowest numbered IP address configured on the device.

When multiple routers on the same network are declaring themselves as DRs, then both priority and router ID are used to select the designated router and backup designated routers.

When only one router on the network claims the DR role despite neighboring routers with higher priorities or router IDs, this router remains the DR. This is also true for BDRs.

The DR and BDR election process is performed when one of the following events occurs:

- an interface is in a waiting state and the wait time expires
- an interface is in a waiting state and a hello packet is received that addresses the BDR
- a change in the neighbor state occurs, such as:
 - a neighbor state transitions from ATTEMPT state to a higher state

OSPFv2

OSPF RFC 1583 and 2328 compliance

- communication to a neighbor is lost
- a neighbor declares itself to be the DR or BDR for the first time

OSPF RFC 1583 and 2328 compliance

Ruckus devices are configured, by default, to be compliant with the RFC 1583 OSPF V2 specification. Ruckus devices can also be configured to operate with the latest OSPF standard, RFC 2328.

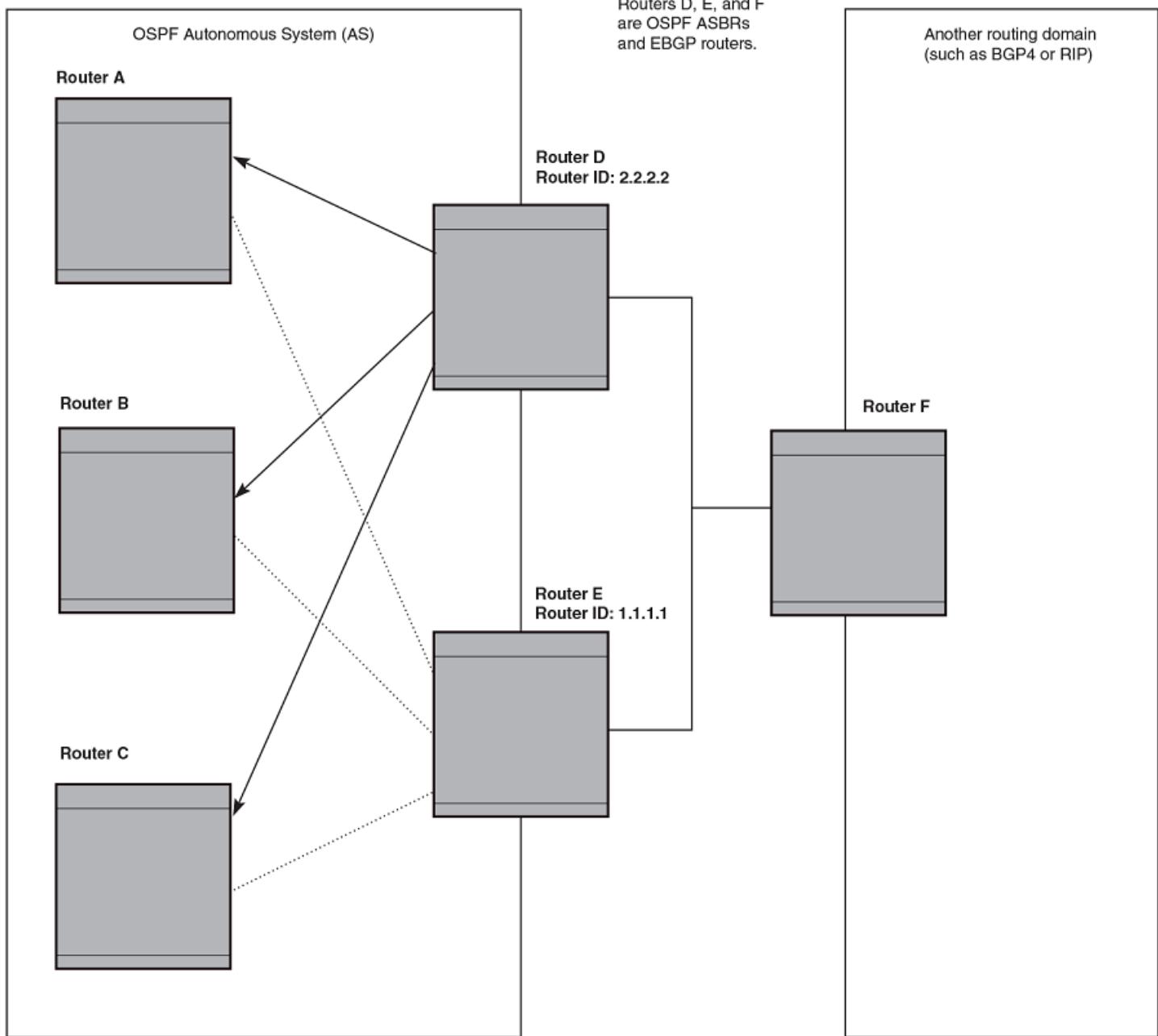
Reduction of equivalent AS external LSAs

An OSPF ASBR uses AS External link advertisements (AS External LSAs) to originate advertisements of a route learned from another routing domain, such as a BGP4 or RIP domain. The ASBR advertises the route to the external domain by flooding AS External LSAs to all the other OSPF routers (except those inside stub networks) within the local OSPF Autonomous System (AS).

In some cases, multiple ASBRs in an AS can originate equivalent LSAs. The LSAs are equivalent when they have the same cost, the same next hop, and the same destination. The device optimizes OSPF by eliminating duplicate AS External LSAs in this case. The device with the lower router ID flushes the duplicate External LSAs from its database and thus does not flood the duplicate External LSAs into the OSPF AS. AS External LSA reduction therefore reduces the size of the link state database on the device. The AS External LSA reduction is described in RFC 2328

In this example, Routers D and E are OSPF ASBRs, and thus communicate route information between the OSPF AS, which contains Routers A, B, and C, and another routing domain, which contains Router F. The other routing domain is running another routing protocol, such as BGP4 or RIP. Routers D, E, and F, therefore, are each running both OSPF and either BGP4 or RIP.

FIGURE 21 AS external LSA reduction



Notice that both Router D and Router E have a route to the other routing domain through Router F.

OSPF eliminates the duplicate AS External LSAs. When two or more devices are configured as ASBRs have equal-cost routes to the same next-hop router in an external routing domain, the ASBR with the highest router ID floods the AS External LSAs for the external domain into the OSPF AS, while the other ASBRs flush the equivalent AS External LSAs from their databases. As a result, the overall volume of route advertisement traffic within the AS is reduced and the devices that flush the duplicate AS External LSAs have more memory for other OSPF data. Because Router D has a higher router ID than Router E, Router D floods the AS External LSAs for Router F to Routers A, B, and C. Router E flushes the equivalent AS External LSAs from its database.

Algorithm for AS external LSA reduction

The AS external LSA reduction example shows the normal AS External LSA reduction feature. The behavior changes under the following conditions:

- There is one ASBR advertising (originating) a route to the external destination, but one of the following happens:
 - A second ASBR comes on-line
 - A second ASBR that is already on-line begins advertising an equivalent route to the same destination.

In either case above, the router with the higher router ID floods the AS External LSAs and the other router flushes its equivalent AS External LSAs. For example, if Router D is offline, Router E is the only source for a route to the external routing domain. When Router D comes on-line, it takes over flooding of the AS External LSAs to Router F, while Router E flushes its equivalent AS External LSAs to Router F.

- One of the ASBRs starts advertising a route that is no longer equivalent to the route the other ASBR is advertising. In this case, the ASBRs each flood AS External LSAs. Since the LSAs either no longer have the same cost or no longer have the same next-hop router, the LSAs are no longer equivalent, and the LSA reduction feature no longer applies.
- The ASBR with the higher router ID becomes unavailable or is reconfigured so that it is no longer an ASBR. In this case, the other ASBR floods the AS External LSAs. For example, if Router D goes off-line, then Router E starts flooding the AS with AS External LSAs for the route to Router F.

Support for OSPF RFC 2328 Appendix E

Ruckus devices support Appendix E in OSPF RFC 2328. Appendix E describes a method to ensure that an OSPF router generates unique link state IDs for type-5 (External) link state advertisements (LSAs) in cases where two networks have the same network address but different network masks.

NOTE

Support for Appendix E of RFC 2328 is enabled automatically and cannot be disabled. No user configuration is required.

Normally, an OSPF router uses the network address alone for the link state ID of the link state advertisement (LSA) for the network. For example, if the router needs to generate an LSA for network 10.1.2.3 255.0.0.0, the router generates ID 10.1.2.3 for the LSA.

However, suppose that an OSPF router needs to generate LSAs for all the following networks:

- 10.0.0.0 255.0.0.0
- 10.0.0.0 255.255.0.0
- 10.0.0.0 255.255.255.0

All three networks have the same network address, 10.0.0.0. Without support for RFC 2328 Appendix E, an OSPF router uses the same link state ID, 10.0.0.0, for the LSAs for all three networks. For example, if the router generates an LSA with ID 10.0.0.0 for network 10.0.0.0 255.0.0.0, this LSA conflicts with the LSA generated for network 10.0.0.0 255.255.0.0 or 10.0.0.0 255.255.255.0. The result is multiple LSAs that have the same ID but that contain different route information.

When appendix E is supported, the router generates the link state ID for a network as the following steps.

1. Does an LSA with the network address as its ID already exist?
 - - No - Use the network address as the ID.
 - - Yes - Go to "Support for OSPF RFC 2328 Appendix E".

2. Compare the networks that have the same network address, to determine which network is more specific. The more specific network is the one that has more contiguous one bits in its network mask. For example, network 10.0.0.0 255.255.0.0 is more specific than network 10.0.0.0 255.0.0.0, because the first network has 16 ones bits (255.255.0.0) whereas the second network has only 8 ones bits (255.0.0.0).
 - - For the less specific network, use the networks address as the ID.
 - For the more specific network, use the network's broadcast address as the ID. The broadcast address is the network address, with all ones bits in the host portion of the address. For example, the broadcast address for network 10.0.0.0 255.255.0.0 is 10.0.255.255.

If this comparison results in a change to the ID of an LSA that has already been generated, the router generates a new LSA to replace the previous one. For example, if the router has already generated an LSA for network with ID 10.0.0.0 for network 10.0.0.0 255.255.255.0, the router must generate a new LSA for the network, if the router needs to generate an LSA for network 10.0.0.0 255.255.0.0 or 10.0.0.0 255.0.0.0.

OSPF graceful restart

The OSPF Graceful Restart feature provides support for high-availability routing. With this feature enabled, disruptions in forwarding are minimized and route flapping diminished to provide continuous service during times when a router experiences a restart.

With OSPF graceful restart enabled, a restarting router sends special LSAs to its neighbors called grace LSAs. These LSAs are sent to neighbors either before a planned OSPF restart or immediately after an unplanned restart. The grace LSA specifies a grace period for the neighbors of the restarting router to continue using the existing routes to and through the router after a restart. The restarting router comes up, it continues to use its existing OSPF routes as if nothing has occurred. In the background, the router re-acquires its neighbors prior to the restart and recalculates its OSPF routes and replaces them with new routes as necessary. Once the grace period has passed, the adjacent routers return to normal operation.

NOTE

By default, graceful restart is enabled.

NOTE

If a Brocade ICX 6650 device is configured for OSPF graceful restart and is intended to be used in switch over, the OSPF dead-interval should be changed to 60 seconds on OSPF interfaces to ensure that the graceful restart process succeeds without a timeout.

OSPF stub router advertisement

OSPFv2 stub router advertisement is an open standard based feature and it is specified in RFC 3137. This feature provides a user with the ability to gracefully introduce and remove an OSPFv2 router from the network by controlling when the data traffic can start and stop flowing through the router in case where there are other OSPFv2 routers present on the network providing alternative paths for the traffic. This feature does not work if there is no alternative for the traffic through other OSPFv2 routers. The router can control the data traffic flowing through it by changing the cost of the paths passing through the configured router. By setting the path cost high the traffic will be redirected to other OSPFv2 routers providing a lower cost path. This change in path cost is accomplished by setting the metric of the links advertised in the Router LSA to a maximum value. When the OSPFv2 router is ready to forward the traffic the links are advertised with the real metric value instead of the maximum value.

The feature is useful for avoiding a loss of traffic during short periods when adjacency failures are detected and traffic is rerouted. Using this feature, traffic can be rerouted before an adjacency failure occurs due to common services interruptions such as a router being shutdown for maintenance.

OSPFv2

OSPF graceful restart

The feature is also useful during router startup because it gives the router enough time to build up its routing table before forwarding traffic. This can be useful where BGP is enabled on the router because it takes time for the BGP routing table to converge.

You can also configure and set a metric value for the following LSA types:

- Summary (type 3 and type 4)
- External (type 5 and type 7)
- Opaque (type 10, TE link)

OSPF Shortest Path First throttling

Rapid triggering of SPF calculations with exponential back-off to offer the advantages of rapid convergence without sacrificing stability. As the delay increases, multiple topology changes can occur within a single SPF. This dampens network activity due to frequent topology changes.

This scheduling method starts with an initial value after which a configured delay time is followed. If a topology change event occurs the SPF is schedule after the time specified by the initial value, the router starts a timer for the time period specified by a configured hold time value. If no topology events occur during this hold time, the router returns to using the initial delay time.

If a topology event occurs during the hold time period, the next hold time period is recalculated to a value that is double the initial value. If no topology events occur during this extended hold time, the router resets to its initial value. If an event occurs during this extended hold time, the next hold time is doubled again. The doubling occurs as long as topology events occur during the calculated hold times until a configured maximum delay time value is reached or no event occurs (which resets the router to the initial hold time). The maximum value is then held until the hold time expires without a topology change event occurring. At any time that a hold time expires without a topology change event occurring, the router reverts to the initial hold value and begins the process all over again.

For example if you set the initial delay timer to 100 milliseconds, the hold timer to 300 and the maximum hold timer to 2000 milliseconds, the following would occur:

If a topology change occurs the initial delay of 100 milliseconds will be observed. If a topology change occurs during the hold time of 300 milliseconds the hold time is doubled to 600 milliseconds. If a topology change event occurs during the 600 millisecond period, the hold time is doubled again to 1200 milliseconds. If a topology change event occurs during the 1200 millisecond period, the hold time is doubled to 2400 milliseconds. Because the maximum hold time is specified as 2000, the value will be held at 2000. This 2000 millisecond period will then repeat as long as topology events occur within the maximum 2000 millisecond hold time. When a maximum hold time expires without a topology event occurring, the router reverts to the initial delay time and the cycle repeats as described.

The purpose of this feature is to use longer SPF scheduling values during network topology instability.

IETF RFC and internet draft support

The implementation of OSPF Graceful Restart supports the following IETF RFC:

- RFC 3623: Graceful OSPF Restart

NOTE

A secondary management module must be installed for the device to function as a graceful restart device. If the device functions as a graceful restart helper device only, there is no requirement for a secondary management module.

Dynamic OSPF activation and configuration

OSPF is automatically activated when you enable it. The protocol does not require a software reload.

You can configure and save the following OSPF changes without resetting the system:

- All OSPF interface-related parameters (for example: area, hello timer, router dead time cost, priority, re-transmission time, transit delay)
- All area parameters
- All area range parameters
- All virtual-link parameters
- All global parameters
- creation and deletion of an area, interface or virtual link
- Changes to address ranges
- Changes to global values for redistribution
- Addition of new virtual links

Configuring OSPF

1. Enable OSPF on the router.
2. Assign the areas to which the router will be attached.
3. Assign individual interfaces to the OSPF areas.
4. Configure route map for route redistribution, if desired.
5. Enable redistribution, if desired.
6. Modify default global and port parameters as required.
7. Modify OSPF standard compliance, if desired.

Configuration rules

The configuration rules are as follows:

- Brocade ICX 6650 devices support a maximum of 676 OSPF interfaces.
- If a router is to operate as an ASBR, you must enable the ASBR capability at the system level.
- Redistribution must be enabled on routers configured to operate as ASBRs.
- All router ports must be assigned to one of the defined areas on an OSPF router. When a port is assigned to an area, all corresponding subnets on that port are automatically included in the assignment.

OSPF parameters

You can modify or set the following global and interface OSPF parameters.

Global parameters

The global OSPF parameters are as follows:

- Modify OSPF standard compliance setting.

- Assign an area.
- Define an area range.
- Define the area virtual link.
- Set global default metric for OSPF.
- Change the reference bandwidth for the default cost of OSPF interfaces.
- Disable or re-enable load sharing.
- Enable or disable default-information-originate.
- Modify Shortest Path First (SPF) timers
- Define external route summarization
- Define redistribution metric type.
- Define redistribution route maps.
- Enable redistribution.
- Change the LSA pacing interval.
- Modify OSPF Traps generated.
- Modify database overflow interval.
- Stub Router advertisement
- Set all the OSPFv2 interfaces to the passive state.

Interface parameters

The interface OSPF parameters are as follows:

- Assign interfaces to an area.
- Define the authentication key for the interface.
- Change the authentication-change interval
- Modify the cost for a link.
- Modify the dead interval.
- Modify MD5 authentication key parameters.
- Modify the priority of the interface.
- Modify the retransmit interval for the interface.
- Modify the transit delay of the interface.

NOTE

You set global level parameters at the OSPF CONFIG Level of the CLI. To reach that level, enter **router ospf** at the global CONFIG Level. Interface parameters for OSPF are set at the interface CONFIG Level using the CLI command **ip ospf**.

When using the Web Management Interface, you set OSPF global parameters using the OSPF configuration panel. All other parameters are accessed through links accessed from the OSPF configuration sheet.

Enable OSPF on the device

When you enable OSPF on the device, the protocol is automatically activated. To enable OSPF on the device, use the following method.

```
device(config)# router ospf
device(config-ospf-router)#{/pre}
```

This command launches you into the OSPF router level where you can assign areas and modify OSPF global parameters.

Note regarding disabling OSPF

If you disable OSPF, the device removes all the configuration information for the disabled protocol from the running configuration. Moreover, when you save the configuration to the startup configuration file after disabling one of these protocols, all the configuration information for the disabled protocol is removed from the startup configuration file.

The CLI displays a warning message such as the following.

```
device(config-ospf-router)#{ no router ospf
router ospf mode now disabled. All ospf config data will be lost when writing to flash!{/pre}
```

The Web Management Interface does not display a warning message.

If you have disabled the protocol but have not yet saved the configuration to the startup configuration file and reloaded the software, you can restore the configuration information by re-entering the **router ospf** command or by selecting the Web management option to enable the protocol. If you have already saved the configuration to the startup configuration file and reloaded the software, the information is gone.

If you are testing an OSPF configuration and are likely to disable and re-enable the protocol, you might want to make a backup copy of the startup configuration file containing the protocol's configuration information. This way, if you remove the configuration information by saving the configuration after disabling the protocol, you can restore the configuration by copying the backup copy of the startup configuration file onto the flash memory.

Assign OSPF areas

Once OSPF is enabled on the system, you can assign areas. Assign an IP address or number as the area ID for each area. The area ID is representative of all IP addresses (subnets) on a router port. Each port on a router can support one area.

An area can be normal, a stub, or a Not-So-Stubby Area (NSSA) :

- Normal - OSPF routers within a normal area can send and receive External Link State Advertisements (LSAs).
- Stub - OSPF routers within a stub area cannot send or receive External LSAs. In addition, OSPF routers in a stub area must use a default route to the area's Area Border Router (ABR) or Autonomous System Boundary Router (ASBR) to send traffic out of the area.
- NSSA - The ASBR of an NSSA can import external route information into the area.
 - ASBRs redistribute (import) external routes into the NSSA as type 7 LSAs. Type-7 External LSAs are a special type of LSA generated only by ASBRs within an NSSA, and are flooded to all the routers within only that NSSA.
 - ABRs translate type 7 LSAs into type 5 External LSAs, which can then be flooded throughout the AS. You can configure address ranges on the ABR of an NSSA so that the ABR converts multiple type-7 External LSAs received from the NSSA into a single type-5 External LSA.

When an NSSA contains more than one ABR, OSPF elects one of the ABRs to perform the LSA translation for NSSA. OSPF elects the ABR with the highest router ID. If the elected ABR becomes unavailable, OSPF automatically elects the ABR with the next highest router ID to take over translation of LSAs for the NSSA. The election process for NSSA ABRs is automatic.

To set up the OSPF areas use the following method.

```
device(config-ospf-router)# area 192.5.1.0
device(config-ospf-router)# area 200.5.0.0
device(config-ospf-router)# area 195.5.0.0
device(config-ospf-router)# area 0.0.0.0
device(config-ospf-router)# write memory
```

Syntax: [no] area { num | ip-addr }

The *num* and *ip-addr* parameters specify the area number, which can be a number or in IP address format. If you specify a number, the number can be from 0 - 2,147,483,647.

Assign a totally stubby area

By default, the device sends summary LSAs (LSA type 3) into stub areas. You can further reduce the number of link state advertisements (LSA) sent into a stub area by configuring the device to stop sending summary LSAs (type 3 LSAs) into the area. You can disable the summary LSAs when you are configuring the stub area or later after you have configured the area.

This feature disables origination of summary LSAs, but the device still accepts summary LSAs from OSPF neighbors and floods them to other neighbors. The device can form adjacencies with other routers regardless of whether summarization is enabled or disabled for areas on each router.

When you enter a command or apply a Web management option to disable the summary LSAs, the change takes effect immediately. If you apply the option to a previously configured area, the device flushes all of the summary LSAs it has generated (as an ABR) from the area.

NOTE

This feature applies only when the device is configured as an Area Border Router (ABR) for the area. To completely prevent summary LSAs from being sent to the area, disable the summary LSAs on each OSPF router that is an ABR for the area.

To disable summary LSAs for a stub area, enter commands such as the following.

```
device(config-ospf-router)# area 40 stub 99 no-summary
```

Syntax: [no] area { num | ip-addr stub cost [no-summary] }

The *num* and *ip-addr* parameters specify the area number, which can be a number or in IP address format. If you specify a number, the number can be from 0 - 2,147,483,647.

The **stub** *cost* parameter specifies an additional cost for using a route to or from this area and can be from 1 - 16777215. There is no default. Normal areas do not use the cost parameter.

The **no-summary** parameter applies only to stub areas and disables summary LSAs from being sent into the area.

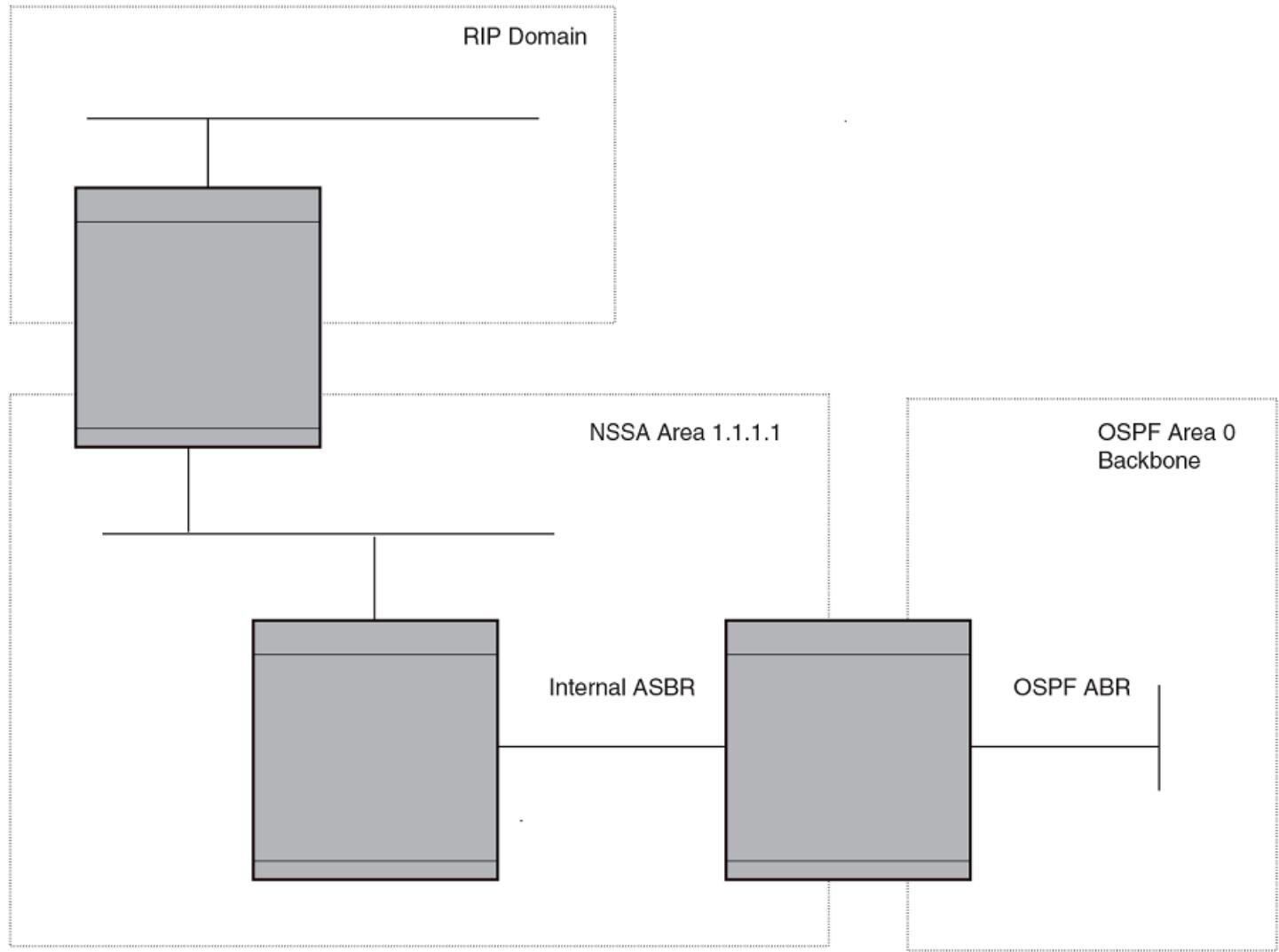
Assign a Not-So-Stubby Area (NSSA)

The OSPF Not So Stubby Area (NSSA) feature enables you to configure OSPF areas that provide the benefits of stub areas, but that also are capable of importing external route information. OSPF does not flood external routes from other areas into an NSSA, but does translate and flood route information from the NSSA into other areas such as the backbone.

NSSAs are especially useful when you want to summarize Type-5 External LSAs (external routes) before forwarding them into an OSPF area. The OSPF specification (RFC 2328) prohibits summarization of Type-5 LSAs and requires OSPF to flood Type-5 LSAs throughout a routing domain. When you configure an NSSA, you can specify an address range for aggregating the external routes that the NSSA's ABR exports into other areas.

The implementation of NSSA is based on RFC 1587.

FIGURE 22 OSPF network containing an NSSA



This example shows two routing domains, a RIP domain and an OSPF domain. The ASBR inside the NSSA imports external routes from RIP into the NSSA as Type-7 LSAs, which the ASBR floods throughout the NSSA.

The ABR translates the Type-7 LSAs into Type-5 LSAs. If an area range is configured for the NSSA, the ABR also summarizes the LSAs into an aggregate LSA before flooding the Type-5 LSAs into the backbone.

Since the NSSA is partially "stubby" the ABR does not flood external LSAs from the backbone into the NSSA. To provide access to the rest of the Autonomous System (AS), the ABR generates a default Type-7 LSA into the NSSA.

Configuring an NSSA

To configure OSPF area 1.1.1.1 as an NSSA, enter the following commands.

```
device(config)# router ospf
device(config-ospf-router)# area 1.1.1.1 nssa 1
device(config-ospf-router)# write memory
```

Syntax: [no] area { num | ip-addr nssa cost [no-summary] | default-information-originate }

The *num* and *ip-addr* parameters specify the area number, which can be a number or in IP address format. If you specify a number, the number can be from 0 - 2,147,483,647.

The **nssa cost** and **default-information-originate** parameters specify that this is a Not-So-Stubby-Area (NSSA). The *cost* specifies an additional cost for using a route to or from this NSSA and can be from 1 - 16777215. There is no default. Normal areas do not use the *cost* parameter. Alternatively, you can use the **default-information-originate** parameter causes the device to inject the default route into the NSSA.

Specifying the **no-summary** option directs the router to not import type 3 summary LSAs into the NSSA area. The default operation is to import summary LSAs into an NSSA area.

NOTE

The device does not inject the default route into an NSSA by default.

To configure additional parameters for OSPF interfaces in the NSSA, use the **ip ospf area** command at the interface level of the CLI.

Disabling the router to perform translations for NSSA LSAs

The **no nssa-translator** command allows you to disable the router to perform translations for NSSA LSAs. When this command is used, type 7 NSSA external LSAs are not translated into type 5 external LSAs. This command is useful when the router is an area border router with many NSSA areas, and does not need to export the NSSA external routes into the backbone.

The following command enables this feature.

```
device(config)# router ospf
device(config-ospf-router)# no nssa-translator
```

Syntax: [no] nssa-translator

Configuring an address range for the NSSA

If you want the ABR that connects the NSSA to other areas to summarize the routes in the NSSA before translating them into Type-5 LSAs and flooding them into the other areas, configure an address range. The ABR creates an aggregate value based on the address range. The aggregate value becomes the address that the ABR advertises instead of advertising the individual addresses represented by the aggregate. You can configure up to 32 ranges in an OSPF area.

To configure an address range in NSSA 1.1.1.1, enter the following commands. This example assumes that you have already configured NSSA 1.1.1.1.

```
device(config)# router ospf
device(config-ospf-router)# area 1.1.1.1 range 209.157.22.1 255.255.0.0
device(config-ospf-router)# write memory
```

Syntax: [no] area { num | ip-addr range ip-addr ip-mask [advertise | not-advertise] }

The *num* and *ip-addr* parameters specify the area number, which can be in IP address format. If you specify a number, the number can be from 0 - 2,147,483,647.

The **range ip-addr** parameter specifies the IP address portion of the range. The software compares the address with the significant bits in the mask. All network addresses that match this comparison are summarized in a single route advertised by the router.

The *ip-mask* parameter specifies the portions of the IP address that a route must contain to be summarized in the summary route. In the example above, all networks that begin with 209.157 are summarized into a single route.

The **advertise** and **not-advertise** parameters specify whether you want the device to send type 3 LSAs for the specified range in this area. The default is **advertise**.

Assigning an area range (optional)

You can assign a range for an area, but it is not required. Ranges allow a specific IP address and mask to represent a range of IP addresses within an area, so that only that reference range address is advertised to the network, instead of all the addresses within that range. Each area can have up to 32 range addresses.

To define an area range for subnets on 10.45.5.1 and 10.45.6.2, enter the following command.

```
device(config)# router ospf
device(config-ospf-router)# area 10.45.5.1 range 10.45.0.0 255.255.0.0
device(config-ospf-router)# area 10.45.6.2 range 10.45.0.0 255.255.0.0
```

Syntax: [no] **area { num | ip-addr } range ip-addr ip-mask**

The *num* and *ip-addr* parameters specify the area number, which can be in IP address format.

The **range ip-addr** parameter specifies the IP address portion of the range. The software compares the address with the significant bits in the mask. All network addresses that match this comparison are summarized in a single route advertised by the router.

The *ip-mask* parameter specifies the portions of the IP address that a route must contain to be summarized in the summary route. In the example above, all networks that begin with 10.45 are summarized into a single route.

Assigning an area cost (optional parameter)

You can assign a cost for an area, but it is not required. To consolidate and summarize routes at an area boundary, use the **area range cost** command in router configuration mode.

If the **cost** parameter is specified, it will be used (overriding the computed cost) to generate the summary LSA. If the **cost** parameter is not specified, then the existing range metric computation max or min cost of routes falling under this range will be used to generate summary LSA.

NOTE

The area should be already configured before using this command.

Creates an area range entry with ip address 10.1.1.1 and network mask 255.255.255.0 with the area-id 10.

```
device(config)# router ospf
device(config-ospf-router)# area 10 range 10.1.1.1 255.255.255.0
```

Modifies the address range status to **DoNotAdvertise**. Neither the individual intra-area routes falling under range nor the ranged prefix is advertised as summary LSA.

```
device(config)# router ospf
device(config-ospf-router)# area 10 range 10.1.1.1 255.255.255.0 not-advertise
```

OSPFv2

Configuring OSPF

Modifies the address range status to advertise and a Type 3 summary link-state advertisement (LSA) can be generated for this address range.

```
device(config)# router ospf  
device(config-ospf-router)# area 10 range 10.1.1.1 255.255.255.0 advertise
```

Modifies the address range status to advertise and assign cost for this area range to 10.

```
device(config)# router ospf  
device(config-ospf-router)# area 10 range 10.1.1.1 255.255.255.0 advertise cost 10
```

Modifies the address range status to not-advertise and cost from 10 to 5.

```
device(config)# router ospf  
device(config-ospf-router)# area 10 range 10.1.1.1 255.255.255.0 not-advertise cost 5
```

Removes the cost from the area range. The area range will be advertised with computed cost which is the max/min(based on RFC 1583 compatibility) of all individual intra-area routes falling under this range.

```
device(config)# router ospf  
device(config-ospf-router)# no area 10 range 10.1.1.1 255.255.255.0 cost 5
```

Removes the area range.

```
device(config)# router ospf  
device(config-ospf-router)# no area 10 range 10.1.1.1 255.255.255.0
```

NOTE

This command does not work in incremental fashion. So both the optional parameters have to be configured each time. Otherwise it will take the default value.

Syntax: **no area { num | ip-addr range ip-addr ip-mask [advertise | not-advertise] cost cost-value }**

The **num** and **ip-addr** parameters specify the area number, which can be in IP address format.

The **range ip-addr** parameter specifies the IP address portion of the range. The software compares the address with the significant bits in the mask. All network addresses that match this comparison are summarized in a single route advertised by the router.

The **ip-mask** parameter specifies the portions of the IP address that a route must contain to be summarized in the summary route.

The **advertise** parameter sets the address range status to advertise and generates a Type 3 summary link-state advertisement (LSA). If at least a single route falls under the range, a ranged LSA will be advertised.

The not-advertise parameter sets the address range status to DoNotAdvertise. Neither the individual intra-area routes falling under range nor the ranged prefix is advertised as summary LSA.

The **cost cost-value** parameter specifies the cost-value to be used while generating type-3 summary LSA. If the cost value is configured, then configured cost is used while generating the summary LSA. If the cost value is not configured, then computed range cost will be used. The cost-value ranges from 1 - 16777215.

To disable this function, use the **no** form of this command.

Assigning interfaces to an area

Once you define OSPF areas, you can assign interfaces to the areas. All router ports must be assigned to one of the defined areas on an OSPF router. When a port is assigned to an area, all corresponding subnets on that port are automatically included in the assignment.

To assign interface 1/1/8 of Router A to area 10.5.0.0 and then save the changes, enter the following commands.

```
RouterA(config)# interface ethernet 1/1/8
RouterA(config-if-e10000-1/1/8)# ip ospf area 10.5.0.0
RouterA(config-if-e10000-1/1/8)# write memory
```

Setting all OSPFv2 interfaces to the passive state

You can set all the Open Shortest Path First Version 2 (OSPFv2) interfaces to the default passive state using the **default-passive-interface** command. When you configure the interfaces as passive, the interfaces drop all the OSPFv2 control packets.

To set all the OSPFv2 interfaces to passive, enter the following command.

```
device# configure terminal
device(config)# router ospf vrf A
device(config-ospf-router-vrf-A)# default-passive-interface
```

Syntax: [no] **default-passive-interface**

Modify interface defaults

OSPF has interface parameters that you can configure. For simplicity, each of these parameters has a default value. No change to these default values is required except as needed for specific network configurations.

Port default values can be modified using the following CLI commands at the interface configuration level of the CLI:

- **ip ospf area**
- **ip ospf auth-change-wait-time**
- **ip ospf authentication-key**
- **ip ospf cost**
- **ip ospf database-filter all out**
- **ip ospf dead-interval**
- **ip ospf hello-interval**
- **ip ospf md5-authentication key-activation-wait-time**
- **ip ospf mtu-ignore**
- **ip ospf passive**
- **ip ospf active**
- **ip ospf priority**
- **ip ospf retransmit-interval**
- **ip ospf transmit-delay**

OSPF interface parameters

The following parameters apply to OSPF interfaces:

- **area**—Assigns an interface to a specific area. You can assign either an IP address or number to represent an OSPF Area ID. If you assign a number, it can be any value from 0 - 2,147,483,647.
- **auth-change-wait-time**—OSPF gracefully implements authentication changes to allow all routers to implement the change and thus prevent disruption to neighbor adjacencies. During the authentication-change interval, both the old

and new authentication information is supported. The default authentication-change interval is 300 seconds (5 minutes). You change the interval to a value from 0 - 14400 seconds.

- **authentication-key** *string*—

By default, the authentication key is encrypted. If you want the authentication key to be in clear text, insert a **0** between **authentication-key** and *string*. For example:

```
device(config-if-e10000-1/1/8)# ip ospf authentication-key 0 morningadmin
```

The software adds a prefix to the authentication key string in the configuration. For example, the following portion of the code has the encrypted code "2".

```
ip ospf authentication-key 2 $on-o
```

The prefix can be one of the following:

- 0 = the key string is not encrypted and is in clear text.
- 1 = the key string uses proprietary simple cryptographic 2-way algorithm.
- **cost**—Indicates the overhead required to send a packet across an interface. You can modify the cost to differentiate between 100 Mbps, 1 Gbps, and 10 Gbps. The default cost is calculated by dividing 100 million by the bandwidth. For 10 Mbps links, the cost is 10. The cost for 100 Mbps, 1 Gbps, and 10 Gbps links is 1, because the speed of 100 Mbps and 10 Gbps was not in use at the time the OSPF cost formula was devised.
- **database-filter**—Blocks all outbound LSAs on the OSPF interface.
- **dead-interval**—Indicates the number of seconds that a neighbor router waits for a hello packet from the current router before declaring the router down. The value can be from 1 - 65535 seconds. The default is 40 seconds.
- **hello-interval**—Represents the length of time between the transmission of hello packets. The value can be from 1 - 65535 seconds. The default is 10 seconds.
- **MD5-authentication activation wait time**—The number of seconds the device waits until placing a new MD5 key into effect. The wait time provides a way to gracefully transition from one MD5 key to another without disturbing the network. The wait time can be from 0 - 14400 seconds. The default is 300 seconds (5 minutes).
- **MD5-authentication key** *string*—The MD5 **authentication-key** is a number from 1 - 255 and identifies the MD5 key that is being used. This parameter is required to differentiate among multiple keys defined on a router.

By default, the authentication key is encrypted. If you want the authentication key to be in clear text, insert a **0** between **authentication-key** and *string*. For example,

```
device(config-if-e10000-1/1/8)# ip ospf 1 md-5-authentication key-id 5 key 2 morningadmin
```

The software adds a prefix to the authentication key string in the configuration. For example, the following portion of the code has the encrypted code "2".

```
ip ospf 1 md-5-authentication key-id 5 key 2 $on-o
```

The prefix can be one of the following:

- 0 = the key string is not encrypted and is in clear text.
- 1 = the key string uses proprietary simple cryptographic 2-way algorithm.
- **mtu-ignore**—A database description packet is rejected if the interface MTU specified in the DBD packet is greater than the MTU of the interface shared between the neighbors. To disable the mismatch condition set "mtu-ignore". By default, the mismatch detection is enabled.
- **passive**—When you configure an OSPF interface to be passive, that interface does not send or receive OSPF route updates. By default, all OSPF interfaces are active and thus can send and receive OSPF route information. Since a

passive interface does not send or receive route information, the interface is in effect a stub network. OSPF interfaces are active by default.

NOTE

This option affects all IP subnets configured on the interface. If you want to disable OSPF updates only on some of the IP subnets on the interface, use the **ospf-ignore** or **ospf-passive** parameter with the **ip address** command.

- active—When you configure an OSPFv2 interface to be active, that interface sends or receives all the control packets and forms the adjacency. By default, the **ip ospf active** command is disabled. Whenever you configure the OSPF interfaces to be passive using the **default-passive-interface** command, all the OSPF interfaces stop sending and receiving control packets. To send and receive packets over specific interfaces, you can use the **ip ospf active** command.
- priority—Allows you to modify the priority of an OSPF router. The priority is used when selecting the designated router (DR) and backup designated routers (BDRs). The value can be from 0 - 255. The default is 1. If you set the priority to 0, the device does not participate in DR and BDR election.
- retransmit-interval—The time between retransmissions of link-state advertisements (LSAs) to adjacent routers for this interface. The value can be from 0 - 3600 seconds. The default is 5 seconds.
- transit-delay—The time it takes to transmit Link State Update packets on this interface. The value can be from 0 - 3600 seconds. The default is 1 second.

Rules for OSPF dead interval and hello interval timers

The following rules apply regarding these timers:

- If both the **hello-interval** and **dead-interval** parameters are configured, they will each be set to the values that you have configured.
- If the **hello-interval** parameter is configured, but not the **dead-interval** parameter, the **dead-interval** parameter will be set to a value that is 4 times the value set for the **hello-interval**.
- If the **dead-interval** parameter is configured, but not the **hello-interval** parameter, the **hello-interval** parameter will be set to a value that is 1/4 the value set for the **dead-interval**. The minimum value for the **hello-interval** is 1.

The recommended setting is that:

- The dead interval is four times that of the hello interval.
- The hello interval is $\frac{1}{4}$ times that of the dead interval.
- If the OSPF hello interval and dead interval are set to more aggressive levels than 1:4 seconds respectively, the OSPF protocol might flap when the **write memory** command is used or in the case of any high CPU.

Changing the timer for OSPF authentication changes

When you make an OSPF authentication change, the software uses the authentication-change timer to gracefully implement the change. The software implements the change in the following ways:

- Outgoing OSPF packets - After you make the change, the software continues to use the old authentication to send packets, during the remainder of the current authentication-change interval. After this, the software uses the new authentication for sending packets.
- Inbound OSPF packets - The software accepts packets containing the new authentication and continues to accept packets containing the older authentication for two authentication-change intervals. After the second interval ends, the software accepts packets only if they contain the new authentication key.

The default authentication-change interval is 300 seconds (5 minutes). You change the interval to a value from 0 - 14400 seconds.

OSPF provides graceful authentication change for all the following types of authentication changes in OSPF:

- Changing authentication methods from one of the following to another of the following:
 - Simple text password
 - MD5 authentication
 - No authentication
- Configuring a new simple text password or MD5 authentication key
- Changing an existing simple text password or MD5 authentication key

To change the authentication-change interval, enter a command such as the following at the interface configuration level of the CLI.

```
device(config-if-e10000-1/2/5)# ip ospf auth-change-wait-time 400
```

Syntax: [no] ip ospf auth-change-wait-time secs

The *secs* parameter specifies the interval and can be from 0 - 14400 seconds. The default is 300 seconds (5 minutes).

NOTE

For backward compatibility, the **ip ospf md5-authentication key-activation-wait-time** command is still supported.

Block flooding of outbound LSAs on specific OSPF interfaces

By default, the device floods all outbound LSAs on all the OSPF interfaces within an area. You can configure a filter to block outbound LSAs on an OSPF interface. This feature is particularly useful when you want to block LSAs from some, but not all, of the interfaces attached to the area.

This command blocks all outbound LSAs to provide options for selective blocking of LSAs.

After you apply filters to block the outbound LSAs, the filtering occurs during the database synchronization and flooding. When a filtering configuration is changed on an interface, all adjacencies on the interface are set to the Extstart state to restart the database exchange process. In cases where an LSA has already been flooded on an interface prior to application of the LSA filter, the LSA will not be flushed out from the remote neighbors. In this situation the user must clear the link state database and the adjacencies on all remote neighbors to flush out the leaked LSAs or wait for the LSAs to be aged out.

If you remove the filters, the blocked LSAs are automatically re-flooded. You do not need to reset OSPF to re-flood the LSAs.

NOTE

You cannot block LSAs on virtual links, and LSA filtering is not supported on sham links.

To apply a filter to an OSPF interface to block flooding of outbound LSAs on the interface, enter the following command at the Interface configuration level for that interface.

```
device(config-if-e10000-1/1/1)# ip ospf database-filter all out
```

The command in this example blocks all outbound LSAs on the OSPF interface configured on port 1/1/1.

Syntax: [no] ip ospf database-filter { all | all-external [allow-default | allow-default-and-type4] | all-summary-external [allow-default | allow-default-and-type4] } out

The **all** parameter directs the router to block all outbound LSAs on the OSPF interface.

The **all-external** option directs the router to allow the following LSAs: Router, Network, Opq-Area-TE, Opq-Link-Graceful and Type-3 Summary while it blocks all Type-4 and Type-5 LSAs unless directed by one of the following keywords:

allow-default - allows only Type-5 default LSAs.

allow-default-and-type4 - allows Type-5 default LSAs and all Type 4 LSAs.

The **all-summary-external** option directs the router to allow the following LSAs: Router, Network, Opq-Area-TE and Opq-Link-Graceful while it blocks all Type-3, Type-4 and Type-5 LSAs unless directed by one of the following keywords:

allow-default - allows only Type-3 or Type-5 default LSAs.

allow-default-and-type4 - allows Type-3 or Type-5 default LSAs and all Type 4 LSAs.

All Type-7 LSAs are always filtered if the **ip ospf database-filter** command is enabled.

By default, OSPF LSA filtering is disabled on all interfaces.

To remove the filter, enter a command such as the following.

```
device(config-if-e10000-1/1/1) # no ip ospf database-filter all out
```

Assign virtual links

All ABRs (area border routers) must have either a direct or indirect link to the OSPF backbone area (0.0.0.0 or 0). If an ABR does not have a physical link to the area backbone, the ABR can configure a virtual link to another router within the same area, which has a physical connection to the area backbone.

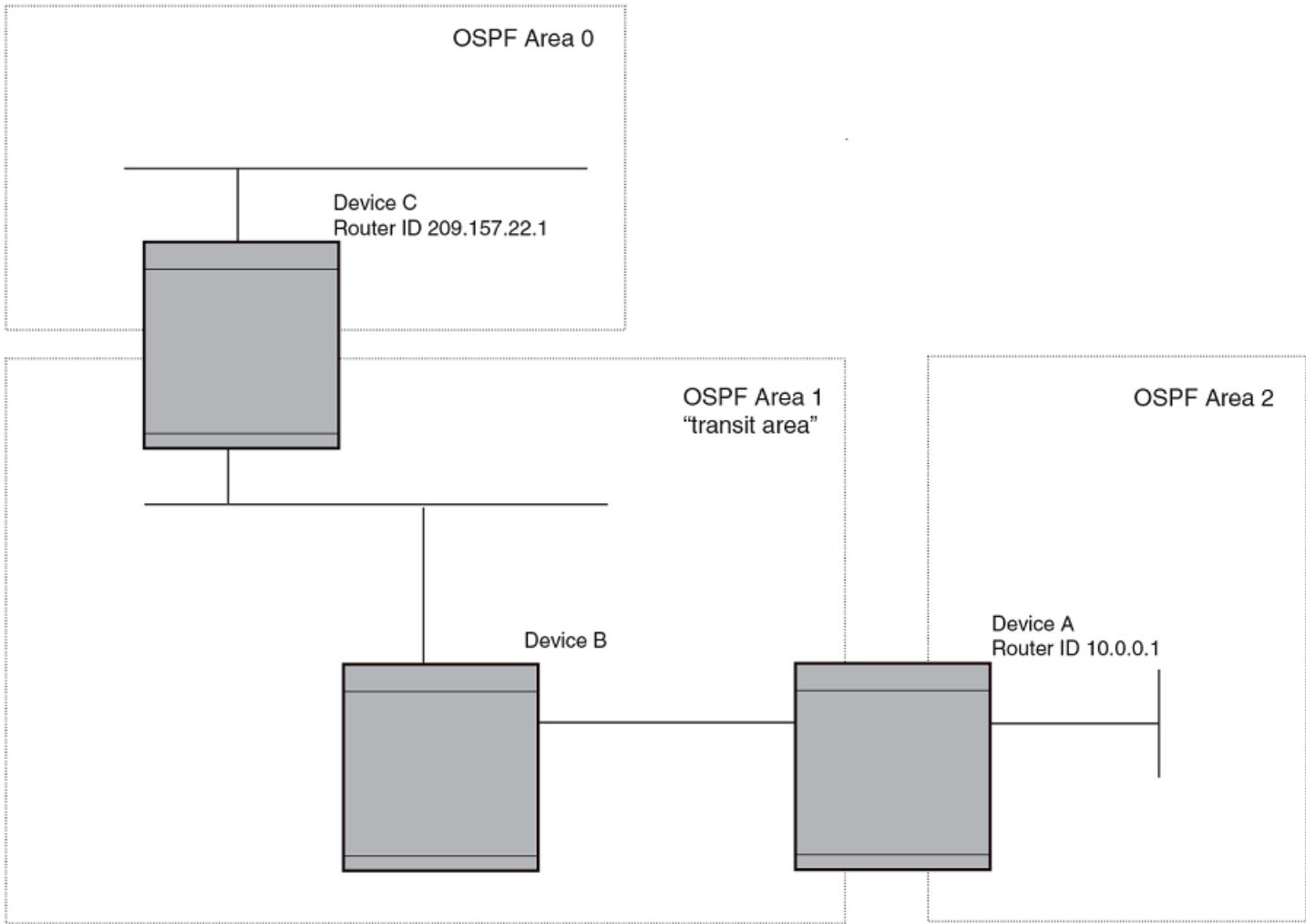
The path for a virtual link is through an area shared by the neighbor ABR (router with a physical backbone connection), and the ABR requiring a logical connection to the backbone.

Two parameters fields must be defined for all virtual links--transit area ID and neighbor router:

- The transit area ID represents the shared area of the two ABRs and serves as the connection point between the two routers. This number should match the area ID value.
- The neighbor router field is the router ID (IP address) of the router that is physically connected to the backbone, when assigned from the router interface requiring a logical connection. When assigning the parameters from the router with the physical connection, the router ID is the IP address of the router requiring a logical connection to the backbone.

NOTE

By default, the Ruckus device's router ID is the IP address configured on the lowest numbered loopback interface. If the device does not have a loopback interface, the default router ID is the lowest numbered IP address configured on the device. When you establish an area virtual link, you must configure it on both of the routers (both ends of the virtual link).

FIGURE 23 Defining OSPF virtual links within a network

The example shows an OSPF area border router, Device A, that is cut off from the backbone area (area 0). To provide backbone access to Device A, you can add a virtual link between Device A and Device C using area 1 as a transit area. To configure the virtual link, you define the link on the router that is at each end of the link. No configuration for the virtual link is required on the routers in the transit area.

To define the virtual link on Device A, enter the following commands.

```
device A(config)# router ospf
device A(config-ospf-router)# area 2
device A(config-ospf-router)# area 1
device A(config-ospf-router)# area 1 virtual-link 209.157.22.1
device A(config-ospf-router)# write memory
```

Enter the following commands to configure the virtual link on Device C.

```
device C(config)# router ospf
device C(config-ospf-router)# area 0
device C(config-ospf-router)# area 1
device C(config-ospf-router)# area 1 virtual-link 10.0.0.1
```

Syntax: [no] area { ip-addr | num } [virtual-link router-id [authentication-key string | dead-interval num | hello-interval num | retransmit-interval num | transmit-delay num | md5-authentication key-activation-wait-time num | md5-authentication key-id num key [0 | 1] string]]

The **area** *ip-addr* and *num* parameters specify the transit area.

The **virtual-link** *router-id* parameter specifies the router ID of the OSPF router at the remote end of the virtual link. To display the router ID on a device, enter the **show ip** command.

Modify virtual link parameters

OSPF has some parameters that you can modify for virtual links. Notice that these are the same parameters as the ones you can modify for physical interfaces.

You can modify default values for virtual links using the following CLI command at the OSPF router level of the CLI, as shown in the following syntax:

Syntax: [no] area { ip-addr | num } [virtual-link router-id dead-interval num | hello-interval num | retransmit-interval num | transmit-delay num | authentication-key string | md5-authentication key *key-string* | md5-authentication key-activation-wait-time num]

Virtual link parameter descriptions

You can modify the following virtual link interface parameters:

area <i>ip-addr</i> <i>num</i>	The IP address or number of the transit area.
virtual-link <i>router-id</i>	The router ID of the OSPF router at the remote end of the virtual link.
dead-interval <i>num</i>	The number of seconds that a neighbor router waits for a hello packet from the current router before declaring the router down. The value can be from 1 - 65535 seconds. The default is 40 seconds.
hello-interval <i>num</i>	The length of time between the transmission of hello packets. The range is 1 - 65535 seconds. The default is 10 seconds.
retransmit-interval <i>num</i>	The interval between the re-transmission of link state advertisements to router adjacencies for this interface. The range is 0 - 3600 seconds. The default is 5 seconds.
transmit-delay <i>num</i>	The period of time it takes to transmit Link State Update packets on the interface. The range is 0 - 3600 seconds. The default is 1 second.
authentication-key <i>string</i>	<p>This parameter allows you to assign different authentication encryption methods on a port-by-port basis. OSPF supports three methods of authentication for each interface: none, simple encryption, and base 64 encryption. Only one encryption method can be active on an interface at a time.</p> <p>The simple encryption and base 64 encryption methods require you to configure an alphanumeric password on an interface. The password can be up to eight characters long. All OSPF packets transmitted on the interface contain this password. All OSPF packets received on the interface are checked for this password. If the password is not present, then the packet is dropped.</p> <p>By default, the authentication key is encrypted. If you want the authentication key to be in clear text, insert a 0 between key and string. For example,</p> <pre>device C(config-ospf-router)# area 1 virtual-link 10.0.0.1 authentication-key 0 afternoon</pre> <p>The software adds a prefix to the authentication key string in the configuration. For example, the following portion of the code has the encrypted code "2".</p> <pre>area 1 virtual-link 12.12.12.25 authentication-key 2 \$on-o</pre> <p>The prefix can be one of the following:</p> <ul style="list-style-type: none"> • 0 = the key string is not encrypted and is in clear text

	<ul style="list-style-type: none"> • 1 = the key string uses proprietary simple cryptographic 2-way algorithm
md5-authentication key <i>string</i>	<p>The MD5 key is a number from 1 - 255 and identifies the MD5 key that is being used. This parameter is required to differentiate among multiple keys defined on a router.</p> <p>When MD5 is enabled, the key-string is an alphanumeric password of up to 16 characters that is later encrypted and included in each OSPF packet transmitted. You must enter a password in this field when the system is configured to operate with either simple or MD5 authentication.</p> <p>By default, the MD5 authentication key is encrypted. If you want the authentication key to be in clear text, insert a 0 between key and string. For example,</p> <pre>device(config-ospf-router)# area 1 virtual-link 10.0.0.1 md-5-authentication key-id 5 key evening</pre> <p>The software adds a prefix to the authentication key string in the configuration. For example, the following portion of the code has the encrypted code "2".</p> <pre>device(config-ospf-router)# area 1 virtual-link 12.12.12.25 md-5-authentication key-id 5 key 2 \$on-o</pre> <p>The prefix can be one of the following:</p> <ul style="list-style-type: none"> • 0 = the key string is not encrypted and is in clear text • 1 = the key string uses proprietary simple cryptographic 2-way algorithm
md5-authentication wait time	<p>This parameter determines when a newly configured MD5 authentication key is valid. This parameter provides a graceful transition from one MD5 key to another without disturbing the network. All new packets transmitted after the key activation wait time interval use the newly configured MD5 Key. OSPF packets that contain the old MD5 key are accepted for up to five minutes after the new MD5 key is in operation.</p> <p>The range for the key activation wait time is from 0 - 14400 seconds. The default value is 300 seconds.</p>

Changing the reference bandwidth for the cost on OSPF interfaces

Each interface on which OSPF is enabled has a cost associated with it. The device advertises its interfaces and their costs to OSPF neighbors. For example, if an interface has an OSPF cost of ten, the device advertises the interface with a cost of ten to other OSPF routers.

By default, an interface's OSPF cost is based on the port speed of the interface. The cost is calculated by dividing the reference bandwidth by the port speed. The default reference bandwidth is 100 Mbps, which results in the following default costs:

- 10 Mbps port - 10
- All other port speeds - 1

You can change the reference bandwidth, to change the costs calculated by the software.

The software uses the following formula to calculate the cost:

$$\text{Cost} = \frac{\text{reference-bandwidth}}{\text{interface-speed}}$$

If the resulting cost is less than 1, the software rounds the cost up to 1. The default reference bandwidth results in the following costs:

- 10 Mbps port's cost = $100/10 = 10$
- 100 Mbps port's cost = $100/100 = 1$
- 1000 Mbps port's cost = $100/1000 = 0.10$, which is rounded up to 1
- 10 Gbps port's cost = $100/10000 = 0.01$, which is rounded up to 1

The bandwidth for interfaces that consist of more than one physical port is calculated as follows:

- LAG group - The combined bandwidth of all the ports.

- Virtual interface - The combined bandwidth of all the ports in the port-based VLAN that contains the virtual interface.

The default reference bandwidth is 100 Mbps. You can change the reference bandwidth to a value from 1 - 4294967.

If a change to the reference bandwidth results in a cost change to an interface, the device sends a link-state update to update the costs of interfaces advertised by the device.

NOTE

If you specify the cost for an individual interface, the cost you specify overrides the cost calculated by the software.

Interface types to which the reference bandwidth does not apply

Some interface types are not affected by the reference bandwidth and always have the same cost regardless of the reference bandwidth in use:

- The cost of a loopback interface is always 1.
- The cost of a virtual link is calculated using the Shortest Path First (SPF) algorithm and is not affected by the auto-cost feature.
- The bandwidth for tunnel interfaces is 9 Kbps and is also subject to the auto-cost reference bandwidth setting.

Changing the reference bandwidth

To change the reference bandwidth, enter a command such as the following at the OSPF configuration level of the CLI.

```
device(config)# router ospf
device(config-ospf-router)# auto-cost reference-bandwidth 500
```

The reference bandwidth specified in this example results in the following costs:

- 10 Mbps port's cost = $500/10 = 50$
- 100 Mbps port's cost = $500/100 = 5$
- 1000 Mbps port's cost = $500/1000 = 0.5$, which is rounded up to 1

The costs for 10 Mbps and 100 Mbps ports change as a result of the changed reference bandwidth. Costs for higher-speed interfaces remain the same.

Syntax: [no] auto-cost { reference-bandwidth num | use-active-ports }

The *num* parameter specifies the reference bandwidth and can be a value from 1 - 4294967. The default is 100.

To restore the reference bandwidth to its default value and thus restore the default costs of interfaces to their default values, enter the following command.

```
device(config-ospf-router)# no auto-cost reference-bandwidth
```

Determining cost calculation for active ports only on LAG and VE interfaces

The default operation is for cost calculation of OSPF interfaces to be based upon all configured ports. There is also an option for the **auto-cost reference-bandwidth** command for the calculation of OSPF costs on active ports of LAG and VE interfaces. This option allows you to calculate cost based on the ports that are currently active. The following example enables cost calculation for currently active ports.

```
device(config-ospf-router)# auto-cost use-active-ports
```

The **use-active-ports** option enables cost calculation for currently active ports only. This option does not have any effect on non-VE or non-LAG interfaces. The default operation is for costs to be based on configured ports.

Define redistribution filters

Route redistribution imports and translates different protocol routes into a specified protocol type. On the device, redistribution is supported for static routes, OSPF, RIP, and BGP4. OSPF redistribution supports the import of static, RIP, and BGP4 routes into OSPF routes.

NOTE

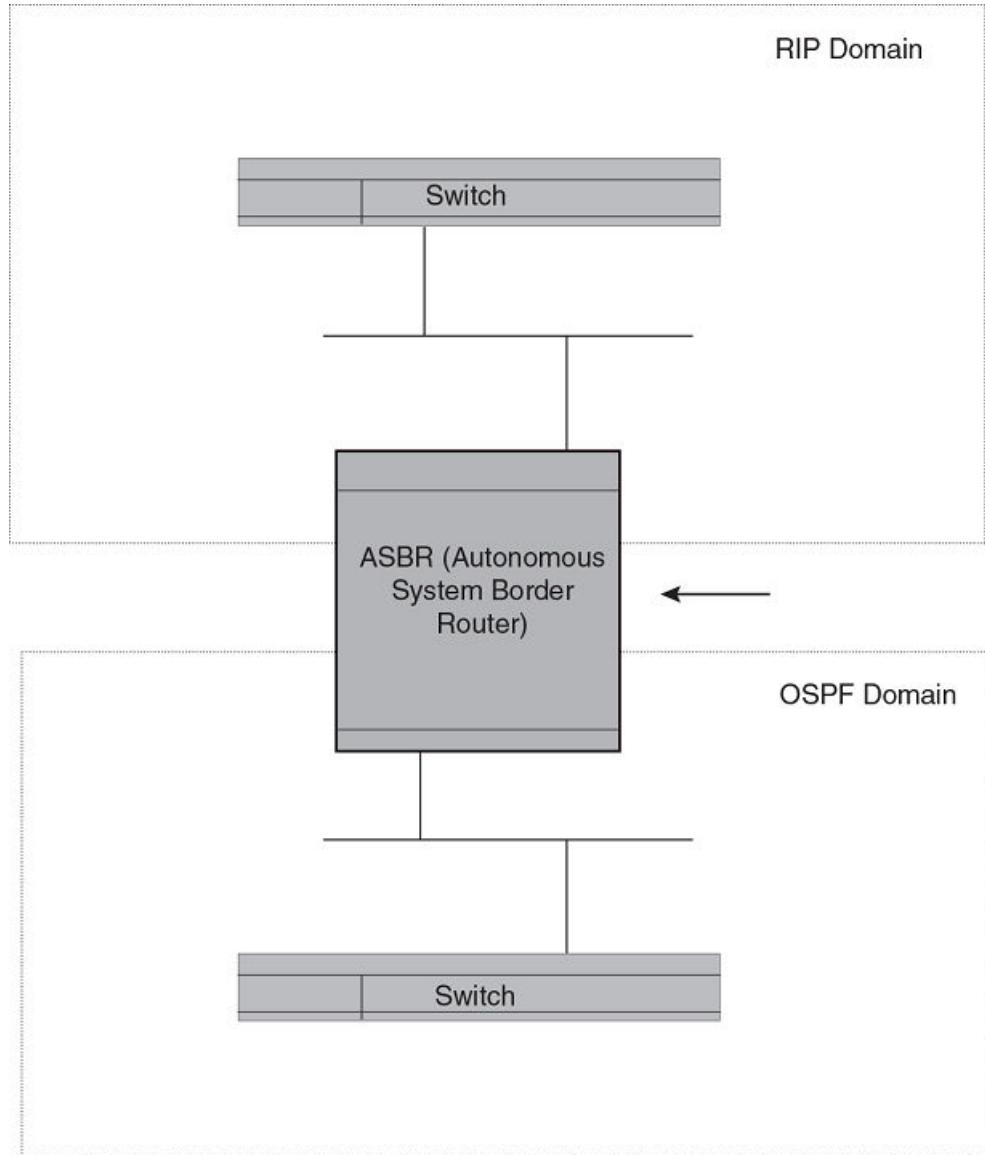
The device advertises the default route into OSPF even if redistribution is not enabled, and even if the default route is learned through an IBGP neighbor. IBGP routes (including the default route) are not redistributed into OSPF by OSPF redistribution (for example, by the OSPF **redistribute** command).

In this example, an administrator wants to configure the device acting as the ASBR (Autonomous System Boundary Router) between the RIP domain and the OSPF domain to redistribute routes between the two domains.

NOTE

The ASBR must be running both RIP and OSPF protocols to support this activity.

FIGURE 24 Redistributing OSPF and static routes to RIP routes



You also have the option of specifying import of just RIP, OSPF, BGP4, or static routes, as well as specifying that only routes for a specific network or with a specific cost (metric) be imported, as shown in the command syntax below.

Syntax: `[no] redistribute { bgp | connected | rip | static [route-map map-name] }`

NOTE

Prior to software release 04.1.00, the **redistribution** command is used instead of **redistribute**.

For example, to enable redistribution of RIP and static IP routes into OSPF, enter the following commands.

```

device(config)# router ospf
device(config-ospf-router)# redistribute rip
device(config-ospf-router)# redistribute static
device(config-ospf-router)# write memory

```

Modify default metric for redistribution

The default metric is a global parameter that specifies the cost applied to all OSPF routes by default. The default value is 10. You can assign a cost from 1 - 65535.

NOTE

You also can define the cost on individual interfaces. The interface cost overrides the default cost.

To assign a default metric of 4 to all routes imported into OSPF, enter the following commands.

```
device(config)# router ospf
device(config-ospf-router)# default-metric 4
```

Syntax: **default-metric** *value*

The *value* can be from 1 - 15. The default is 10.

Enable route redistribution

NOTE

Do not enable redistribution until you have configured the redistribution route map. Otherwise, you might accidentally overload the network with routes you did not intend to redistribute.

To enable redistribution of RIP and static IP routes into OSPF, enter the following commands.

```
device(config)# router ospf
device(config-ospf-router)# redistribute rip
device(config-ospf-router)# redistribute static
device(config-ospf-router)# write memory
```

Example using a route map

To configure a route map and use it for redistribution of routes into OSPF, enter commands such as the following.

```
device(config)# ip route 1.1.0.0 255.255.0.0 10.95.7.30
device(config)# ip route 1.2.0.0 255.255.0.0 10.95.7.30
device(config)# ip route 1.3.0.0 255.255.0.0 10.95.7.30
device(config)# ip route 4.1.0.0 255.255.0.0 10.95.6.30
device(config)# ip route 4.2.0.0 255.255.0.0 10.95.6.30
device(config)# ip route 4.3.0.0 255.255.0.0 10.95.6.30
device(config)# ip route 4.4.0.0 255.255.0.0 10.95.6.30 5
device(config)# route-map abc permit 1
device(config-routemap abc)# match metric 5
device(config-routemap abc)# set metric 8
device(config-routemap abc)# router ospf
device(config-ospf-router)# redistribute static route-map abc
```

The commands in this example configure some static IP routes, then configure a route map and use the route map for redistributing static IP routes into OSPF.

The **ip route** commands configure the static IP routes. The **route-map** command begins configuration of a route map called "abc". The number indicates the route map entry (called the "instance") you are configuring. A route map can contain multiple entries. The software compares routes to the route map entries in ascending numerical order and stops the comparison once a match is found.

The **match** command in the route map matches on routes that have 5 for their metric value (cost). The **set** command changes the metric in routes that match the route map to 8.

The **redistribute static** command enables redistribution of static IP routes into OSPF, and uses route map "abc" to control the routes that are redistributed. In this example, the route map allows a static IP route to be redistributed into OSPF only if the route has a metric of 5, and changes the metric to 8 before placing the route into the OSPF route table.

The following command shows the result of the redistribution. Since only one of the static IP routes configured above matches the route map, only one route is redistributed. Notice that the route's metric is 5 before redistribution but is 8 after redistribution.

```
device# show ip ospf database external
Index Aging LS ID           Router      Netmask Metric   Flag
 1       2    4.4.0.0        10.10.10.60  ffff0000 80000008 0000
```

Syntax: [no] **redistribute** { **bgp** | **connected** | **rip** | **isis** [**level-1** | **level-1-2** | **level-2**] | **static** [**route-map** *map-name*] }

The **bgp**, **connected**, **rip**, and **static** parameters specify the route source.

The **route-map** *map-name* parameter specifies the route map name. The following match parameters are valid for OSPF redistribution:

- **match ip address** | **next-hop** *acl-num*
- **match metric** *num*
- **match tag** *tag-value*

NOTE

A match tag can take up to 16 tags. During the execution of a route-map a match on any tag value in the list is considered a successful match.

The following set parameters are valid for OSPF redistribution:

- **set ip next hop** *ip-addr*
- **set metric** [+ | -] *num* | **none**
- **set metric-type** **type-1** **type-1** | **type-2**
- **set tag** *tag-value*

NOTE

You must configure the route map before you configure a redistribution that uses the route map.

NOTE

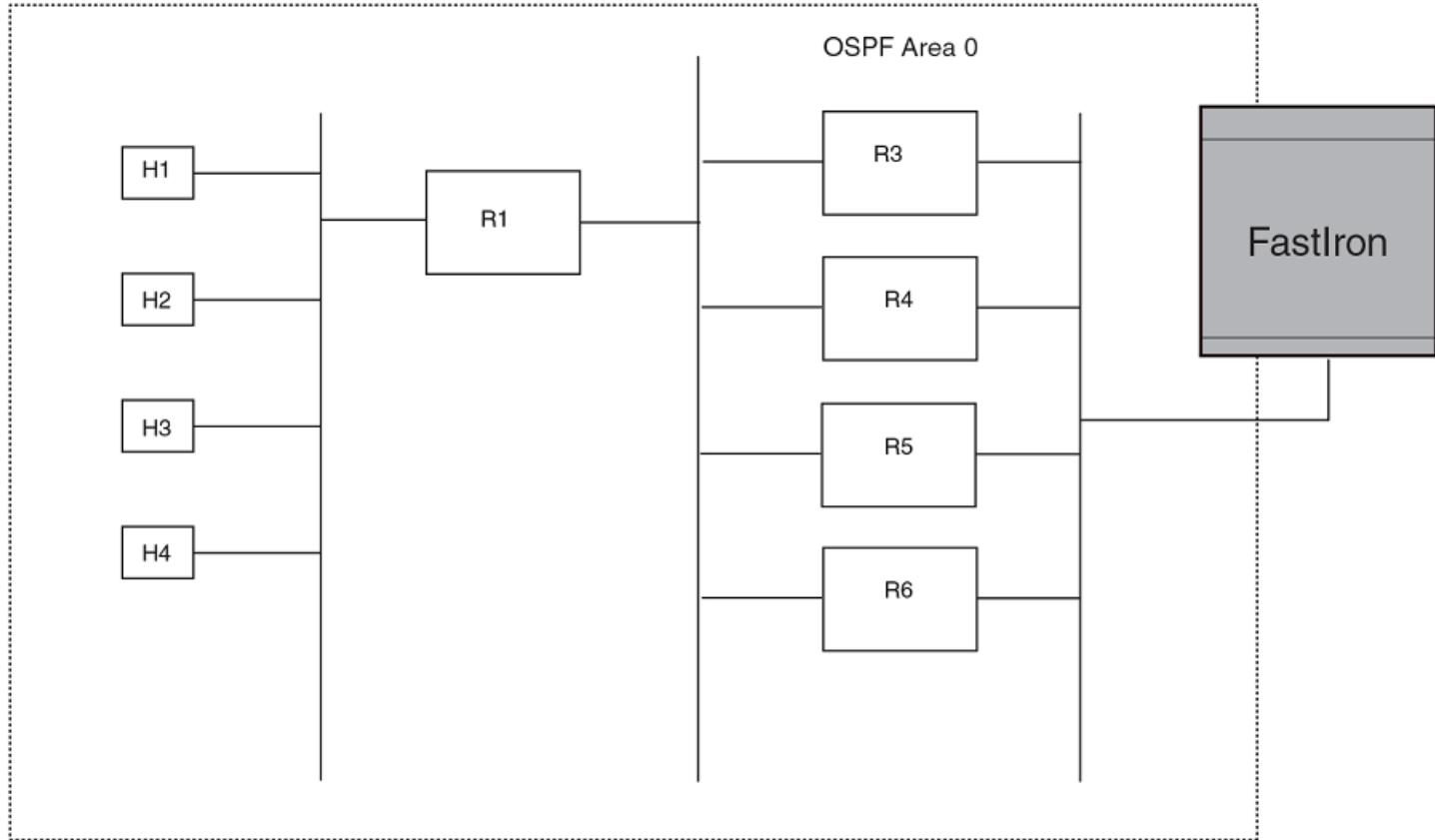
When you use a route map for route redistribution, the software disregards the permit or deny action of the route map.

NOTE

For an external route that is redistributed into OSPF through a route map, the metric value of the route remains the same unless the metric is set by a **set metric** command inside the route map. The **default-metric** *num* command has no effect on the route. This behavior is different from a route that is redistributed without using a route map. For a route redistributed without using a route map, the metric is set by the **default-metric** command.

Disable or re-enable load sharing

Ruckus devices can load share among up to eight equal-cost IP routes to a destination. By default, IP load sharing is enabled. The default is 4 equal-cost paths but you can specify from 2 - 8 paths. On the ICX 7750 device, the value range for the maximum number of load-sharing paths is from 2 through 32 which is controlled by the **system-max max-ecmp** command. The router software can use the route information it learns through OSPF to determine the paths and costs.

FIGURE 25 Example OSPF network with four equal-cost paths

The device has four paths to R1:

- Router ->R3
- Router ->R4
- Router ->R5
- Router ->R6

Normally, the device will choose the path to the R1 with the lower metric. For example, if the metric for R3 is 1400 and the metric for R4 is 600, the device will always choose R4.

However, suppose the metric is the same for all four routers in this example. If the costs are the same, the router now has four equal-cost paths to R1. To allow the router to load share among the equal cost routes, enable IP load sharing. The software supports four equal-cost OSPF paths by default when you enable load sharing.

NOTE

The device is not source routing in these examples. The device is concerned only with the paths to the next-hop routers, not the entire paths to the destination hosts.

OSPF load sharing is enabled by default when IP load sharing is enabled.

Configure external route summarization

When the device is an OSPF Autonomous System Boundary Router (ASBR), you can configure it to advertise one external route as an aggregate for all redistributed routes that are covered by a specified address range.

When you configure an address range, the range takes effect immediately. All the imported routes are summarized according to the configured address range. Imported routes that have already been advertised and that fall within the range are flushed out of the AS and a single route corresponding to the range is advertised.

If a route that falls within a configured address range is imported by the device, no action is taken if the device has already advertised the aggregate route; otherwise the device advertises the aggregate route. If an imported route that falls within a configured address range is removed by the device, no action is taken if there are other imported routes that fall within the same address range; otherwise the aggregate route is flushed.

You can configure up to 32 address ranges. The device sets the forwarding address of the aggregate route to zero and sets the tag to zero.

If you delete an address range, the advertised aggregate route is flushed and all imported routes that fall within the range are advertised individually.

If an external LSDB overflow condition occurs, all aggregate routes are flushed out of the AS, along with other external routes. When the device exits the external LSDB overflow condition, all the imported routes are summarized according to the configured address ranges.

NOTE

If you use redistribution filters in addition to address ranges, the device applies the redistribution filters to routes first, then applies them to the address ranges.

NOTE

If you disable redistribution, all the aggregate routes are flushed, along with other imported routes.

NOTE

This option affects only imported, type 5 external routes. A single type 5 LSA is generated and flooded throughout the AS for multiple external routes. Type 7-route redistribution is not affected by this feature. All type 7 routes will be imported (if redistribution is enabled). To summarize type 7 LSAs or exported routes, use NSSA address range summarization.

To configure a summary address for OSPF routes, enter commands such as the following.

```
device(config-ospf-router) # summary-address 10.1.0.0 255.255.0.0
```

The command in this example configures summary address 10.1.0.0, which includes addresses 10.1.1.0, 10.1.2.0, 10.1.3.0, and so on. For all of these networks, only the address 10.1.0.0 is advertised in external LSAs.

Syntax: **summary-address** *ip-addr ip-mask*

The *ip-addr* parameter specifies the network address.

The *ip-mask* parameter specifies the network mask.

To display the configured summary addresses, enter the following command at any level of the CLI.

```
device# show ip ospf config
Router OSPF: Enabled
Nonstop Routing: Disabled
Graceful Restart: Disabled
Graceful Restart Helper: Enabled
Graceful Restart Time: 120
Graceful Restart Notify Time: 0
```

OSPFv2

Configuring OSPF

```
Redistribution: Disabled
Default OSPF Metric: 50
OSPF Auto-cost Reference Bandwidth: Disabled
Default Passive Interface: Enabled
OSPF Redistribution Metric: Type2
OSPF External LSA Limit: 1447047
OSPF Database Overflow Interval: 0
RFC 1583 Compatibility: Enabled
Router id: 207.95.11.128
Interface State Change Trap: Enabled
Virtual Interface State Change Trap: Enabled
Neighbor State Change Trap: Enabled
Virtual Neighbor State Change Trap: Enabled
Interface Configuration Error Trap: Enabled
Virtual Interface Configuration Error Trap: Enabled
Interface Authentication Failure Trap: Enabled
Virtual Interface Authentication Failure Trap: Enabled
Interface Receive Bad Packet Trap: Enabled
Virtual Interface Receive Bad Packet Trap: Enabled
Interface Retransmit Packet Trap: Disabled
Virtual Interface Retransmit Packet Trap: Disabled
Originate LSA Trap: Disabled
Originate MaxAge LSA Trap: Disabled
Link State Database Overflow Trap: Disabled
Link State Database Approaching Overflow Trap: Disabled
OSPF Area currently defined:
Area-ID Area-Type Cost
0 normal 0
OSPF Interfaces currently defined:
Ethernet Interface: 1/3/1-1/3/2
ip ospf md5-authentication-key-activation-wait-time 300
ip ospf cost 0
```

Syntax: `show ip ospf config`

Configure default route origination

When the device is an OSPF Autonomous System Boundary Router (ASBR), you can configure it to automatically generate a default external route into an OSPF routing domain. This feature is called "default route origination" or "default information origination".

By default, the device does not advertise the default route into the OSPF domain. If you want the device to advertise the OSPF default route, you must explicitly enable default route origination.

When you enable OSPF default route origination, the device advertises a type 5 default route that is flooded throughout the AS (except stub areas and NSSAs). In addition, internal NSSA ASBRs advertise their default routes as translatable type 7 default routes.

The device advertises the default route into OSPF even if OSPF route redistribution is not enabled, and even if the default route is learned through an IBGP neighbor.

NOTE

The device never advertises the OSPF default route, regardless of other configuration parameters, unless you explicitly enable default route origination using the following method.

If the device is an ASBR, you can use the "always" option when you enable the default route origination. The always option causes the ASBR to create and advertise a default route if it does not already have one configured.

If default route origination is enabled and you disable it, the default route originated by the device is flushed. Default routes generated by other OSPF routers are not affected. If you re-enable the feature, the feature takes effect immediately and thus does not require you to reload the software.

NOTE

The ABR (device) will not inject the default route into an NSSA by default and the command described in this section will not cause the device to inject the default route into the NSSA. To inject the default route into an NSSA, use the **area nssa default-information-originate** command.

To enable default route origination, enter the following command.

```
device (config-ospf-router) # default-information-originate
-ospf-router) # default-information-originate
```

To disable the feature, enter the following command.

```
device (config
-ospf-router) # no default-information-originate
```

Syntax: [no] **default-information-originate** [**always**] [**metric value**] [**metric-type type**]

The **always** parameter advertises the default route regardless of whether or not the router has a default route. This option is disabled by default.

NOTE

The **always** parameter is not necessary pre-FastIron 8.0 releases.

The **metric value** parameter specifies a metric for the default route. If this option is not used, the default metric is used for the route.

The **metric-type type** parameter specifies the external link type associated with the default route advertised into the OSPF routing domain. The *type* can be one of the following:

- type1 - Type 1 external route
- type2 - Type 2 external route

If you do not use this option, the default redistribution metric type is used for the route type.

The **route-map** parameter overrides other options. If **set** commands for **metric** and **metric-type** are specified in the route-map, the command-line values of metric and metric-type if specified, are "ignored" for clarification.

The **route-map rmap** parameter specifies the route map reference.

The corresponding route-map should be created before configuring the **route-map** option along with the **default-information-originate** command . If the corresponding route-map was not been created beforehand, then the an error message will be displayed stating that the route-map must be created.

NOTE

The route-map option cannot be used with a non-default address in the match conditions. The default-route LSA shall not be generated if a default route is not present in the routing table and a **match ip address** condition for an existing non-default route is configured in the route-map. The **match ip-address** command in the route-map is a no-op operation for the default information originate command.

Supported match and set conditions

The supported **match** and **set** conditions of a normal route-map configuration are as follows:

TABLE 55 Match Conditions

Match Conditions

OSPFv2

OSPF non-stop routing

TABLE 55 Match Conditions (continued)

ip nexthop prefix-list	<i>prefixList</i>
ip nexthop	<i>accessList</i>
interface	<i>interfaceName</i>
metric	<i>metricValue</i>
tag	<i>routeTagValue</i>
protocol-type	<i>protocol route type and (or) sub-type value</i>
route-type	<i>route type (IS-IS sub-type values)</i>

TABLE 56 Set Conditions

Set Conditions:	
metric	<i>metricValue</i>
metric-type	<i>type1/type2</i>
tag	<i>routeTagValue</i>

OSPF non-stop routing

The graceful restart feature supported by open shortest path first (OSPF) maintains area topology and dataflow. Though the network requires neighboring routers to support graceful restart and perform hitless failover, the graceful restart feature may not be supported by all routers in the network. To eliminate this dependency, the non-stop routing (NSR) feature is supported on Brocade devices. NSR does not require support from neighboring routers to perform hitless failover. NSR does not support virtual link, so traffic loss is expected while performing hitless failover.

NSR does not require support from neighboring routers to perform hitless failover.

If the active management module fails, the standby management module takes over and maintains the current OSPF routes, link-state advertisements (LSAs), and neighbor adjacencies, so that there is no loss of existing traffic to the OSPF destination.

Synchronization of critical OSPF elements

All types of LSAs and the neighbor information are synchronized to the standby module using the NSR synchronization library and IPC mechanism to transmit and receive packets.

Link state database synchronization

When the active management module fails, the standby management module takes over from the active management module with the identical OSPF link state database it had before the failure to ensure non-stop routing. The next shortest path first (SPF) run after switchover yields the same result in routes as the active module had before the failure and OSPF protocol requires that all routers in the network to have identical databases.

LSA delayed acknowledging

When an OSPF router receives LSAs from its neighbor, it acknowledges the LSAs. After the acknowledgement is received, the neighbor removes this router from its retransmission list and stops resending the LSAs.

In the case of NSR, the router fails after receiving the LSA from its neighbor and has acknowledged that neighbor upon receipt of an LSA, and the LSA synchronization to the standby module is completed. In this case, the standby module when taking over from the active module does not have that LSA in its database and the already acknowledged neighbor does not retransmit that LSA. For this reason, the NSR-capable router waits for LSA synchronization of the standby module to complete (Sync-Ack) and then acknowledges the neighbor that sent the LSA.

LSA syncing and packing

When the LSA processing is completed on the active management module and the decision is made to install the LSA in its link state database (LSDB), OSPF synchronizes that LSA to the standby module. OSPF checks the current state of the database entry whether or not it is marked for deletion. After checking the database state, OSPF packs the LSA status and other necessary information needed for direct installation in the standby OSPF LSDB along with the LSA portion. When the LSA reaches the standby module, OSPF checks the database entry state in the buffer and takes appropriate action, such as adding, overwriting, updating, or deleting the LSA from the LSDB.

Neighbor router synchronization

When the neighbor router is added in the active management module, it is synchronized and added to the standby module. When the neighbor is deleted in the active module, it is synchronized to the standby and deleted in the standby. When the neighbor router state becomes 2WAY or FULL, the neighbor router is synchronized to the standby module. The following attributes of the neighbor router is synchronized to the standby module:

- Neighbor router id
- Neighbor router ip address
- Destination router or backup destination router information
- Neighbor state 2WAY or FULL
- MD5 information
- Neighbor priority

Limitations

- If a neighbor router is inactive for 30 seconds, and if the standby module takes over in another 10 seconds, the neighbor router cannot be dropped. The inactivity timer starts again and takes another 40 seconds to drop the neighbor router.
- In standby module, the valid neighbor states are LOADING, DOWN, 2WAY, and FULL. If the active management processor (MP) fails when the neighbor state is LOADING, the standby module cannot continue from LOADING, but the standby can continue from 2WAY and tries to establish adjacency between the neighboring routers.
- The minimum OSPF dead-interval timer value is 40 seconds (default dead-interval value). When the dead-interval value is configured less than this minimum value, OSPF NSR cannot be supported.

Interface synchronization

Interface information is synchronized for interfaces such as PTPT, broadcast, and non-broadcast. Interface wait time is not synchronized to the standby module. If an interface waits for 30 seconds to determine the identity of designated router (DR) or backup designated router (BDR), and if the standby module takes over, the wait timer starts again and takes another 40 seconds for the interface state to change from waiting to BDR, DR, or DROther.

Standby module operations

The standby management module with OSPF configuration performs the following functions.

Neighbor database

Neighbor information is updated in the standby module based on updates from the active module. Certain neighbor state and interface transitions are synchronized to the standby module. By default, the neighbor timers on the standby module are disabled.

LSA database

The standby module processes LSA synchronization events from the active module and unpacks the LSA synchronization information to directly install it in its LSDB as the LSA has already been processed on the active module. The information required to install all types of LSAs (and special LSAs such as Grace LSAs) is packed by OSPF on the active module in the synchronization buffer, so that you can directly install LSAs on the standby module without extra processing.

The standby module is not allowed to originate any LSAs of its own. This is to maintain all information consistently from the active module. The active module synchronizes self-originated LSAs to the standby module.

LSA aging is not applicable on the standby module. During synchronization from the active, the current LSA age is recorded and the new database timestamp is created on the standby to later derive the LSA age as needed.

When the active module sends the LSAs to the standby module, based on the message, the standby module deletes or updates its link state database with the latest information.

LSA acknowledging or flooding are not done on the standby module. When the LSA synchronization update arrives from the active module, it will be directly installed into the LSDB.

Enabling and disabling NSR

To enable NSR for OSPF, enter the following commands:

```
device(config)# router ospf
device(config-ospf-router)# nonstop-routing
```

To disable NSR for OSPF, enter the following commands:

```
device(config)# router ospf
device(config-ospf-router)# no nonstop-routing
```

Syntax: [no] nonstop-routing

If you enter the **graceful-restart** command when NSR is already enabled, the command is rejected with the following message: "Error - Please disable NSR before enabling Graceful Restart."

Similarly, if you enter the **nonstop-routing** command when graceful restart is already enabled, the command is rejected and the following message is displayed: "Error - Please disable Graceful Restart before enabling NSR."

To disable **graceful-restart** command, the following commands:

```
Brocade (config)# router ospf
Brocade (config-ospf-router)# no graceful-restart
```

Limitations of NSR

Following are the limitations of NSR:

- Configurations that occur before the switchover are lost due to the CLI synchronization.
- NSR does not support virtual link.
- Changes in the neighbor state or interface state before or during a switchover do not take effect.
- Traffic counters are not synchronized because the neighbor and LSA database counters are recalculated on the standby module during synchronization.
- LSA acknowledging is delayed because it has to wait until standby acknowledging occurs.
- Depending on the sequence of redistribution or new LSAs (from neighbors), the LSAs accepted within the limits of the database may change after switchover.
- In NSR hitless failover, after switchover, additional flooding-related protocol traffic is generated to the directly connected neighbors.
- OSPF startup timers, database overflow, and max-metric, are not applied during NSR switchover.
- Brocade Netiron devices may generate OSPF log messages or OSPF neighbor timers are reset but these issues do not cause any OSPF or traffic disruption.

Disabling configuration

To disable the **route-map** parameter from the configuration, enter the following command:

```
device(config-ospf-router) # no default-information-originate route-map defaultToOspf
```

The above CLI would retain the configuration with **default-information-originate** alone and the **route-map** option would get reset or removed.

The following commands with any or all of the options will remove the options from the **default-information-originate** command if any of the options are configured:

```
device(config-ospf-router) # no default-information-originate always
device(config-ospf-router) # no default-information-originate always route-map test
device(config-ospf-router) # no default-information-originate always route-map test metric 200
device(config-ospf-router) # no default-information-originate always route-map test metric 200 metric-type type1
```

In the following example, the parameters of the **default-information-originate** command are reset if they are configured and if none of the parameters are configured then, these commands will have no effect.

To disable the origination of default route, issue the command with **no** option and without any other options. This would remove the configuration of the **default information origination** even if any of the above mentioned options are configured.

Syntax: [no] **default-information-originate** [**always**] [**metric** *metricvalue*] [**metric-type** *metric-type*] [**route-map** *rmap-name*]

The **always** parameter advertises the default route regardless of whether the router has a default route. This option is disabled by default.

The **metric value** parameter specifies a metric for the default route. If this option is not used, the default metric is used for the route.

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The **metric-type** *type* parameter specifies the external link type associated with the default route advertised into the OSPF routing domain. The *type* can be one of the following:

- type1 - Type 1 external route
- type2 - Type 2 external route

If you do not use this option, the default redistribution metric type is used for the route type.

NOTE

If you specify a metric and metric type, the values you specify are used even if you do not use the **always** option.

The **route-map** parameter overrides other options. If **set** commands for **metric** and **metric-type** are specified in the route-map, the command-line values of metric and metric-type if specified, are ignored for clarification.

The **route-map** *rmap* parameter specifies the route map reference.

The corresponding route-map should be created before configuring the **route-map** option along with the **default-information-originate**. If the corresponding route-map was not been created beforehand, then the an error message will be displayed stating that the route-map must be created.

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This feature configures a distribution list to explicitly deny specific routes from being eligible for installation in the IP route table. By default, all OSPF routes in the OSPF route table are eligible for installation in the IP route table. This feature does not block receipt of LSAs for the denied routes. The device still receives the routes and installs them in the OSPF database. The feature only prevents the software from installing the denied OSPF routes into the IP route table.

The OSPF distribution list can be managed using ACLs or Route Maps to identify routes to be denied as described in the following sections:

- Configuring an OSPF Distribution List using ACLs
- Configuring an OSPF Distribution List using Route Maps

Configuring an OSPF distribution list using ACLs

To configure an OSPF distribution list using ACLs:

- Configure an ACL that identifies the routes you want to deny. Using a standard ACL lets you deny routes based on the destination network, but does not filter based on the network mask. To also filter based on the destination network's network mask, use an extended ACL.
- Configure an OSPF distribution list that uses the ACL as input.

Examples

In the following example, the first three commands configure a standard ACL that denies routes to any 10.x.x.x destination network and allows all other routes for eligibility to be installed in the IP route table. The last three commands change the CLI to the OSPF configuration level and configure an OSPF distribution list that uses the ACL as input. The distribution list prevents routes to any 10.x.x.x destination network from entering the IP route table. The distribution list does not prevent the routes from entering the OSPF database.

```
device(config)# ip access-list standard no_ip
device(config-std-nacl)# deny 10.0.0.0 0.255.255.255
device(config-std-nacl)# permit any
```

```
device(config)# router ospf
device(config-ospf-router) # area 0
device(config-ospf-router) # distribute-list no_ip in
```

In the following example, the first three commands configure an extended ACL that denies routes to any 10.31.39.x destination network and allows all other routes for eligibility to be installed in the IP route table. The last three commands change the CLI to the OSPF configuration level and configure an OSPF distribution list that uses the ACL as input. The distribution list prevents routes to any 10.31.39.x destination network from entering the IP route table. The distribution list does not prevent the routes from entering the OSPF database.

```
device(config)# ip access-list extended DenyNet39
device(config-ext-nacl)# deny ip 10.31.39.0 0.0.0.255 any
device(config-ext-nacl)# permit ip any any
device(config)# router ospf
device(config-ospf-router) # area 0
device(config-ospf-router) # distribute-list DenyNet39 in
```

In the following example, the first command configures a numbered ACL that denies routes to any 10.31.39.x destination network and allows all other routes for eligibility to be installed in the IP route table. The last three commands change the CLI to the OSPF configuration level and configure an OSPF distribution list that uses the ACL as input. The distribution list prevents routes to any 10.31.39.x destination network from entering the IP route table. The distribution list does not prevent the routes from entering the OSPF database.

```
device(config)# ip access-list 100 deny ip 10.31.39.0 0.0.0.255 any
device(config)# ip access-list 100 permit ip any any
device(config)# router ospf
device(config-ospf-router) # area 0
device(config-ospf-router) # distribute-list 100 in
```

Syntax: [no] **distribute-list** { *acl-name* | *acl-number* } **in**

The **distribute-list** command is applied globally to all interfaces on the router where it is executed.

Configuring an OSPF distribution list using route maps

You can manage an OSPF distribution list using route maps that apply match operations as defined by an ACL or an IP prefix list. You can also use other options available within the route maps and ACLs to further control the contents of the routes that OSPF provides to the IP route table. This section describes an example of an OSPF distribution list using a route map to specify an OSPF administrative distance for routes identified by an IP prefix list.

To configure an OSPF distribution list using route maps:

- Configure a route map that identifies the routes you want to manage
- Optionally configure an OSPF administrative distance to apply to the OSPF routes
- Configure an OSPF distribution list that uses the route map as input

In the following example, the first two commands identify two routes using the **ip prefix-list test1** command. Next, a route map is created that uses the **prefix-list test1** command to identify the two routes and the **set distance** command to set the OSPF administrative distance of those routes to 200. A distribution list is then configured under the OSPF configuration that uses the route map named "setdistance" as input.

```
device(config)# ip prefix-list test1 seq 5 permit 10.0.0.2/32
device(config)# ip prefix-list test1 seq 10 permit 10.102.1.0/24
device(config)# route-map setdistance permit 1
device(config-routemap setdistance)# match ip address prefix-list test1
device(config-routemap setdistance)# set distance 200
device(config-routemap setdistance)# exit
device(config)# route-map setdistance permit 2
device(config-routemap setdistance)# exit
device(config)# router ospf
```

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```
device(config-ospf-router)# area 0
device(config-ospf-router)# area 1
device(config-ospf-router)# distribute-list route-map setdistance in
device(config-ospf-router)# exit
```

Once this configuration is implemented, the routes identified by the **ip prefix-list** command and matched in the route map will have their OSPF administrative distance to 200. This is displayed in the output from the **show ip route** command, as shown in the following.

```
device# show ip route
Total number of IP routes: 4
Type Codes - B:BGP D:Connected O:OSPF R:RIP S:Static; Cost - Dist/Metric
BGP Codes - i:iBGP e:eBGP
OSPF Codes - i:Inter Area 1:External Type 1 2:External Type 2
  Destination      Gateway      Port      Cost      Type Uptime
1    10.0.0.2/32    10.1.1.2    ve 100    200/501   O    1h3m
2    10.102.1.0/24  10.1.1.2    ve 100    200/2     O    1h3m
3    10.102.6.0/24  10.1.1.2    ve 100    110/2     O    1h3m
4    10.102.8.0/30  DIRECT      ve 100    0/0       D    1h4m
```

Routes 1 and 2 demonstrate the actions of the example configuration as both display an OSPF administrative distance value of 200. Note that the value is applied to both OSPF learned routes that match the route-map instance containing the set distance clause. The other OSPF route (route 3), which does not match the relevant instance, continues to have the default OSPF administrative distance of 110.

The following is an example of the **distribute-list** command applied with route-map "setdistance" set as the input.

```
device(config-ospf-router)# distribute-list route-map setdistance in
```

Syntax: [no] distribute-list route-map routemap-name in

The *routemap-name* variable specifies the name of the route map being used to define the OSPF distribute list.

The *distribute-list* command is applied to all OSPF LSAs on the router where it is executed.

NOTE

A route map used with the **distribute-list** command can use either the **ip prefix-list** command (as shown in the example) or an ACL to define the routes.

The **set distance** command is used in association with a route map configuration.

Modify SPF timers

The device uses the following timers when calculating the shortest path for OSPF routes:

- **SPF delay** - When the device receives a topology change, the software waits before it starts a Shortest Path First (SPF) calculation. By default, the software waits 0 (zero) seconds. You can configure the SPF delay to a value from 0 - 65535 seconds. If you set the SPF delay to 0 seconds, the software immediately begins the SPF calculation after receiving a topology change.
- SPF hold time - The device waits for a specific amount of time between consecutive SPF calculations. By default, the device waits zero seconds. You can configure the SPF hold time to a value from 0 - 65535 seconds. If you set the SPF hold time to 0 seconds, the software does not wait between consecutive SPF calculations.

You can set the delay and hold time to lower values to cause the device to change to alternate paths more quickly in the event of a route failure. Note that lower values require more CPU processing time.

You can change one or both of the timers.

To change the SPF delay and hold time, enter commands such as the following.

```
device(config-ospf-router)# timers spf 10 20
```

The command in this example changes the SPF delay to 10 seconds and changes the SPF hold time to 20 seconds.

To set the timers back to their default values, enter a command such as the following.

```
device(config-ospf-router)# no timers spf 10 20
```

Syntax: [no] **timers spf** *delay hold-time*

The *delay* parameter specifies the SPF delay.

The *hold-time* parameter specifies the SPF hold time.

NOTE

OSPF incrementally updates the OSPF routing table when new Type-3 or Type-4 Summary, Type-5 External, or Type-7 External NSSA LSAs are received.

Modify redistribution metric type

The redistribution metric type is used by default for all routes imported into OSPF unless you specify different metrics for individual routes using redistribution filters. Type 2 specifies a big metric (three bytes). Type 1 specifies a small metric (two bytes). The default value is type 2.

To modify the default value to type 1, enter the following command.

```
device(config-ospf-router)# metric-type type1
```

Syntax: [no] **metric-type type1 | type2**

The default is **type2**.

Modify administrative distance

The device can learn about networks from various protocols, including Border Gateway Protocol version 4 (BGP4), RIP, and OSPF. Consequently, the routes to a network may differ depending on the protocol from which the routes were learned. The default administrative distance for OSPF routes is 110.

The router selects one route over another based on the source of the route information. To do so, the router can use the administrative distances assigned to the sources. You can bias the decision the device makes by changing the default administrative distance for OSPF routes.

Configuring administrative distance based on route type

You can configure a unique administrative distance for each type of OSPF route. For example, you can use this feature to prefer a static route over an OSPF inter-area route but you also want to prefer OSPF intra-area routes to static routes.

The distance you specify influences the choice of routes when the device has multiple routes for the same network from different protocols. The device prefers the route with the lower administrative distance.

You can specify unique default administrative distances for the following route types:

- Intra-area routes
- Inter-area routes
- External routes

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The default for all these OSPF route types is 110.

NOTE

This feature does not influence the choice of routes within OSPF. For example, an OSPF intra-area route is always preferred over an OSPF inter-area route, even if the intra-area route's distance is greater than the inter-area route's distance.

To change the default administrative distances for inter-area routes, intra-area routes, and external routes, enter the following command.

```
device(config-ospf-router)# distance external 100  
device(config-ospf-router)# distance inter-area 90  
device(config-ospf-router)# distance intra-area 80
```

Syntax: [no] **distance { external | inter-area | intra-area } distance**

The **distance external**, **inter-area**, and **intra-area** parameters specify the route type for which you are changing the default administrative distance.

The *distance* parameter specifies the new distance for the specified route type. Unless you change the distance for one of the route types using commands such as those shown above, the default is 110.

To reset the administrative distance to its system default (110), enter a command such as the following.

```
device(config-ospf-router)# no distance external 100
```

Configure OSPF group LSA pacing

The device paces Link State Advertisement (LSA) refreshes by delaying the refreshes for a specified time interval instead of performing a refresh each time an individual LSA refresh timer expires. The accumulated LSAs constitute a group, which the device refreshes and sends out together in one or more packets.

The pacing interval, which is the interval at which the device refreshes an accumulated group of LSAs, is configurable to a range from 10 - 1800 seconds (30 minutes). The default is 240 seconds (four minutes). Thus, every four minutes, the device refreshes the group of accumulated LSAs and sends the group together in the same packets.

Usage guidelines

The pacing interval is inversely proportional to the number of LSAs the device is refreshing and aging. For example, if you have approximately 10,000 LSAs, decreasing the pacing interval enhances performance. If you have a very small database (40 - 100 LSAs), increasing the pacing interval to 10 - 20 minutes might enhance performance slightly.

Changing the LSA pacing interval

To change the LSA pacing interval, use the following CLI method.

To change the LSA pacing interval to two minutes (120 seconds), enter the following command.

```
device(config-ospf-router)# timers lsa-group-pacing 120
```

Syntax: [no] **timers lsa-group-pacing secs**

The *secs* parameter specifies the number of seconds and can be from 10 - 1800 (30 minutes). The default is 240 seconds (four minutes).

To restore the pacing interval to its default value, enter the following command.

```
device(config-ospf-router)# no timers lsa-group-pacing
```

Modify OSPF traps generated

OSPF traps as defined by RFC 1850 are supported on device.

You can disable all or specific OSPF trap generation by entering the following CLI command.

```
device(config)# no snmp-server trap ospf
```

To later re-enable the trap feature, enter **snmp-server trap ospf**.

To disable a specific OSPF trap, enter the command as **no snmp-server trap ospf *ospf-trap***.

These commands are at the OSPF router Level of the CLI.

Here is a summary of OSPF traps supported on device, their corresponding CLI commands, and their associated MIB objects from RFC 1850. The first list are traps enabled by default:

- **interface-state-change-trap** - [MIB object: OspfIfstateChange]
- **virtual-interface-state-change-trap** - [MIB object: OspfVirtIfStateChange]
- **neighbor-state-change-trap** - [MIB object: ospfNbrStateChange]
- **virtual-neighbor-state-change-trap** - [MIB object: ospfVirtNbrStateChange]
- **interface-config-error-trap** - [MIB object: ospfIfConfigError]
- **virtual-interface-config-error-trap** - [MIB object: ospfVirtIfConfigError]
- **interface-authentication-failure-trap** - [MIB object: ospfIfAuthFailure]
- **virtual-interface-authentication-failure-trap** - [MIB object: ospfVirtIfAuthFailure]
- **interface-receive-bad-packet-trap** - [MIB object: ospfIfrxBadPacket]
- **virtual-interface-receive-bad-packet-trap** - [MIB object: ospfVirtIfRxBadPacket]

The following traps are disabled by default.

- **interface-retransmit-packet-trap** - [MIB object: ospfTxRetransmit]
- **virtual-interface-retransmit-packet-trap** - [MIB object: ospfVirtIfTxRetransmit]
- **originate-lsa-trap** - [MIB object: ospfOriginateLsa]
- **originate-maxage-lsa-trap** - [MIB object: ospfMaxAgeLsa]
- **link-state-database-overflow-trap** - [MIB object: ospfLsdbOverflow]
- **link-state-database-approaching-overflow-trap** - [MIB object: ospfLsdbApproachingOverflow]

To stop an OSPF trap from being collected, use the CLI command: **no trap *ospf-trap*** at the Router OSPF level of the CLI. To disable reporting of the neighbor-state-change-trap, enter the following command.

```
device(config-ospf-router)# no trap neighbor-state-change-trap
```

To reinstate the trap, enter the following command.

```
device(config-ospf-router)# trap neighbor-state-change-trap
```

Syntax: [no] trap ospf-trap

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Modify exit overflow interval

If a database overflow condition occurs on a router, the router eliminates the condition by removing entries that originated on the router. The exit overflow interval allows you to set how often a device checks to see if the overflow condition has been eliminated. The default value is 0. The range is 0 - 86400 seconds (24 hours). If the configured value of the database overflow interval is zero, then the router never leaves the database overflow condition.

To modify the exit overflow interval to 60 seconds, enter the following command.

```
device(config-ospf-router)# database-overflow-interval 60
```

Syntax: [no] **database-overflow-interval** *value*

The *value* can be from 0 - 86400 seconds. The default is 0 seconds.

Specify types of OSPF Syslog messages to log

You can specify which kinds of OSPF-related Syslog messages are logged. By default, the only OSPF messages that are logged are those indicating possible system errors. If you want other kinds of OSPF messages to be logged, you can configure the device to log them.

For example, to specify that all OSPF-related Syslog messages be logged, enter the following commands.

```
device(config)# router ospf
device(config-ospf-router)# log all
```

Syntax: [no] **log** { **all** | **adjacency** [**dr-only**] | **bad_packet** [**checksum**] | **database** | **memory** | **retransmit** }

The **log** command has the following options:

The **all** option causes all OSPF-related Syslog messages to be logged. If you later disable this option with the **no log all** command, the OSPF logging options return to their default settings.

The **adjacency** option logs essential OSPF neighbor state changes, especially on error cases. This option is disabled by default. The **dr-only** sub-option only logs essential OSPF neighbor state changes where the interface state is designated router (DR).

NOTE

For interfaces where the designated router state is not applicable, such as point-to-point and virtual links, OSPF neighbor state changes will always be logged irrespective of the setting of the **dr-only** sub-option.

NOTE

A limitation with the **dr-only** sub-option is that when a DR/BDR election is underway, OSPF neighbor state changes pertaining to non-DR/BDR routers are not logged. Logging resumes once a DR is elected on that network.

The **bad_packet checksum** option logs all OSPF packets that have checksum errors. This option is enabled by default.

The **bad_packet** option logs all other bad OSPF packets. This option is disabled by default.

The **database** option logs OSPF LSA-related information. This option is disabled by default.

The **memory** option logs abnormal OSPF memory usage. This option is enabled by default.

The **retransmit** option logs OSPF retransmission activities. This option is disabled by default.

Configuring an OSPF network type

To configure an OSPF network, enter commands such as the following.

```
device(config)# interface ethernet 1/1/5
device(config-if-1/1/5)# ip ospf network point-to-point
```

This command configures an OSPF point-to-point link on Interface 5 in slot 1 in unit 1.

Syntax: [no] ip ospf network { point-to-point | broadcast | non-broadcast }

The **point-to-point** option configures the network type as a point to point connection. This is the default option for tunnel interfaces.

NOTE

Ruckus devices support numbered point-to-point networks, meaning the OSPF router must have an IP interface address which uniquely identifies the router over the network. Ruckus devices do not support unnumbered point-to-point networks.

The **broadcast** option configures the network type as a broadcast connection. This is the default option for Ethernet, VE and Loopback interfaces.

The **non-broadcast** option configures the network type as a non-broadcast connection. This allows you to configure the interface to send OSPF traffic to its neighbor as unicast packets rather than multicast packets. This can be useful in situations where multicast traffic is not feasible (for example when a firewall does not allow multicast packets).

On a non-broadcast interface, the routers at either end of this interface must configure non-broadcast interface type and the neighbor IP address. There is no restriction on the number of routers sharing a non-broadcast interface (for example, through a hub/switch).

To configure an OSPF interface as a non-broadcast interface, you enable the feature on a physical interface or a VE, following the **ip ospf area** statement, and then specify the IP address of the neighbor in the OSPF configuration. The non-broadcast interface configuration must be done on the OSPF routers at either end of the link.

For example, the following commands configure VE 20 as a non-broadcast interface.

```
device(config)# interface ve 20
device(config-vif-20)# ip address 10.1.20.4/24
device(config-vif-20)# ip ospf area 0
device(config-vif-20)# ip ospf network non-broadcast
```

The following commands specify 10.1.20.1 as an OSPF neighbor address. The address specified must be in the same sub-net as the non-broadcast interface.

```
device(config)# router ospf
device(config-ospf-router)# neighbor 10.1.20.1
```

For example, to configure the feature in a network with three routers connected by a hub or switch, each router must have the linking interface configured as a non-broadcast interface, and the two other routers must be specified as neighbors.

Configuring OSPF Graceful Restart

OSPF Graceful Restart can be enabled in the following configurations:

- **Configuring OSPF Graceful Restart for the Global Instance** - In this configuration all OSPF neighbors other than those used by VRFs are made subject to the Graceful Restart capability. The restart timer set globally does not apply to Graceful Restart on a configured VRF.

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- **Configuring OSPF Graceful Restart per VRF** - In this configuration all OSPF neighbors for the specified VRF are made subject to the Graceful Restart capability. The restart timer set for a specific VRF only applies to that VRF.

Configuring OSPF Graceful Restart for the global instance

OSPF Graceful restart can be configured for the global instance or for a specified Virtual Routing and Forwarding (VRF) instance. Configuring OSPF Graceful restart for the global instance does not configure it for any VRFs. The following sections describe how to enable the OSPF graceful restart feature for the global instance on a device.

Use the following command to enable the graceful restart feature for the global instance on a device.

```
device(config)# router ospf
device(config-ospf-router)# graceful-restart
```

Syntax: [no] graceful-restart

Configuring OSPF Graceful Restart time for the global instance

Use the following command to specify the maximum amount of time advertised to a neighbor router to maintain routes from and forward traffic to a restarting router.

```
device(config)# router ospf
device(config-ospf-router)# graceful-restart restart-time 120
```

Syntax: [no] graceful-restart restart-time *seconds*

The *seconds* variable sets the maximum restart wait time advertised to neighbors.

Possible values are 10 - 1800 seconds.

The default value is 120 seconds.

Disabling OSPF Graceful Restart helper mode for the global instance

By default, a router supports other restarting routers as a helper. You can prevent your router from participating in OSPF Graceful Restart by using the following command.

```
device(config)# router ospf
device(config-ospf-router)# graceful-restart helper-disable
```

Syntax: [no] graceful-restart helper-disable

This command disables OSPF Graceful Restart helper mode.

The default behavior is to help the restarting neighbors.

Configuring OSPF Graceful Restart per VRF

The following sections describe how to enable the OSPF Graceful Restart feature on a specified VRF.

Use the following command to enable the graceful restart feature on a specified VRF.

```
device(config)# router ospf vrf blue
device(config-ospf-router)# graceful-restart
```

Syntax: [no] graceful-restart

NOTE

By default, graceful restart is enabled.

Configuring OSPF Graceful Restart time per VRF

Use the following command to specify the maximum amount of time advertised to an OSPF neighbor router to maintain routes from and forward traffic to a restarting router.

```
device(config)# router ospf vrf blue
device(config-ospf-router)# graceful-restart restart-time 120
```

Syntax: [no] graceful-restart restart-time seconds

The **seconds** variable sets the maximum restart wait time advertised to OSPF neighbors of the VRF.

Possible values are 10 - 1200 seconds.

The default value is 60 seconds.

Disabling OSPF Graceful Restart helper mode per VRF

You can prevent your router from participating in OSPF Graceful Restart with VRF neighbors by using the following command.

```
device(config)# router ospf vrf blue
device(config-ospf-router)# graceful-restart helper-disable
```

Syntax: [no] graceful-restart helper-disable

This command disables OSPF Graceful Restart helper mode.

The default behavior is to help the restarting neighbors.

Configuring OSPF router advertisement

You can configure OSPF router advertisement in the **router ospf** mode or**router ospf vrf** mode as shown in the following examples.

```
device(config)# router ospf
device(config-ospf-router)# max-metric router-lsa all-vrfs on-startup 30 link all
device(config)# router ospf vrf blue
device(config-ospf-router)# max-metric router-lsa on-startup 30 link all
```

Syntax: [no] max-metric router-lsa [all-vrfs] [on-startup { time | wait-for-bgp }] [summary-lsa metric-value] [external-lsa metric-value] [te-lsa metric-value] [all-lsas] [link { ptp | stub | transit | all }]

The **all-vrfs** parameter specifies that the command will be applied to all VRF instances of OSPFv2.

NOTE

This command is supported only for VRFs that are already configured when the **max-metric router-lsa all-vrfs** command is issued.

Any new OSPF instance configured after the **max-metric** configuration is completed requires that the **max-metric** command be configured again to take in the new OSPF instance.

The **on-startup** parameter specifies that the OSPF router advertisement be performed at the next system startup. This is an optional parameter.

When using the **on-startup** option you can set a *time* in seconds for which the specified links in Router LSA will be advertised with the metric set to a maximum value of 0xFFFF. Optional values for *time* are 5 to 86400 seconds. There is no default value for *time*.

The **wait-for-bgp** option for the **on-startup** parameter directs OSPF to wait for either 600 seconds or until BGP has finished route table convergence (whichever event happens first), before advertising the links with the normal metric.

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Using the **link** parameter you can specify the type of links for which the maximum metric is to be advertised. The default value is for maximum metric to be advertised for transit links only. This is an optional parameter.

Additional options are supported that allow you to select the following LSA types and set the required metric:

The **summary-lsa** option specifies that the metric for all summary type 3 and type 4 LSAs will be modified to the specified *metric-value* or the default value. The range of possible values for the *metric-value* variable are 1 to 16777214 (Hex: 0x00001 to 0x00FFFFFF). The default value is 16711680 (Hex: 0x00FF0000).

The **external-lsa** option specifies that the metric for all external type 5 and type 7 LSAs will be modified to the specified *metric-value* or a default value. The range of possible values for the *metric-value* variable are 1 to 16777214 (Hex: 0x00001 to 0x00FFFFFF). The default value is 16711680 (Hex: 0x00FF0000).

The **te-lsa** option specifies that the TE metric field in the TE metric sub tlv for all type 10 Opaque LSAs LINK TLV originated by the router will be modified to the specified *metric-value* or a default value. The range of possible values for the *metric-value* variable are 1 to 4294967295 (Hex: 0x00001 to 0xFFFFFFFF). The default value is 4294967295 (Hex: 0xFFFFFFFF). This parameter only applies to the default instance of OSPF.

Examples

The following examples of the command max-metric router-lsa command demonstrate how it can be used:

The following command indicates that OSPF is being shutdown and that all links in the router LSA should be advertised with the value 0xFFFF and the metric value for all external and summary LSAs is set to 0xFF0000 until OSPF is restarted. This configuration will not be saved.

```
device(config)# router ospf
device(config-ospf-router)# max-metric router-lsa external-lsa summary-lsa link all
```

The following command indicates that OSPF is being shutdown and that all links in the router LSA should be advertised with the value 0xFFFF and the metric value for all external and summary LSAs should be set to 0xFF0000 until OSPF is restarted. Also, if OSPF TE is enabled then all LINK TLVs advertised by the router in Opaque LSAs should be updated with the TE Metric set to 0xFFFFFFFF and the available bandwidth set to 0. This configuration will not be saved.

```
device(config)# router ospf
device(config-ospf-router)# max-metric router-lsa all-lsas link all
```

The following command indicates that OSPF is being shutdown and that all links in the router LSA should be advertised with the value 0xFFFF and the metric value for all summary LSAs should be set to 0xFFFFFE until OSPF is restarted. This configuration will not be saved.

```
device(config)# router ospf
device(config-ospf-router)# max-metric router-lsa summary-lsa 16777214 link all
```

The following command turns off the advertisement of special metric values in all Router, Summary, and External LSAs.

```
device(config)# router ospf
device(config-ospf-router)# no max-metric router-lsa
```

Configuring OSPF shortest path first throttling

To set OSPF shortest path first throttling to the values in the previous example, use the following command.

```
device(config-ospf-router)# timer throttle spf 200 300 2000
```

Syntax: [no] **timer throttle spf initial-delay hold-time max-hold-time**

The *initial-delay* variable sets the initial value for the SPF delay in milliseconds. Possible values are between 0 and 65535 milliseconds.

The *hold-time* variable sets the minimum hold time between SPF calculations after the initial delay. This value will be doubled after hold-time expires until the max-hold-time is reached. Possible values are between 0 and 65535 milliseconds.

The *max-hold-time* variable sets the maximum hold time between SPF calculations. Possible values are between 0 and 65535 milliseconds.

NOTE

The hold time values that you specify are rounded up to the next highest 100 ms value. For example, any value between 0 and 99 will be configured as 100 ms.

Command replacement

This command overlaps in functionality with the timer throttle spf command which will be phased out. To use this command to replicate the exact functionality of the **timer throttle spf** command configure it as shown in the following.

```
device(config-ospf-router)# timer throttle spf 1000 5000 5000
```

Displaying OSPF Router Advertisement

Using the **show ip ospf** command you can display the current OSPF Router Advertisement configuration.

```
device# show ip ospf
OSPF Version          Version 2
Router Id             192.168.98.213
ASBR Status           Yes
ABR Status            Yes      (1)
Redistribute Ext Routes from Connected RIP
Initial SPF schedule delay 0      (msecs)
Minimum hold time for SPFs 0      (msecs)
Maximum hold time for SPFs 0      (msecs)
External LSA Counter   2
External LSA Checksum Sum 000104fc
Originate New LSA Counter 737
Rx New LSA Counter     1591
External LSA Limit      6990506
Database Overflow Interval 0
Database Overflow State : NOT OVERFLOWED
RFC 1583 Compatibility : Enabled
NSSA Translator:        Enabled
Nonstop Routing:        Disabled
Graceful Restart:       Enabled,   timer 120
Graceful Restart Helper: Enabled      0      35m5s
```

Displaying OSPF information

You can use CLI commands and Web management options to display the following OSPF information:

- Trap, area, and interface information
- CPU utilization statistics
- Area information
- Neighbor information
- Interface information
- Route information

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- External link state information
- Database Information
- Link state information
- Virtual Neighbor information
- Virtual Link information
- ABR and ASBR information
- Trap state information
- OSPF Point-to-Point Links
- OSPF Graceful Restart information
- OSPF Router Advertisement information

Displaying general OSPF configuration information

To display general OSPF configuration information, enter the following command at any CLI level.

```
device# show ip ospf config
Router OSPF: Enabled
Nonstop Routing: Disabled
Graceful Restart: Disabled
Graceful Restart Helper: Enabled
Graceful Restart Time: 120
Graceful Restart Notify Time: 0
Redistribution: Disabled
Default OSPF Metric: 50
OSPF Auto-cost Reference Bandwidth: Disabled
Default Passive Interface: Enabled
OSPF Redistribution Metric: Type2
OSPF External LSA Limit: 1447047
OSPF Database Overflow Interval: 0
RFC 1583 Compatibility: Enabled
Router id: 10.95.11.128
Interface State Change Trap: Enabled
Virtual Interface State Change Trap: Enabled
Neighbor State Change Trap: Enabled
Virtual Neighbor State Change Trap: Enabled
Interface Configuration Error Trap: Enabled
Virtual Interface Configuration Error Trap: Enabled
Interface Authentication Failure Trap: Enabled
Virtual Interface Authentication Failure Trap: Enabled
Interface Receive Bad Packet Trap: Enabled
Virtual Interface Receive Bad Packet Trap: Enabled
Interface Retransmit Packet Trap: Disabled
Virtual Interface Retransmit Packet Trap: Disabled
Originate LSA Trap: Disabled
Originate MaxAge LSA Trap: Disabled
Link State Database Overflow Trap: Disabled
Link State Database Approaching Overflow Trap: Disabled
OSPF Area currently defined:
Area-ID      Area-Type Cost
0           normal      0
OSPF Interfaces currently defined:
Ethernet Interface: 1/3/1-1/3/2
ip ospf md5-authentication-key-activation-wait-time 300
ip ospf cost 0
ip ospf area 0
Ethernet Interface: v1
ip ospf md5-authentication-key-activation-wait-time 300
ip ospf cost 0
ip ospf area 0
```

Syntax: show ip ospf config

The information related to the OSPF interface state is shown in bold text in the previous output.

TABLE 57 show ip ospf config output descriptions

Field	Description
Router OSPF	Shows whether or not the router OSPF is enabled.
Nonstop Routing	Shows whether or not the non-stop routing is enabled.
Graceful Restart	Shows whether or not the graceful restart is enabled.
Graceful Restart Helper	Shows whether or not the OSPF graceful restart helper mode is enabled.
Graceful Restart Time	Shows the maximum restart wait time advertised to neighbors.
Graceful Restart Notify Time	Shows the graceful restart notification time.
Redistribution	Shows whether or not the redistribution is enabled.
Default OSPF Metric	Shows the default OSPF metric value.
OSPF Auto-cost Reference Bandwidth	Shows whether or not the auto-cost reference bandwidth option is enabled.
Default Passive Interface	Shows whether or not the default passive interface state is enabled.
OSPF Redistribution Metric	Shows the OSPF redistribution metric type, which can be one of the following: <ul style="list-style-type: none"> • Type1 • Type2
OSPF External LSA Limit	Shows the external LSA limit value.
OSPF Database Overflow Interval	Shows the database overflow interval value.
RFC 1583 Compatibility	Shows whether or not the RFC 1583 compatibility is enabled.
Router id	Shows the ID of the OSPF router.
OSPF traps	Shows whether or not the following OSPF traps generation is enabled. <ul style="list-style-type: none"> • Interface State Change Trap • Virtual Interface State Change Trap • Neighbor State Change Trap • Virtual Neighbor State Change Trap • Interface Configuration Error Trap • Virtual Interface Configuration Error Trap • Interface Authentication Failure Trap • Virtual Interface Authentication Failure Trap • Interface Receive Bad Packet Trap • Virtual Interface Receive Bad Packet Trap • Interface Retransmit Packet Trap • Virtual Interface Retransmit Packet Trap • Originate LSA Trap • Originate MaxAge LSA Trap • Link State Database Overflow Trap • Link State Database Approaching Overflow Trap
Area-ID	Shows the area ID of the interface.
Area-Type	Shows the area type, which can be one of the following: <ul style="list-style-type: none"> • nssa • normal • stub
Cost	Shows the cost of the area.

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Displaying OSPF information

TABLE 57 show ip ospf config output descriptions (continued)

Field	Description
Ethernet Interface	Shows the OSPF interface.
ip ospf md5-authentication-key-activation-wait-time	Shows the wait time of the device until placing a new MD5 key into effect.
ip ospf area	Shows the area of the interface.
ip ospf cost	Shows the overhead required to send a packet across an interface.

Displaying OSPF area information

To display OSPF area information, enter the following command at any CLI level.

```
device# show ip ospf area
Idx Area      Type  Cost   SPFR   ABR   ASBR   LSA   Chksum(Hex)
1  0.0.0.0    normal 0     1      0      0      1      0000781f
2  10.147.60.0 normal 0     1      0      0      1      0000fee6
3  10.147.80.0 stub   1     1      0      0      2      000181cd
```

Syntax: **show ip ospf area [area-id] [num]**

The *area-id* parameter shows information for the specified area.

The *num* parameter identifies the position of the entry number in the area table.

TABLE 58 show ip ospf area output descriptions

This field	Displays
Index	The row number of the entry in the router's OSPF area table.
Area	The area number.
Type	The area type, which can be one of the following: <ul style="list-style-type: none"> • nssa • normal • stub
Cost	The area's cost.
SPFR	The SPFR value.
ABR	The ABR number.
ASBR	The ASBR number.
LSA	The LSA number.
Chksum(Hex)	The checksum for the LSA packet. The checksum is based on all the fields in the packet except the age field. The device uses the checksum to verify that the packet is not corrupted.

Displaying OSPF neighbor information

To display OSPF neighbor information, enter the following command at any CLI level.

```
device# show ip ospf neighbor
Port Address      Pri State      Neigh Address  Neigh ID      Ev Op Cnt
v10  10.1.10.1    1   FULL/DR  10.1.10.2    10.65.12.1  5  2  0
v11  10.1.11.1    1   FULL/DR  10.1.11.2    10.65.12.1  5  2  0
v12  10.1.12.1    1   FULL/DR  10.1.12.2    10.65.12.1  5  2  0
v13  10.1.13.1    1   FULL/DR  10.1.13.2    10.65.12.1  5  2  0
v14  10.1.14.1    1   FULL/DR  10.1.14.2    10.65.12.1  5  2  0
```

Syntax: show ip ospf neighbor [router-id ip-addr | num | extensive]

The **router-id ip-addr** parameter displays only the neighbor entries for the specified router.

The **num** parameter displays only the entry in the specified index position in the neighbor table. For example, if you enter "1", only the first entry in the table is displayed.

The **extensive** option displays detailed information about the neighbor.

TABLE 59 show ip ospf neighbor output descriptions

Field	Description
Port	The port through which the device is connected to the neighbor.
Address	The IP address of the port on which this device is connected to the neighbor.
Pri	<p>The OSPF priority of the neighbor.</p> <ul style="list-style-type: none"> • For multi-access networks, the priority is used during election of the Designated Router (DR) and Backup designated Router (BDR). • For point-to-point links, this field shows one of the following values: • 1 = point-to-point link • 3 = point-to-point link with assigned subnet
State	<p>The state of the conversation between the device and the neighbor. This field can have one of the following values:</p> <ul style="list-style-type: none"> • Down - The initial state of a neighbor conversation. This value indicates that there has been no recent information received from the neighbor. • Attempt - This state is only valid for neighbors attached to non-broadcast networks. It indicates that no recent information has been received from the neighbor. • Init - A Hello packet has recently been seen from the neighbor. However, bidirectional communication has not yet been established with the neighbor. (The router itself did not appear in the neighbor's Hello packet.) All neighbors in this state (or higher) are listed in the Hello packets sent from the associated interface. • 2-Way - Communication between the two routers is bidirectional. This is the most advanced state before beginning adjacency establishment. The Designated Router and Backup Designated Router are selected from the set of neighbors in the 2-Way state or greater. • ExStart - The first step in creating an adjacency between the two neighboring routers. The goal of this step is to decide which router is the master, and to decide upon the initial Database Description (DD) sequence number. Neighbor conversations in this state or greater are called adjacencies. • Exchange - The router is describing its entire link state database by sending Database Description packets to the neighbor. Each Database Description packet has a DD sequence number, and is explicitly acknowledged. Only one Database Description packet can be outstanding at any time. In this state, Link State Request packets can also be sent asking for the neighbor's more recent advertisements. All adjacencies in Exchange state or greater are used by the flooding procedure. In fact, these adjacencies are fully capable of transmitting and receiving all types of OSPF routing protocol packets.

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Displaying OSPF information

TABLE 59 show ip ospf neighbor output descriptions (continued)

Field	Description
	<ul style="list-style-type: none"> • Loading - Link State Request packets are sent to the neighbor asking for the more recent advertisements that have been discovered (but not yet received) in the Exchange state. • Full - The neighboring routers are fully adjacent. These adjacencies will now appear in router links and network link advertisements.
Neigh Address	<p>The IP address of the neighbor.</p> <p>For point-to-point links, the value is as follows:</p> <ul style="list-style-type: none"> • If the Pri field is "1", this value is the IP address of the neighbor router's interface. • If the Pri field is "3", this is the subnet IP address of the neighbor router's interface.
Neigh ID	The neighbor router's ID.
Ev	The number of times the neighbor's state changed.
Opt	The sum of the option bits in the Options field of the Hello packet. This information is used by Ruckus technical support. Refer to Section A.2 in RFC 2178 for information about the Options field in Hello packets.
Cnt	The number of LSAs that were retransmitted.

Displaying OSPF interface information

To display OSPF interface information, enter the following command at any CLI level. The details of interface options are highlighted in the output.

```
device# show ip ospf interface ethernet 1/1/11
Ethernet 1/1/11 admin up, oper up
    IP Address 15.1.1.15, Area 0
    Database Filter: Not Configured
    State active(default passive), Pri 1, Cost 1, Options 2, Type broadcast Events 2
    Timers(sec): Transmit 1, Retrans 5, Hello 10, Dead 40
    DR: Router ID 192.168.254.1      Interface Address 15.1.1.1
    BDR: Router ID 10.0.0.15        Interface Address 15.1.1.15
    Neighbor Count = 1, Adjacent Neighbor Count= 1
    Neighbor: 15.1.1.1 (DR)
    Authentication-Key: None
    MD5 Authentication: Key None, Key-Id None, Auth-change-wait-time 300
```

If you specify an interface that is not configured within a specified VRF, then the following error message will display as shown in the example below:

```
device# show ip ospf vrf one interface ethernet 1/1/1
Error: Interface(eth 1/1/1) not part of VRF(one)
```

NOTE

You cannot display multiple ports for any interfaces. For example, when displaying OSPF interface information on ethernet 1/1/1 only one port can be displayed at a given time.

Syntax: show ip ospf [vrf vrf-name] interface [ip-addr] [brief] [ethernet unit/slot/port | loopback number | tunnel number | ve number]

The **vrf vrf-name** parameter displays information for VRF, or a specific vrf-name.

The **ip-addr** parameter displays the OSPF interface information for the specified IP address.

The **brief** parameter displays interface information in the brief mode.

The **ethernet**, **loopback**, **tunnel**, and **ve** parameters to specify the interface for which to display information. If you specify an Ethernet interface, you can also specify the unit, slot and port number associated with the interface. If you specify a loopback, tunnel, or VE interface, you can also specify the number associated with the interface.

TABLE 60 show ip ospf interface output descriptions

This field	Displays
Interface	The type of interface type and the port number or number of the interface.
IP Address	The IP address of the interface.
Area	The OSPF area configured on the interface
Database Filter	The router's configuration for blocking outbound LSAs on an OSPF interface. If Not Configured is displayed, there is no outbound LSA filter configured. This is the default condition.
State	The state of the interface. Possible states include the following: <ul style="list-style-type: none"> DR - The interface is functioning as the Designated Router for OSPFv2. BDR - The interface is functioning as the Backup Designated Router for OSPFv2. Loopback - The interface is functioning as a loopback interface. P2P - The interface is functioning as a point-to-point interface. Passive - The interface is up but it does not take part in forming an adjacency. Waiting - The interface is trying to determine the identity of the BDR for the network. None - The interface does not take part in the OSPF interface state machine. Down - The interface is unusable. No protocol traffic can be sent or received on such a interface. DR other - The interface is a broadcast or NBMA network on which another router is selected to be the DR. Active - The interface sends or receives all the OSPFv2 control packets and forms the adjacency.
default	Shows whether or not the default passive state is set.
Pri	The interface priority.
Cost	The configured output cost for the interface.
Options	OSPF Options (Bit7 - Bit0): <ul style="list-style-type: none"> unused:1 opaque:1 summary:1 dont_propagate:1 nssa:1 multicast:1 external route capable:1 tos:1

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Displaying OSPF information

TABLE 60 show ip ospf interface output descriptions (continued)

This field	Displays
Type	The area type, which can be one of the following: <ul style="list-style-type: none"> • Broadcast • Point to Point • non-broadcast • Virtual Link
Events	OSPF Interface Event: <ul style="list-style-type: none"> • Interface_Up = 0x00 • Wait_Timer = 0x01 • Backup_Seen = 0x02 • Neighbor_Change = 0x03 • Loop_Indication = 0x04 • Unloop_Indication = 0x05 • Interface_Down = 0x06 • Interface_Passive = 0x07
Timer intervals	The interval, in seconds, of the transmit-interval, retransmit-interval, hello-interval, and dead-interval timers.
DR	The router ID (IPv4 address) of the DR.
BDR	The router ID (IPv4 address) of the BDR.
Neighbor Count	The number of neighbors to which the interface is connected.
Adjacent Neighbor Count	The number of adjacent neighbor routers.
Neighbor:	The IP address of the neighbor.

Displaying OSPF interface brief information

The following command displays the OSPF database brief information.

```
device# show ip ospf interface brief
Number of Interfaces is 1
Interface Area IP Addr/Mask Cost State Nbrs (F/C)
eth 1/1/2      0    10.1.1.2/24   1     down  0/0
```

TABLE 61 show ip ospf interface brief output descriptions

This field	Displays
Interface	The interface through which the router is connected to the neighbor.
Area	The OSPF Area that the interface is configured in.
IP Addr/Mask	The IP address and mask of the interface.
Cost	The configured output cost for the interface.
State	The state of the conversation between the router and the neighbor. This field can have one of the following values: <ul style="list-style-type: none"> • Down - The initial state of a neighbor conversation. This value indicates that there has been no recent information received from the neighbor. • Attempt - This state is only valid for neighbors attached to non-broadcast networks. It indicates that no recent information has been received from the neighbor. • Init - A Hello packet has recently been seen from the neighbor. However, bidirectional communication has not yet been established with the neighbor. (The router itself did

TABLE 61 show ip ospf interface brief output descriptions (continued)

This field	Displays
	<p>not appear in the neighbor's Hello packet.) All neighbors in this state (or higher) are listed in the Hello packets sent from the associated interface.</p> <ul style="list-style-type: none"> • 2-Way - Communication between the two routers is bidirectional. This is the most advanced state before beginning adjacency establishment. The Designated Router and Backup Designated Router are selected from the set of neighbors in the 2-Way state or greater. • ExStart - The first step in creating an adjacency between the two neighboring routers. The goal of this step is to decide which router is the master, and to decide upon the initial Database Description (DD) sequence number. Neighbor conversations in this state or greater are called adjacencies. • Exchange - The router is describing its entire link state database by sending Database Description packets to the neighbor. Each Database Description packet has a DD sequence number, and is explicitly acknowledged. Only one Database Description packet can be outstanding at any time. In this state, Link State Request packets can also be sent asking for the neighbor's more recent advertisements. All adjacencies in Exchange state or greater are used by the flooding procedure. In fact, these adjacencies are fully capable of transmitting and receiving all types of OSPF routing protocol packets. • Loading - Link State Request packets are sent to the neighbor asking for the more recent advertisements that have been discovered (but not yet received) in the Exchange state. • Full - The neighboring routers are fully adjacent. These adjacencies will now appear in router links and network link advertisements.
Nbrs(F/C)	The number of adjacent neighbor routers. The number to the left of the "/" are the neighbor routers that are fully adjacent and the number to the right represents all adjacent neighbor routers.

Displaying OSPF route information

To display OSPF route information, enter the following command at any CLI level.

```
device# show ip ospf route
OSPF Area 0x00000000 ASBR Routes 1:
  Destination      Mask      Path_Cost Type2_Cost Path_Type
  10.65.12.1      255.255.255.255 1          0          Intra
  Adv Router       Link_State Dest_Type State      Tag      Flags
  10.65.12.1      10.65.12.1   Asbr     Valid    0        6000
  Paths Out_Port  Next_Hop   Type      State
  1    v49         10.1.49.2  OSPF     21 01
  2    v12         10.1.12.2  OSPF     21 01
  3    v11         10.1.11.2  OSPF     21 01
  4    v10         10.1.10.2  OSPF     00 00
OSPF Area 0x000000041 ASBR Routes 1:
  Destination      Mask      Path_Cost Type2_Cost Path_Type
  10.65.12.1      255.255.255.255 1          0          Intra
  Adv Router       Link_State Dest_Type State      Tag      Flags
  10.65.12.1      10.65.12.1   Asbr     Valid    0        6000
  Paths Out_Port  Next_Hop   Type      State
  1    v204        10.65.5.251 OSPF     21 01
  2    v201        10.65.2.251 OSPF     20 d1
  3    v202        10.65.3.251 OSPF     20 cd
```

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Displaying OSPF information

```

4      v205      10.65.6.251      OSPF      00 00
OSPF Area Summary Routes 1:
  Destination      Mask      Path_Cost  Type2_Cost  Path_Type  Type
  10.65.0.0        255.255.0.0   0          0           Inter
  Adv_Router        Link_State  Dest_Type  State       Tag        Flags
  10.1.10.1        0.0.0.0      Network    Valid      0          0000
  Paths Out_Port   Next_Hop   Type       State
  1     1/1         0.0.0.0      DIRECT    00 00

OSPF Regular Routes 208:
  Destination      Mask      Path_Cost  Type2_Cost  Path_Type
  10.1.10.0        255.255.255.252 1          0           Intra
  Adv_Router        Link_State  Dest_Type  State       Tag        Flags
  10.1.10.1        10.1.10.2    Network    Valid      0          0000
  Paths Out_Port   Next_Hop   Type       State
  1     v10         0.0.0.0      OSPF     00 00
  Destination      Mask      Path_Cost  Type2_Cost  Path_Type
  10.1.11.0        255.255.255.252 1          0           Intra
  Adv_Router        Link_State  Dest_Type  State       Tag        Flags
  10.1.10.1        10.1.11.2    Network    Valid      0          0000
  Paths Out_Port   Next_Hop   Type       State
  1     v11         0.0.0.0      OSPF     00 00

```

Syntax: `show ip ospf routes [ip-addr]`

The `ip-addr` parameter specifies a destination IP address. If you use this parameter, only the route entries for that destination are shown.

TABLE 62 show ip ospf routes output descriptions

This field	Displays
Destination	The IP address of the route's destination.
Mask	The network mask for the route.
Path_Cost	The cost of this route path. (A route can have multiple paths. Each path represents a different exit port for the device.)
Type2_Cost	The type 2 cost of this path.
Path_Type	The type of path, which can be one of the following: <ul style="list-style-type: none"> • - Inter - The path to the destination passes into another area. - Intra - The path to the destination is entirely within the local area. - External1 - The path to the destination is a type 1 external route. - External2 - The path to the destination is a type 2 external route.
Adv_Router	The OSPF router that advertised the route to this device.
Link-State	The link state from which the route was calculated.
Dest_Type	The destination type, which can be one of the following: <ul style="list-style-type: none"> • - ABR - Area Border Router - ASBR - Autonomous System Boundary Router - Network - the network
State	The route state, which can be one of the following: <ul style="list-style-type: none"> • - Changed - Invalid - Valid This information is used by Ruckus technical support.
Tag	The external route tag.
Flags	State information for the route entry. This information is used by Ruckus technical support.

TABLE 62 show ip ospf routes output descriptions (continued)

This field	Displays
Paths	The number of paths to the destination.
Out_Port	The router port through which the device reaches the next hop for this route path.
Next_Hop	The IP address of the next-hop router for this path.
Type	The route type, which can be one of the following: <ul style="list-style-type: none"> • - OSPF - Static Replaced by OSPF
State	State information for the path. This information is used by Ruckus technical support.

Displaying the routes that have been redistributed into OSPF

You can display the routes that have been redistributed into OSPF. To display the redistributed routes, enter the following command at any level of the CLI.

```
device# show ip ospf redistribute route
 4.3.0.0 255.255.0.0 static
 3.1.0.0 255.255.0.0 static
 10.11.61.0 255.255.255.0 connected
 4.1.0.0 255.255.0.0 static
```

In this example, four routes have been redistributed. Three of the routes were redistributed from static IP routes and one route was redistributed from a directly connected IP route.

Syntax: show ip ospf redistribute route [ip-addr ip-mask]

The *ip-addr ip-mask* parameter specifies a network prefix and network mask. Here is an example.

```
Brocade# show ip ospf redistribute route 192.213.1.0 255.255.255.254
 192.213.1.0 255.255.255.254 fwd 0.0.0.0 (0) metric 10 connected
```

Displaying OSPF database information

The following command displays the OSPF database.

```
device# show ip ospf database
Index Area ID          Type LS ID                               Adv Rtr           Seq(Hex) Age
Cksm SyncState
1    0.0.0.200   Rtr  192.168.98.111 192.168.98.111 8000003b 626 0xf885 Done
2    0.0.0.200   Rtr  192.168.98.213 192.168.98.213 800000c9 963 0x209c Done
3    0.0.0.200   Rtr  192.168.98.113 192.168.98.113 80000028 169 0x0275 Done
4    0.0.0.200   Rtr  192.168.98.112 192.168.98.112 8000002d 226 0x1c03 Done
5    0.0.0.200   Net  193.113.111.113 192.168.98.113 8000001f 1132 0x353d Done
6    0.0.0.200   Net  192.213.111.213 192.168.98.213 8000002d 1683 0x17bc Done
```

Syntax: show ip ospf database

TABLE 63 show ip ospf database output descriptions

This field	Displays
Index	ID of the entry
Area ID	ID of the OSPF area
Type	Link state type of the route.
LS ID	The ID of the link-state advertisement from which the router learned this route.

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Displaying OSPF information

TABLE 63 show ip ospf database output descriptions (continued)

This field	Displays
Adv Rtr	ID of the advertised route.
Seq(Hex)	The sequence number of the LSA. The OSPF neighbor that sent the LSA stamps the LSA with a sequence number. This number enables the device and other OSPF routers to determine which LSA for a given route is the most recent.
Age	The age of the LSA in seconds.
Chksum	The checksum for the LSA packet. The checksum is based on all the fields in the packet except the age field. The device uses the checksum to verify that the packet is not corrupted.
SyncState	This field indicates whether the synchronization is complete or not.

Displaying OSPF external link state information

To display external link state information, enter the following command at any CLI level.

```
device# show ip ospf database external-link-state
Index Age LS ID          Router      Netmask     Metric   Flag       Fwd Address
SyncState
1      591 10.65.13.0 10.65.12.1 ffffff00 8000000a 0000      0.0.0.0           Done
2      591 10.65.16.0 10.65.12.1 ffffff00 8000000a 0000      0.0.0.0           Done
3      591 10.65.14.0 10.65.12.1 ffffff00 8000000a 0000      0.0.0.0           Done
4      591 10.65.17.0 10.65.12.1 ffffff00 8000000a 0000      0.0.0.0           Done
5      592 10.65.12.0 10.65.12.1 ffffff00 8000000a 0000      0.0.0.0           Done
6      592 10.65.15.0 10.65.12.1 ffffff00 8000000a 0000      0.0.0.0           Done
7      592 10.65.18.0 10.65.12.1 ffffff00 8000000a 0000      0.0.0.0           Done
```

Syntax: **show ip ospf [vrf *vrf-name*] database external-link-state [advertise *num* | extensive | link-state-id *A.B.C.D* | router-id *A.B.C.D* | sequence-number *num(Hex)*]**

The **vrf *vrf-name*** parameter displays information for a VRF, or a specific *vrf-name*.

The **advertise *num*** parameter displays the decoded data in the specified LSA packet. The *num* parameter identifies the LSA packet by its position in the router's External LSA table. To determine an LSA packet's position in the table, enter the **show ip ospf external-link-state** command to display the table.

The **extensive** option displays the LSAs in the decoded format.

NOTE

You cannot use the **extensive** option in combination with other display options. The entire database is displayed.

The **link-state-id *A.B.C.D*** parameter displays the External LSAs for the LSA source specified by *A.B.C.D* (link state ID).

The **router-id *A.B.C.D*** (advertising router ID) parameter shows the External LSAs for the specified OSPF router.

The **sequence-number *num(Hex)*** parameter displays the External LSA entries for the specified hexadecimal LSA sequence number.

TABLE 64 show ip ospf database external-link-state output descriptions

This field	Displays
Index	ID of the entry
Age	The age of the LSA in seconds.
LS ID	The ID of the link-state advertisement.
Router	The router IP address.

TABLE 64 show ip ospf database external-link-state output descriptions (continued)

This field	Displays
Netmask	The subnet mask of the network.
Metric	The cost (value) of the route.
Flag	State information for the route entry. This information is used by Brocade technical support.

Displaying OSPF database-summary information

To display database-summary information, enter the following command at any CLI level.

```
device# show ip ospf database database-summary
Area ID    Router Network Sum-Net Sum-ASBR NSSA-Ext Opg-Area Subtotal
0.0.0.0    104     184      19      42      0       0       349
AS External
Total      104     184      19      42      0       0       657
```

Syntax: **show ip ospf database database-summary**

TABLE 65 show ip ospf database database-summary output descriptions

This field	Displays
Area ID	The area number.
Router	The number of router link state advertisements in that area.
Network	The number of network link state advertisements in that area.
Sum-Net	The number of summary link state advertisements in that area.
Sum-ASBR	The number of summary autonomous system boundary router (ASBR) link state advertisements in that area
NSSA-Ext	The number of not-so-stubby
Opg-area	the number of Type-10 (area-scope) Opaque LSAs

Displaying OSPF database link state information

To display database link state information, enter the following command at any CLI level.

```
device# show ip ospf database link-state
Index Area ID Type LS ID      Adv Rtr      Seq(Hex) Age   Cksum      SyncState
1     0        Rtr  10.1.10.1  10.1.10.1  800060ef 3    0x4be2      Done
2     0        Rtr  10.65.12.1  10.65.12.1 80005264 6    0xc870      Done
3     0        Net   10.1.64.2  10.65.12.1 8000008c 1088 0x06b7      Done
4     0        Net   10.1.167.2 10.65.12.1 80000093 1809 0x86c8      Done
5     0        Net   10.1.14.2  10.65.12.1 8000008c 1088 0x2ec1      Done
6     0        Net   10.1.117.2 10.65.12.1 8000008c 1087 0xbccb      Done
7     0        Net   10.1.67.2  10.65.12.1 8000008c 1088 0xe4d5      Done
8     0        Net   10.1.170.2 10.65.12.1 80000073 604  0xa5c6      Done
9     0        Net   10.1.17.2  10.65.12.1 8000008c 1088 0x0ddf      Done
10    0        Net   10.1.120.2 10.65.12.1 8000008c 1087 0x9be9      Done
11    0        Net   10.1.70.2  10.65.12.1 8000008c 1088 0xc3f3      Done
12    0        Net   10.1.173.2 10.65.12.1 80000017 1087 0x3d88      Done
13    0        Net   10.1.20.2  10.65.12.1 8000008c 1088 0xebfd      Done
14    0        Net   10.1.123.2 10.65.12.1 8000008c 1087 0x7a08      Done
15    0        Net   10.1.73.2  10.65.12.1 8000008c 1088 0xa212      Done
16    0        Net   10.1.176.2 10.65.12.1 80000025 1087 0xffffb4      Done
17    0        Net   10.1.23.2  10.65.12.1 8000008c 1088 0xcac1c     Done
18    0        Net   10.1.126.2 10.65.12.1 8000008c 1087 0x5926      Done
```

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Displaying OSPF information

Syntax: **show ip ospf [vrf *vrf-name*] database link-state [advertise *num* | asbr [*ip-addr*] [adv-router *ip-addr*] | extensive | link-state-id *ip-addr* | network [*ip-addr*] [adv-router *ip-addr*] | nssa [*ip-addr*] [adv-router *ip-addr*] | router [*ip-addr*] [adv-router *ip-addr*] | router-id *ip-addr* | self-originated | sequence-number *num(Hex)* | summary [*ip-addr*] [adv-router *ip-addr*]]**

The **vrf *vrf-name*** parameter displays information for a VRF, or a specific *vrf-name*.

The **advertise *num*** parameter displays the decoded data in the specified LSA packet. The *num* parameter identifies the LSA packet by its position in the router's LSA table. To determine an LSA packet's position in the table, enter the **show ip ospf link-state** command to display the table.

The **asbr** option shows ASBR LSAs.

The **extensive** option displays the LSAs in the decoded format.

NOTE

You cannot use the **extensive** option in combination with other display options. The entire database is displayed.

The **link-state-id *A.B.C.D*** parameter displays the LSAs for the LSA source specified by *A.B.C.D* (link state ID).

The **network** option shows network LSAs.

The **nssa** option shows NSSA LSAs.

The **router-id *A.B.C.D*** (advertising router ID) parameter shows the LSAs for the specified OSPF router.

The **sequence-number *num*** parameter displays the LSA entries for the specified hexadecimal LSA sequence number.

The **self-originated** option shows self-originated LSAs.

TABLE 66 show ip ospf database link-state output descriptions

This field	Displays
Index	ID of the entry
Area ID	ID of the OSPF area
Type LS ID	Type and ID of the link state advertisement.
Adv Rtr	ID of the advertising router.
Seq(Hex)	The sequence number of the LSA. The OSPF neighbor that sent the LSA stamps the LSA with a sequence number. This number enables the device and other OSPF routers to determine which LSA for a given route is the most recent.
Age	The age of the LSA in seconds.
Cksum	The checksum for the LSA packet. The checksum is based on all the fields in the packet except the age field. The device uses the checksum to verify that the packet is not corrupted.

Displaying OSPF ABR and ASBR information

To display OSPF ABR and ASBR information, enter the following command at any CLI level.

```
device# show ip ospf border-routers 192.168.98.111
router ID          router type next hop router outgoing interface   Area
192.168.98.111   ABR           193.213.111.111  4/3/1*8/3/1          0
```

Syntax: **show ip ospf border-routers [*ip-addr*]**

The *ip-addr* parameter displays the ABR and ASBR entries for the specified IP address.

```
device# show ip ospf border-routers
    router ID      router type next hop router  outgoing interface  Area
1     10.65.12.1   ABR        10.1.49.2    v49                  0
1     10.65.12.1   ASBR       10.1.49.2    v49                  0
1     10.65.12.1   ABR        10.65.2.251  v201                65
1     10.65.12.1   ASBR       10.65.2.251  v201                65
```

Syntax: show ip ospf border-routers

TABLE 67 show ip ospf border-routers output descriptions

This field	Displays
(Index)	Displayed index number of the border router.
Router ID	ID of the OSPF router
Router type	Type of OSPF router: ABR or ASBR
Next hop router	ID of the next hop router
Outgoing interface	ID of the interface on the router for the outgoing route.
Area	ID of the OSPF area to which the OSPF router belongs

Displaying OSPF trap status

All traps are enabled by default when you enable OSPF.

To display the state of each OSPF trap, enter the following command at any CLI level.

```
device# show ip ospf trap
Interface State Change Trap:           Enabled
Virtual Interface State Change Trap:   Enabled
Neighbor State Change Trap:            Enabled
Virtual Neighbor State Change Trap:    Enabled
Interface Configuration Error Trap:   Enabled
Virtual Interface Configuration Error Trap: Enabled
Interface Authentication Failure Trap: Enabled
Virtual Interface Authentication Failure Trap: Enabled
Interface Receive Bad Packet Trap:     Enabled
Virtual Interface Receive Bad Packet Trap: Enabled
Interface Retransmit Packet Trap:      Disabled
Virtual Interface Retransmit Packet Trap: Disabled
Originate LSA Trap:                   Disabled
Originate MaxAge LSA Trap:            Disabled
Link State Database Overflow Trap:    Disabled
Link State Database Approaching Overflow Trap: Disabled
```

Syntax: show ip ospf trap

Viewing Configured OSPF point-to-point links

You can use the *show ip ospf interface* command to display OSPF point-to-point information. Enter the following command at any CLI level.

```
device# show ip ospf interface 192.168.1.1
Ethernet 1/2/1, OSPF enabled
IP Address 192.168.1.1, Area 0
OSPF state ptr2ptr, Pri 1, Cost 1, Options 2, Type pt-2-pt Events 1
Timers(sec): Transit 1, Retrans 5, Hello 10, Dead 40
DR: Router ID 0.0.0.0 Interface Address 0.0.0.0
BDR: Router ID 0.0.0.0 Interface Address 0.0.0.0
Neighbor Count = 0, Adjacent Neighbor Count= 1
Neighbor: 2.2.2.2
```

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Displaying OSPF information

```
Authentication-Key:None
MD5 Authentication: Key None, Key-Id None, Auth-change-wait-time 300
```

Syntax: show ip ospf interface [ip-addr]

The *ip-addr* parameter displays the OSPF interface information for the specified IP address.

TABLE 68 show ip ospf interface output descriptions

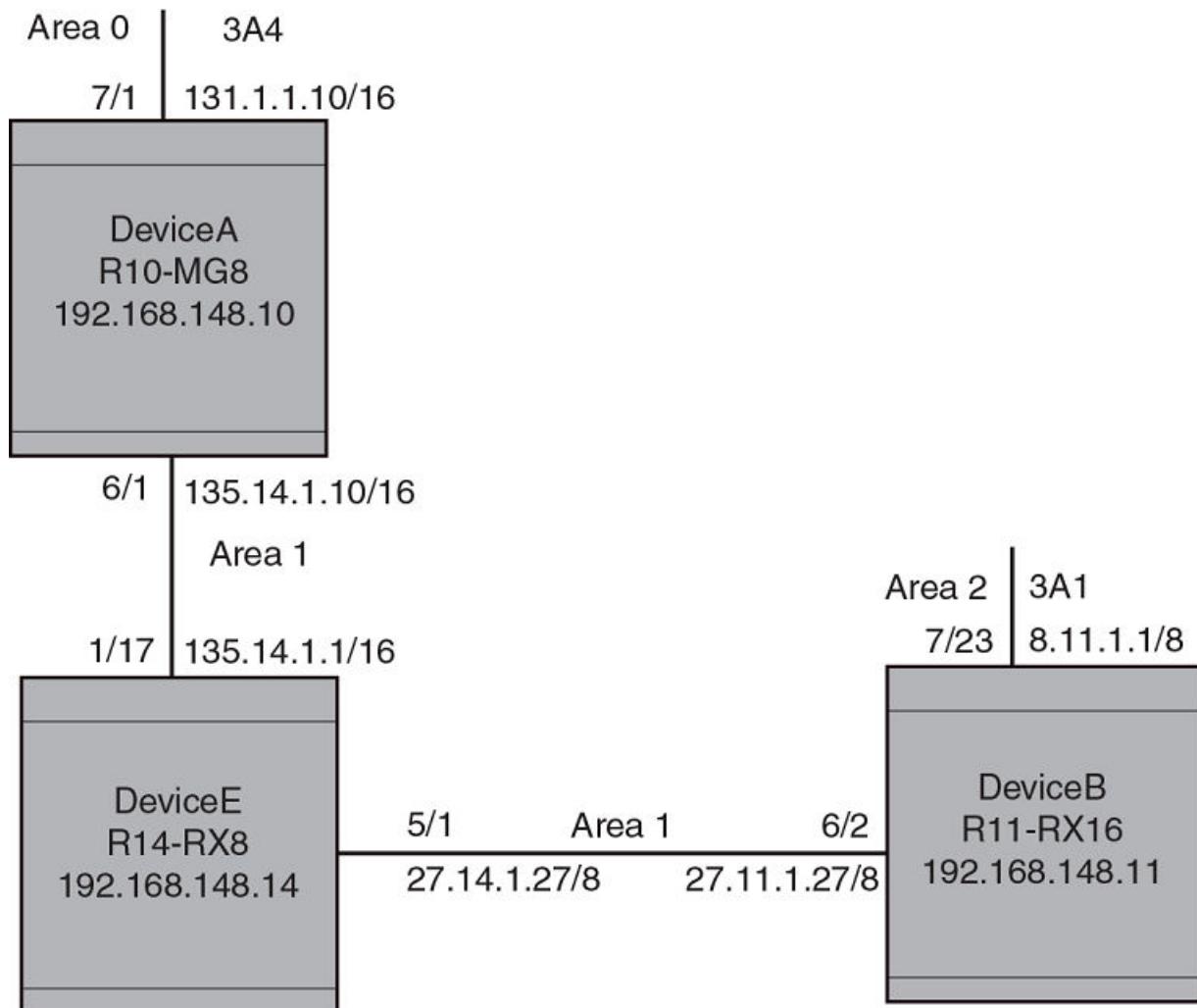
This field	Displays
IP Address	The IP address of the interface.
OSPF state	The OSPF state of the interface.
Pri	The router priority.
Cost	The configured output cost for the interface.
Options	OSPF Options (Bit7 - Bit0): <ul style="list-style-type: none"> • unused:1 • opaque:1 • summary:1 • dont_propagate:1 • nssa:1 • multicast:1 • externals:1 • tos:1
Type	The area type, which can be one of the following: <ul style="list-style-type: none"> • Broadcast = 0x01 • NBMA = 0x02 • Point to Point = 0x03 • Virtual Link = 0x04 • Point to Multipoint = 0x05
Events	OSPF Interface Event: <ul style="list-style-type: none"> • Interface_Up = 0x00 • Wait_Timer = 0x01 • Backup_Seen = 0x02 • Neighbor_Change = 0x03 • Loop_Indication = 0x04 • Unloop_Indication = 0x05 • Interface_Down = 0x06 • Interface_Passive = 0x07
Adjacent Neighbor Count	The number of adjacent neighbor routers.
Neighbor:	The IP address of the neighbor.

Displaying OSPF virtual neighbor and link information

You can display OSPF virtual neighbor and virtual link information.

```
# show run
Current configuration:
!
ver V2.2.1T143
module 1 rx-bi-1g-24-port-fiber
module 2 rx-bi-10g-4-port
module 6 rx-bi-10g-4-port
module 7 rx-bi-1g-24-port-copper
```

```
!
!
no spanning-tree
!
vlan 1 name DEFAULT-VLAN
!
!
clock summer-time
clock timezone us Pacific
hostname R11-RX8
router ospf
area 2
area 1
area 1 virtual-link 10.1.1.10
```

FIGURE 26 OSPF virtual neighbor and virtual link example

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Displaying OSPF information

Displaying OSPF virtual neighbor

Use the **show ip ospf virtual neighbor** command to display OSPF virtual neighbor information.

```
device# show ip ospf virtual neighbor
Indx Transit Area    Router ID      Neighbor address options
1       1            131.1.1.10   135.14.1.10      2
      Port Address     state        events      count
      6/2/3          27.11.1.27   FULL         5           0
```

Syntax: **show ip ospf virtual neighbor [num]**

The *num* parameter displays the table beginning at the specified entry number.

Displaying OSPF virtual link information

Use the **show ip ospf virtual link** command to display OSPF virtual link information.

```
device# show ip ospf virtual link
Indx Transit Area    Router ID      Transit(sec) Retrans(sec) Hello(sec)
1       1            131.1.1.10   1             5            10
      Dead(sec)     events       state        Authentication-Key
      40            1            ptr2ptr      None
      MD5 Authentication-Key: None
      MD5 Authentication-Key-Id: None
      MD5 Authentication-Key-Activation-Wait-Time: 300
```

Syntax: **show ip ospf virtual link [num]**

The *num* parameter displays the table beginning at the specified entry number.

Clearing OSPF neighbors

You can clear all OSPF neighbors or a specified OSPF neighbor using the following command.

```
device# clear ip ospf neighbor all
```

Syntax: **clear ip ospf neighbor { all | ip-address }**

Selecting the **all** option clears all of the OSPF neighbors on the router.

The *ip-address* variable allows you to clear a specific OSPF neighbor.

Displaying OSPF Graceful Restart information

To display OSPF Graceful Restart information for OSPF neighbors use the **show ip ospf neighbors** command as shown in the following.

```
device# show ip ospf neighbors
Port  Address      Pri State      Neigh Address  Neigh ID      Ev Opt Cnt
2/7   50.50.50.10  0   FULL/OTHER  50.50.50.1   10.10.10.30  21 66  0
      < in graceful restart state, helping 1, timer 60 sec >
```

Use the following command to display Type 9 Graceful LSAs on a router.

```
device# show ip ospf database grace-link-state
Graceful Link States
Area  Interface  Adv Rtr  Age Seq(Hex) Prd Rsn  Nbr Intf IP
0     eth 1/1/2   2.2.2.2 7   80000001 60  SW   6.1.1.2
```

TABLE 69 show ip ospf database grace-link-state output descriptions

This field	Displays
Area	The OSPF area that the interface configured for OSPF graceful restart is in.
Interface	The interface that is configured for OSPF graceful restart.
Adv Rtr	ID of the advertised route.
Age	The age of the LSA in seconds.
Seq(Hex)	The sequence number of the LSA. The OSPF neighbor that sent the LSA stamps the LSA with a sequence number. This number enables the device and other OSPF routers to determine which LSA for a given route is the most recent.
Prd	Grace Period: The number of seconds that the router's neighbors should continue to advertise the router as fully adjacent, regardless of the state of database synchronization between the router and its neighbors. Since this time period began when grace-LSA's LS age was equal to 0, the grace period terminates when either: <ul style="list-style-type: none"> the LS age of the grace-LSA exceeds the value of a Grace Period the grace-LSA is flushed.
Rsn	Graceful restart reason: The reason for the router restart defined as one of the following: <ul style="list-style-type: none"> UK - unknown RS - software restart UP - software upgrade or reload SW - switch to redundant control processor
Nbr Intf IP	The IP address of the OSPF graceful restart neighbor.

Displaying OSPF Router Advertisement information

Using the **show ip ospf** command you can display the current OSPF Router Advertisement configuration. The text shown below in bold is displayed for an OSPF Router Advertisement configuration.

```
device# show ip ospf
OSPF Version                                Version 2
Router Id                                     10.10.10.10
ASBR Status                                    No
ABR Status                                     No      (0)
Redistribute Ext Routes from
External LSA Counter                          5
External LSA Checksum Sum                     0002460e
Originate New LSA Counter                     5
Rx New LSA Counter                           8
External LSA Limit                           14447047
Database Overflow Interval                   0
Database Overflow State :                  NOT OVERFLOWED
RFC 1583 Compatibility :                  Enabled
Originating router-LSAs with maximum metric
  Condition: Always Current State: Active
  Link Type: PTP STUB TRANSIT
  Additional LSAs originated with maximum metric:
    LSA Type           Metric Value
    AS-External        16711680
    Type 3 Summary    16711680
    Type 4 Summary    16711680
    Opaque-TE         4294967295
```

The **show ip ospf** command displays LSAs that have been configured with a maximum metric.

OSPFv2

Clearing OSPF information

Clearing OSPF information

You can use the **clear ip ospf** commands to clear OSPF data on a router as described in the following:

- Neighbor information
- Reset the OSPF process
- Clear and re-add OSPF routes

Clearing OSPF neighbors

You can use the following command to delete and relearn all OSPF neighbors, all OSPF neighbors for a specified interface or a specified OSPF neighbor.

```
device# clear ip ospf neighbor all
```

Syntax: **clear ip ospf [vrf vrf-name] neighbor all [interface] | interface | ip-address [interface]**

Selecting the **all** option without specifying an interface clears all of the OSPF neighbors on the router.

The *interface* variable specifies the interface that you want to clear all of the OSPF neighbors on. The following types of interfaces can be specified:

- **ethernet unit/slot/port**
- **tunnel tunnel-ID**
- **veve-ID**

The *ip-address* variable allows you to clear a specific OSPF neighbor.

Disabling and re-enabling the OSPF process

You can use the following command to disable and re-enable the OSPF process on a router.

```
device# clear ip ospf all
```

Syntax: **clear ip ospf [vrf vrf-name] all**

This command resets the OSPF process and brings it back up after releasing all memory used while retaining all configurations.

Clearing OSPF routes

You can use the following command to clear all OSPF routes or to clear a specific OSPF route.

```
device# clear ip ospf routes all
```

Syntax: **clear ip ospf [vrf vrf-name] routes { all | ip-address/prefix-length }**

Selecting the **all** option resets the OSPF routes including external routes, and OSPF internal routes.

The *ip-address* and *prefix-length* variables specify a particular route to delete and then reschedules the SPF calculation.

OSPFv3

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OSPFv3 overview

IPv6 supports OSPF Version 3 (OSPFv3). OSPFv3 functions similarly to OSPF Version 2 (OSPFv2), with several enhancements.

Open Shortest Path First (OSPF) is a link-state routing protocol. OSPF uses link-state advertisements (LSAs) to update neighboring routers about its interfaces and information on those interfaces. A device floods LSAs to all neighboring routers to update them about the interfaces. Each router maintains an identical database that describes its area topology to help a router determine the shortest path between it and any neighboring router.

IPv6 supports OSPF Version 3 (OSPFv3), which functions similarly to OSPF Version 2 (OSPFv2), the version that IPv4 supports, except for the following enhancements:

- Support for IPv6 addresses and prefixes.
- Ability to configure several IPv6 addresses on a device interface. (While OSPFv2 runs per IP subnet, OSPFv3 runs per link. In general, you can configure several IPv6 addresses on a router interface, but OSPFv3 forms one adjacency per interface only, using the interface associated link-local address as the source for OSPF protocol packets. On virtual links, OSPFv3 uses the global IP address as the source. OSPFv3 imports all or none of the address prefixes configured on a router interface. You cannot select the addresses to import.)
- Ability to run one instance of OSPFv2 and one instance of OSPFv3 concurrently on a link.
- Support for IPv6 link-state advertisements (LSAs).

NOTE

Although OSPFv2 and OSPFv3 function in a similar manner, Ruckus has implemented the user interface for each version independently of the other. Therefore, any configuration of OSPFv2 features will not affect the configuration of OSPFv3 features and vice versa.

NOTE

You are required to configure a router ID when running only IPv6 routing protocols.

LSA types for OSPFv3

Communication among OSPFv3 areas is provided by means of link state advertisements (LSAs). OSPFv3 supports a number of types of LSAs.

- Router LSAs (Type 1)
- Network LSAs (Type 2)
- Interarea-prefix LSAs for ABRs (Type 3)
- Interarea-router LSAs for ASBRs (Type 4)
- Autonomous system External LSAs (Type 5)

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- Group Membership LSA (Type 6)
- NSSA External LSAs (Type 7)
- Link LSAs (Type 8)
- Intra-area-prefix LSAs (Type 9)

For more information about these LSAs, refer to RFC 5340.

Configuring OSPFv3

To configure OSPFv3, you must perform the following steps.

- Enable OSPFv3 globally.
- Assign OSPFv3 areas.
- Assign device interfaces to an OSPF area.

The following configuration tasks are optional:

- Configure a virtual link between an Area Border Router (ABR) without a physical connection to a backbone area and the device in the same area with a physical connection to the backbone area.
- Change the reference bandwidth for the cost on OSPFv3 interfaces.
- Configure the redistribution of routes into OSPFv3.
- Configure default route origination.
- Modify the shortest path first (SPF) timers.
- Modify the administrative distances for OSPFv3 routes.
- Configure the OSPFv3 LSA pacing interval.
- Modify how often the Ruckus device checks on the elimination of the database overflow condition.
- Modify the external link state database limit.
- Modify the default values of OSPFv3 parameters for device interfaces.
- Disable or re-enable OSPFv3 event logging.
- Set all the OSPFv3 interfaces to the passive state.

Enabling OSPFv3

Before enabling the device to run OSPFv3, you must perform the following steps.

- Enable the forwarding of IPv6 traffic on the device using the **ipv6 unicast-routing** command.
- Enable IPv6 on each interface over which you plan to enable OSPFv3. You enable IPv6 on an interface by configuring an IPv6 address or explicitly enabling IPv6 on that interface.

By default, OSPFv3 is disabled. To enable OSPFv3 for a default Virtual Routing and Forwarding (VRF), you must enable it globally.

To enable OSPFv3 globally, enter the following command.

```
device(config)# ipv6 router ospf  
device(config-ospf6-router) #
```

After you enter this command, the Ruckus device enters the IPv6 OSPF configuration level, where you can access several commands that allow you to configure OSPFv3.

Enabling OSPFv3 in a VRF

To enable OSPFv3 for a default Virtual Routing and Forwarding (VRF), enter a command such as the following.

```
device(config-ospf6-router)# ipv6 router ospf vrf red
```

Syntax: [no] **ipv6 router ospf vrf vrf-name**

The *vrf-name* parameter specifies the name of the VRF in which OSPFv3 is being initiated.

Disabling OSPFv3 in a VRF

To disable OSPFv3 for a default Virtual Routing and Forwarding (VRF), enter a command such as the following.

```
device(config-ospf6-router)# no ipv6 router ospf vrf red
```

Syntax: [no] **ipv6 router ospf vrf vrf-name**

The *vrf-name* parameter specifies the name of the VRF in which OSPFv3 is being initiated.

If you disable OSPFv3, the device removes all the configuration information for the disabled protocol from the running-configuration file. Moreover, when you save the configuration to the startup-config file after disabling one of these protocols, all the configuration information for the disabled protocol is removed from the startup-config file.

When you disable OSPFv3, the following warning message is displayed on the console.

```
device(config-ospf6-router)# no ipv6 router ospf
ipv6 router ospf mode now disabled. All ospf config data will be lost when writing to flash!
```

If you have disabled the protocol but have not yet saved the configuration to the startup-config file and reloaded the software, you can restore the configuration information by re-entering the command to enable the protocol (for example, **ipv6 router ospf**). If you have already saved the configuration to the startup-config file and reloaded the software, the configuration information is gone. If you are testing an OSPF configuration and are likely to disable and re-enable the protocol, you should make a backup copy of the startup-config file containing the protocol configuration information. This way, if you remove the configuration information by saving the configuration after disabling the protocol, you can restore the configuration by copying the backup copy of the startup-config file onto the flash memory.

NOTE

All the configuration examples below are applicable for OSPFv3 configuration mode in VRFs as well.

Assigning OSPFv3 areas

After OSPFv3 is enabled, you can assign OSPFv3 areas. You can assign an IPv4 address or a number as the area ID for each area. The area ID is representative of all IPv4 addresses (subnets) on a device interface. Each device interface can support one area.

An area can be normal, a stub, or a Not-So-Stubby Area (NSSA) :

- Normal - OSPFv3 devices within a normal area can send and receive External Link State Advertisements (LSAs).
- Stub - OSPFv3 devices within a stub area cannot send or receive External LSAs. In addition, OSPF devices in a stub area must use a default route to the area's Area Border Router (ABR) or Autonomous System Boundary Router (ASBR) to send traffic out of the area.
- NSSA - The ASBR of an NSSA can import external route information into the area.
 - ASBRs redistribute (import) external routes into the NSSA as type 7 LSAs. Type-7 External LSAs are a special type of LSA generated only by ASBRs within an NSSA, and are flooded to all the routers within only that NSSA.

- ABRs translate type 7 LSAs into type 5 External LSAs, which can then be flooded throughout the AS. You can configure address ranges on the ABR of an NSSA so that the ABR converts multiple type-7 External LSAs received from the NSSA into a single type-5 External LSA.

When an NSSA contains more than one ABR, OSPFv3 elects one of the ABRs to perform the LSA translation for NSSA. OSPF elects the ABR with the highest router ID. If the elected ABR becomes unavailable, OSPFv3 automatically elects the ABR with the next highest router ID to take over translation of LSAs for the NSSA. The election process for NSSA ABRs is automatic.

For example, to set up OSPFv3 areas 10.70.12.10, 10.70.12.11, 10.70.12.12, and 10.70.12.13, enter the following commands.

```
device(config-ospf6-router)# area 10.70.12.10
device(config-ospf6-router)# area 10.70.12.11
device(config-ospf6-router)# area 10.70.12.12
device(config-ospf6-router)# area 10.70.12.13
```

Syntax: [no] area {number | ipv4-address}

The *number* and *ipv4-address* parameters specify the area number, which can be a number or in IPv4 address format.

NOTE

You can assign only one area on a device interface.

Assigning a totally stubby area

By default, the device sends summary LSAs (type 3 LSAs) into stub areas. You can reduce the number of LSAs sent into a stub area by configuring the device to stop sending summary LSAs into the area. You can disable the summary LSAs when you are configuring the stub area or later after you have configured the area.

This feature disables origination of summary LSAs into a stub area, but the device still accepts summary LSAs from OSPF neighbors and floods them to other areas. The device can form adjacencies with other routers regardless of whether summarization is enabled or disabled for areas on each router.

When you disable the summary LSAs, the change takes effect immediately. If you apply the option to a previously configured area, the device flushes all of the summary LSAs it has generated (as an ABR) from the area.

NOTE

This feature applies only when the Ruckus device is configured as an Area Border Router (ABR) for the area. To completely prevent summary LSAs from being sent to the area, disable the summary LSAs on each OSPF router that is an ABR for the area.

For example, to disable summary LSAs for stub area 40 and specify an additional metric of 99, enter the following command.

```
device(config-ospf6-router)# area 40 stub 99 no-summary
```

Syntax: [no] area {number | ipv4-address} stub metric [no-summary]

The *number* and *ipv4-address* parameters specify the area number, which can be a number or in IPv4 address format. If you specify a number, the number can be from 0 through 2,147,483,647.

The **stub** *metric* parameter specifies an additional cost for using a route to or from this area and can be from 1 through 16777215. There is no default. Normal areas do not use the cost parameter.

The **no-summary** parameter applies only to stub areas and disables summary LSAs from being sent into the area.

Assign a Not-So-Stubby Area (NSSA)

The OSPF Not So Stubby Area (NSSA) feature enables you to configure OSPF areas that provide the benefits of stub areas, but that also are capable of importing external route information. OSPF does not flood external routes from other areas into an NSSA, but does translate and flood route information from the NSSA into other areas such as the backbone.

NSSAs are especially useful when you want to summarize Type-5 External LSAs (external routes) before forwarding them into an OSPF area. The OSPF specification (RFC 2740) prohibits summarization of Type-5 LSAs and requires OSPF to flood Type-5 LSAs throughout a routing domain. When you configure an NSSA, you can specify an address range for aggregating the external routes that the NSSAs ABR exports into other areas.

Since the NSSA is partially "stubby" the ABR does not flood external LSAs from the backbone into the NSSA. To provide access to the rest of the Autonomous System (AS), the ABR generates a default Type-7 LSA into the NSSA.

Configuring an NSSA

Using the **area nssa** command, you can block the generation of type-3 and type-7 LSAs into an NSSA. This command also provides an option to configure the NSSA translator role.

Configuration examples

The following example creates an NSSA area with an area-id 100. If the router is an ABR then a type-3 summary LSA will be originated into the NSSA area and if the router is an ASBR then type-7 NSSA external LSA will be generated into NSSA area with a default external metric value of 10. The routers NSSA translator role will be set to candidate and it will participate in NSSA translation election.

```
device(config-ospf6-router)# area 100 nssa
```

The following example modifies the NSSA area 100 wherein type-7 NSSA external LSA will not be originated into NSSA area. But the type-3 summary LSAs will still be originated into NSSA area.

```
device(config-ospf6-router)# area 100 nssa no-redistribution
```

The following example modifies the NSSA area 100 wherein origination of type-3 summary LSAs (apart from type-3 default summary) will be blocked into NSSA area. The CLI works in incremental fashion and the origination of type-7 LSA will be continued to be blocked as 'no-redistribution' option was enabled in the previous command.

```
device(config-ospf6-router)# area 100 nssa no-summary
```

The following example modifies the NSSA area 100 wherein origination of the self-router acts as NSSA translator. The generation of type-3 & type-7 LSA will still be blocked into NSSA area.

```
device(config-ospf6-router)# area 100 nssa translator-always
```

The following example modifies the NSSA area 100 wherein origination of type-3 summary will be allowed, but origination of type-7 LSA will still be blocked. Also the self-router will still act as NSSA translator-always.

```
device(config-ospf6-router)# no area 100 nssa no-summary
```

Although the NSSA configuration can be done in an incremental fashion during show-run, all the configuration options will be displayed in just one line. For example, the output of the **show run** would be:

```
device(config-ospf6-router)# area 100 nssa no-redistribution translator-always
```

The following example deletes the NSSA area 100.

```
device(config-ospf6-router)# no area 100
```

Syntax: [no] area *area-id* nssa [[*stub-metric*] [**default-information-originate** [*metric metric-value* | **metric-type type-value**]] [**no-summary**] [**no-redistribution**] [**translator-always**] [**translator-interval stability-interval**]]]

The *area-id* parameter specifies the area number, which can be a number or in IP address format. If you specify a number, the number can be from 0 to 2,147,483,647.

The **nssa** *stub-metric* parameter configures an area as a not-so-stubby-area (NSSA). The *stub-metric* will be the metric used for generating default LSA in a NSSA. The range of the value is 1 to 1048575. The default value is 10.

The **default-information-originate** parameter generates a default route into an NSSA. If no-summary option is enabled then a type-3 default LSA will be generated into NSSA else a type-7 LSA will be generated into NSSA. By default the **default-information-originate** parameter is not set.

The **metric** *metric-value* parameter specifies the cost of the default LSA originated into the NSSA area. The range is 1 to 1048575. There is no default

The **metric-type** *type-value* parameter specifies the type of the default external LSA originated into the NSSA area. It can be either type-1 or type-2. The default is type-1.

The **no-summary** parameter prevents an NSSA ABR from generating a type-3 summary into an NSSA. By default the summary LSA is originated into NSSA.

The **no-redistribution** parameter prevents an NSSA ABR from generating external (type-7) LSA into an NSSA area. This is used in the case where an ASBR should generate type-5 LSA into normal areas and should not generate type-7 LSA into NSSA area. By default, redistribution is enabled in a NSSA.

The **translator-always** parameter configures the translator-role. When configured on an ABR, this causes the router to unconditionally assume the role of an NSSA translator. By default, translator-always is not set, the translator role by default is candidate.

The **translator-interval** *stability-interval* parameter configures the time interval for which an elected NSSA translator continues to perform its duties even after its NSSA translator role has been disposed by another router. By default the stability-interval is 40 seconds and its range will be 10 to 60 seconds.

Configuring an address range for the NSSA

If you want the ABR that connects the NSSA to other areas to summarize the routes in the NSSA before translating them into Type-5 LSAs and flooding them into the other areas, configure an address range. The ABR creates an aggregate value based on the address range. The aggregate value becomes the address that the ABR advertises instead of advertising the individual addresses represented by the aggregate. You can configure up to 32 ranges in an OSPF area.

To configure an address range in NSSA 10.1.1.1, enter the following commands. This example assumes that you have already configured NSSA 10.1.1.1.

```
device(config)# router ospf
device(config-ospf6-router)# area 10.1.1.1 range 2001:DB8::/32
device(config-ospf6-router)# write memory
```

Syntax: [no] area *{num | ip-addr}* {range *ipv6-addr/ipv6-subnet-mask*} [**advertise** | **not-advertise**]

The *num* and *ip-addr* parameters specify the area number, which can be in IP address format. If you specify a number, the number can be from 0 - 2,147,483,647.

The **range** *ipv6-addr* parameter specifies the IP address portion of the range. The software compares the address with the significant bits in the mask. All network addresses that match this comparison are summarized in a single route advertised by the router.

The *ipv6-subnet-mask* parameter specifies the portions of the IPv6 address that a route must contain to be summarized in the summary route. In the example above, all networks that begin with 2001:DB8:: are summarized into a single route.

The **advertise** and **not-advertise** parameters specify whether you want the device to send type 3 LSAs for the specified range in this area. The default is **advertise**.

Assigning an area cost for OSPFv3 (optional parameter)

You can assign a cost for an area, but it is not required. To consolidate and summarize routes at an area boundary, use the **area range cost** command in router configuration mode.

If the **cost** parameter is specified, it will be used (overriding the computed cost) to generate the summary LSA. If the **cost** parameter is not specified, then the existing range metric computation max or min cost of routes falling under this range will be used to generate summary LSA.

NOTE

The area should be already configured before using this command.

Creates an area range entry with prefix 2001:db8::1/64 with the area-id 10.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# area 10 range 2001:db8::1/64
```

Modifies the address range status to DoNotAdvertise. Neither the individual intra-area routes falling under range nor the ranged prefix is advertised as summary LSA.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# area 10 range 2001:db8::1/64 not-advertise
```

Modifies the address range status to advertise and a Type 3 summary link-state advertisement (LSA) can be generated for this address range.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# area 10 range 2001:db8::1/64 advertise
```

Modifies the address range status to advertise and assign cost for this area range to 10.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# area 10 range 2001:db8::1/64 advertise cost 10
```

Modifies the address range status to not-advertise and cost from 10 to 5.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# area 10 range 2001:db8::1/64 not-advertise cost 5
```

Removes the cost from the area range. The area range will be advertised with computed cost which is the max/min (based on RFC 1583 compatibility) of all individual intra-area routes falling under this range.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# no area 10 range 2001:db8::1/64 cost 5
```

Removes the area range.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# no area 10 range 2001:db8::1/64
```

NOTE

This command does not work in incremental fashion. So both the optional parameters have to be configured each time. Otherwise it will take the default value.

Syntax: [no] area {num | ipv6-addr} range ipv6-addr/ipv6-subnet-mask [advertise | not-advertise] [cost cost-value]

The *num* and *ipv6-addr* parameters specify the area number, which can be in IP address format.

The **range** *ipv6-addr* parameter specifies the IP address portion of the range. The software compares the address with the significant bits in the mask. All network addresses that match this comparison are summarized in a single route advertised by the router.

The *ipv6-subnet-mask* parameter specifies the portions of the IPv6 address that a route must contain to be summarized in the summary route. In the example above, all networks that begin with 193.45 are summarized into a single route.

The **advertise** parameter sets the address range status to advertise and generates a Type 3 summary link-state advertisement (LSA). If at least a single route falls under the range, a ranged LSA will be advertised.

The not-advertise parameter sets the address range status to DoNotAdvertise. Neither the individual intra-area routes falling under range nor the ranged prefix is advertised as summary LSA.

The **cost** *cost-value* parameter specifies the cost-value to be used while generating type-3 summary LSA. If the cost value is configured, then configured cost is used while generating the summary LSA. If the cost value is not configured, then computed range cost will be used. The cost-value ranges from 1 to 16777215.

To disable this function, use the **no** form of this command.

Assigning interfaces to an area

After you define OSPFv3 areas, you must assign device interfaces to the areas. All device interfaces must be assigned to one of the defined areas on an OSPF router. When an interface is assigned to an area, all corresponding subnets on that interface are automatically included in the assignment.

For example, to assign Ethernet interface 1/3/1 to area 10.5.0.0, enter the following commands.

```
device(config)# interface Ethernet 1/3/1
device(config-if-e100-1/3/1)# ipv6 ospf area 10.5.0.0
```

Syntax: [no] ipv6 ospf area {number | ipv4-address}

The *number* and *ipv4-address* parameters specify the area number, which can be a number or in IPv4 address format. If you specify a number, the number can be from 0 through 2,147,483,647.

To remove the interface from the specified area, use the **no** form of this command.

Specifying a network type

You can specify a point-to-point or broadcast network type for any OSPF interface of the following types: Ethernet, or VE interface. To specify the network type for an OSPF interface, use the following commands.

```
device(config)# interface ethernet 1/3/1
device(config-if-e100-1/3/1)# ipv6 ospf network broadcast
```

Syntax: [no] ipv6 ospf network {point-to-point | broadcast}

The **point-to-point** parameter specifies that the OSPF interface will support point-to-point networking. This is the default setting for tunnel interfaces.

The **broadcast** parameter specifies that the OSPF interface will support broadcast networking. This is the default setting for Ethernet and VE interfaces.

The **no** form of the command disables the command configuration.

Configuring virtual links

All ABRs must have either a direct or indirect link to an OSPF backbone area (0.0.0.0 or 0). If an ABR does not have a physical link to a backbone area, you can configure a virtual link from the ABR to another router within the same area that has a physical connection to the backbone area.

The path for a virtual link is through an area shared by the neighbor ABR (router with a physical backbone connection) and the ABR requiring a logical connection to the backbone.

Two parameters must be defined for all virtual links -- transit area ID and neighbor router:

- The transit area ID represents the shared area of the two ABRs and serves as the connection point between the two routers. This number should match the area ID value.
- The neighbor router is the router ID (IPv4 address) of the router that is physically connected to the backbone when assigned from the router interface requiring a logical connection. The neighbor router is the router ID (IPv4 address) of the router requiring a logical connection to the backbone when assigned from the router interface with the physical connection.

NOTE

By default, the router ID is the IPv4 address configured on the lowest-numbered loopback interface. If the device does not have a loopback interface, the default router ID is the lowest-numbered IPv4 address configured on the device.

When you establish an area virtual link, you must configure it on both ends of the virtual link. For example, imagine that ABR1 in areas 1 and 2 is cut off from the backbone area (area 0). To provide backbone access to ABR1, you can add a virtual link between ABR1 and ABR2 in area 1 using area 1 as a transit area. To configure the virtual link, you define the link on the router that is at each end of the link. No configuration for the virtual link is required on the routers in the transit area.

To define the virtual link on ABR1, enter the following command on ABR1.

```
device(config-ospf6-router)# area 1 virtual-link 10.157.22.1
```

To define the virtual link on ABR2, enter the following command on ABR2.

```
device(config-ospf6-router)# area 1 virtual-link 10.0.0.1
```

Syntax: [no] area {number | ipv4-address} virtual-link router-id

The *number* and *ipv4-address* parameters specify the transit area ID, area number, which can be a number, or in IPv4 address format. If you specify a number, the number can be from 0 through 2,147,483,647.

The *router-id* parameter specifies the router ID of the OSPF router at the remote end of the virtual link. To display the router ID on a router, enter the **show ip** command.

Modifying virtual link parameters

You can modify the following virtual link parameters:

- Dead-interval: The number of seconds that a neighbor router waits for a hello packet from the device before declaring the router is down. The range is from 1 through 65535 seconds. The default is 40 seconds.
- Hello-interval: The length of time between the transmission of hello packets. The range is from 1 through 65535 seconds. The default is 10 seconds.
- Retransmit-interval: The interval between the retransmission of link state advertisements to router adjacencies for this interface. The range is from 0 through 3600 seconds. The default is 5 seconds.
- Transmit-delay: The period of time it takes to transmit Link State Update packets on the interface. The range is from 0 through 3600 seconds. The default is 1 second.

NOTE

The values of the **dead-interval** and **hello-interval** parameters must be the same at both ends of a virtual link. Therefore, if you modify the values of these parameters at one end of a virtual link, you must make the same modifications on the other end of the link. The values of the other virtual link parameters do not require synchronization.

For example, to change the **dead-interval** parameter to 60 seconds on the virtual links defined on ABR1 and ABR2, enter the following command on ABR1.

```
device(config-ospf6-router)# area 1 virtual-link 10.157.22.1
dead-interval 60
```

Enter the following command on ABR2.

```
device(config-ospf6-router)# area 1 virtual-link 10.0.0.1 dead-interval 60
```

Syntax: [no] **area** {*number* | *ipv4-address*} **virtual-link** *router-id* [**dead-interval** *seconds* | **hello-interval** *seconds* | **retransmit-interval** *seconds* | **transmit-delay** *seconds*]

The **area** *number* and *ipv4-address* parameters specify the transit area ID.

The *router-id* parameter specifies the router ID of the OSPF router at the remote end of the virtual link. To display the router ID on a device, enter the **show ip** command.

The **dead-interval**, **hello-interval**, **retransmit-interval**, and **transmit-delay** parameters are described earlier in this section.

Changing the reference bandwidth for the cost on OSPFv3 interfaces

Each interface on which OSPFv3 is enabled has a cost associated with it. The device advertises its interfaces and their costs to OSPFv3 neighbors. For example, if an interface has an OSPF cost of 10, the device advertises the interface with a cost of 10 to other OSPF routers.

By default, OSPF cost of an interface is based on the port speed of the interface. The software uses the following formula to calculate the cost.

Cost = reference-bandwidth/interface-speed

By default, the reference bandwidth is 100 Mbps. If the resulting cost is less than 1, the software rounds the cost up to 1. The default reference bandwidth results in the following costs:

- 10 Mbps port cost = $100/10 = 10$
- 100 Mbps port cost = $100/100 = 1$
- 1000 Mbps port cost = $100/1000 = 0.10$, which is rounded up to 1
- 155 Mbps port cost = $100/155 = 0.65$, which is rounded up to 1
- 622 Mbps port cost = $100/622 = 0.16$, which is rounded up to 1
- 2488 Mbps port cost = $100/2488 = 0.04$, which is rounded up to 1

The interfaces that consist of more than one physical port is calculated as follows:

- LAG group- The combined bandwidth of all the ports.
- Virtual (Ethernet) interface - The combined bandwidth of all the ports in the port-based VLAN that contains the virtual interface.

You can change the default reference bandwidth from 100 Mbps to a value from 1 through 4294967.

If a change to the reference bandwidth results in a cost change to an interface, the Ruckus device sends a link-state update to update the costs of interfaces advertised by the Ruckus device.

NOTE

If you specify a cost for an interface, your specified cost overrides the cost that the software calculates.

Some interface types are not affected by the reference bandwidth and always have the same cost regardless of the reference bandwidth in use:

- The cost of a loopback interface is always 1.
- The cost of a virtual link is calculated using the Shortest Path First (SPF) algorithm and is not affected by the auto-cost feature.
- The bandwidth for tunnel interfaces is 9 Kbps and is subject to the auto-cost feature.

For example, to change the reference bandwidth to 500, enter the following command.

```
device(config-ospf6-router)# auto-cost reference-bandwidth 500
```

The reference bandwidth specified in this example results in the following costs:

- 10 Mbps port cost = $500/10 = 50$
- 100 Mbps port cost = $500/100 = 5$
- 1000 Mbps port cost = $500/1000 = 0.5$, which is rounded up to 1
- 155 Mbps port cost = $500/155 = 3.23$, which is rounded up to 4
- 622 Mbps port cost = $500/622 = 0.80$, which is rounded up to 1
- 2488 Mbps port cost = $500/2488 = 0.20$, which is rounded up to 1

The costs for 10 Mbps, 100 Mbps, and 155 Mbps ports change as a result of the changed reference bandwidth. Costs for higher-speed interfaces remain the same.

Syntax: [no] auto-cost reference-bandwidth *number*

The *number* parameter specifies the reference bandwidth in the range from 1 through 4294967. The default is 100.

To restore the reference bandwidth to its default value and thus restore the default costs of the interfaces to their default values, enter the **no** form of this command.

Redistributing routes into OSPFv3

In addition to specifying which routes are redistributed into OSPFv3, you can configure the following aspects related to route redistribution:

- Default metric.
- Metric type.
- Advertisement of an external aggregate route.

Configuring route redistribution into OSPFv3

You can configure the device to redistribute routes from the following sources into OSPFv3:

- IPv6 static routes
- Directly connected IPv6 networks
- BGP4+

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- RIPng

You can redistribute routes in the following ways:

- By route types, for example, the Ruckus device redistributes all IPv6 static and RIPng routes.
- By using a route map to filter which routes to redistribute, for example, the device redistributes specified IPv6 static and RIPng routes only.

For example, to configure the redistribution of all IPv6 static and RIPng, enter the following commands.

```
device(config-ospf6-router)# redistribute static  
device(config-ospf6-router)# redistribute rip
```

Syntax: [no] **redistribute {bgp | connected | rip | static [metric number | metric-type type]}**

The **bgp**, **connected**, **rip**, and **static** keywords specify the route source.

The **metric number** parameter specifies the metric used for the redistributed route. If a value is not specified for this option, and the value for the **default-metric** command is set to 0, its default metric, then routes redistributed from the various routing protocols will have the metric value of the protocol from which they are redistributed.

The **metric-type type** parameter specifies an OSPF metric type for the redistributed route. You can specify external type 1 or external type 2. If a value is not specified for this option, the device uses the value specified by the **metric-type** command.

For example, to configure a route map and use it for redistribution of routes into OSPFv3, enter commands such as the following.

```
device(config)# ipv6 route 2001:db8:1::/32 2001:db8:343e::23  
device(config)# ipv6 route 2001:db8:2::/32 2001:db8:343e::23  
device(config)# ipv6 route 2001:db8:3::/32 2001:db8:343e::23 metric 5  
device(config)# route-map abc permit 1  
device(config-routemap abc)# match metric 5  
device(config-routemap abc)# set metric 8  
device(config-routemap abc)# ipv6 router ospf  
device(config-ospf6-router)# redistribute static route-map abc
```

The commands in this example configure some static IPv6 routes and a route map, and use the route map for redistributing the static IPv6 routes into OSPFv3.

The **ipv6 route** commands configure the static IPv6 routes.

The **route-map** command begins configuration of a route map called "abc". The number indicates the route map entry (called the "instance") you are configuring. A route map can contain multiple entries. The software compares packets to the route map entries in ascending numerical order and stops the comparison once a match is found.

NOTE

The default action rule for route-map is to deny all routes that are not explicitly permitted.

The **match** command in the route map matches on routes that have 5 for their metric value (cost). The **set** command changes the metric in routes that match the route map to 8.

The **redistribute** command configures the redistribution of static IPv6 routes into OSPFv3, and uses route map "abc" to control the routes that are redistributed. In this example, the route map allows a static IPv6 route to be redistributed into OSPF only if the route has a metric of 5, and changes the metric to 8 before placing the route into the OSPF route redistribution table.

Syntax: [no] **redistribute {bgp | connected | rip | static [route-map map-name]}**

The **bgp**, **connected**, **isis**, **ip**, and **static** keywords specify the route source.

The **route-map map-name** parameter specifies the route map name. The following match parameters are valid for OSPFv3 redistribution:

- **match ipv6 address | next-hopacl-number**

- **match metric number**
- **match tag tag-value**

The following set parameters are valid for OSPFv3 redistribution:

- **set ipv6 next-hop *ipv6 address***
- **set metric [+ | -] *number* | none**
- **set metric-type type-1 | type-2**
- **set tag *tag-value***

NOTE

You must configure the route map before you configure a redistribution filter that uses the route map.

NOTE

When you use a route map for route redistribution, the software disregards the permit or deny action of the route map.

NOTE

For an external route that is redistributed into OSPFv3 through a route map, the metric value of the route remains the same unless the metric is set by a **set metric** command inside the route map or the **default-metric** command. For a route redistributed without using a route map, the metric is set by the metric parameter if set or the **default-metric** command if the metric parameter is not set.

Modifying default metric for routes redistributed into OSPF Version 3

The default metric is a global parameter that specifies the cost applied by default to routes redistributed into OSPFv3. The default value is 0.

If the **metric** parameter for the **redistribute** command is not set and the **default-metric** command is not set, the metric is set to 1, its default value, then routes redistributed from the various routing protocols will have the metric value of the protocol from which they are redistributed.

NOTE

You also can define the cost on individual interfaces. The interface cost overrides the default cost.

To assign a default metric of 4 to all routes imported into OSPFv3, enter the following command.

```
device(config-ospf6-router)# default-metric 4
```

Syntax: [no] default-metric *number*

You can specify a value from 0 - 65535. The default is 0.

To restore the default metric to the default value, use the **no** form of this command.

Modifying metric type for routes redistributed into OSPFv3

The device uses the **metric-type** parameter by default for all routes redistributed into OSPFv3 unless you specify a different metric type for individual routes using the **redistribute** command.

A type 1 route specifies a small metric (two bytes), while a type 2 route specifies a big metric (three bytes). The default value is type 2.

To modify the default value of type 2 to type 1, enter the following command.

```
device(config-ospf6-router)# metric-type type1
```

Syntax: [no] metric-type {type1 | type2}

To restore the metric type to the default value, use the **no** form of this command.

Configuring external route summarization

When the Ruckus device is an OSPF Autonomous System Boundary Router (ASBR), you can configure it to advertise one external route as an aggregate for all redistributed routes that are covered by a specified IPv6 address range.

When you configure an address range, the range takes effect immediately. All the imported routes are summarized according to the configured address range. Imported routes that have already been advertised and that fall within the range are flushed out of the AS and a single route corresponding to the range is advertised.

If a route that falls within a configured address range is imported by the device, no action is taken if the device has already advertised the aggregate route; otherwise, the device advertises the aggregate route. If an imported route that falls within a configured address range is removed by the device, no action is taken if there are other imported routes that fall within the same address range; otherwise the aggregate route is flushed.

You can configure up to 32 address ranges. The device sets the forwarding address of the aggregate route to zero and sets the tag to zero.

If you delete an address range, the advertised aggregate route is flushed and all imported routes that fall within the range are advertised individually.

If an external link state database overflow (LSDB) condition occurs, all aggregate routes are flushed out of the AS, along with other external routes. When the device exits the external LSDB overflow condition, all the imported routes are summarized according to the configured address ranges.

NOTE

If you use redistribution filters in addition to address ranges, the Ruckus device applies the redistribution filters to routes first, then applies them to the address ranges.

NOTE

If you disable redistribution, all the aggregate routes are flushed, along with other imported routes.

NOTE

This option affects only imported, type 5 external routes. A single type 5 LSA is generated and flooded throughout the AS for multiple external routes.

To configure the summary address 2001:db8::/24 for routes redistributed into OSPFv3, enter the following command.

```
device(config-ospf6-router)# summary-address 2001:db8::/24
```

In this example, the summary prefix 2001:db8::/24 includes addresses 2001:db8::1 through 2001:db8::/24. Only the address FEC0::/24 is advertised in an external link-state advertisement.

Syntax: summary-address { ipv6-prefix/prefix-length}

You must specify the *ipv6-prefix* parameter in hexadecimal using 16-bit values between colons as documented in RFC 2373.

You must specify the *prefix-length* parameter as a decimal value. A slash mark (/) must follow the *ipv6-prefix* parameter and precede the *prefix-length* parameter.

Filtering OSPFv3 routes

You can filter the routes to be placed in the OSPFv3 route table by configuring distribution lists. OSPFv3 distribution lists can be applied globally or to an interface.

The functionality of OSPFv3 distribution lists is similar to that of OSPFv2 distribution lists.

However, unlike OSPFv2 distribution lists, which filter routes based on criteria specified in an Access Control List (ACL), OSPFv3 distribution lists can filter routes using information specified in an IPv6 prefix list or a route map.

Configuration examples

The following sections show examples of filtering OSPFv3 routes using prefix lists globally and for a specific interface, as well as filtering OSPFv3 routes using a route map.

You can configure the device to use all three types of filtering. When you do this, filtering using route maps has higher priority over filtering using global prefix lists. Filtering using prefix lists for a specific interface has lower priority than the other two filtering methods.

The examples in this section assume the following routes are in the OSPFv3 route table.

```
device# show ipv6 ospf route
Current Route count: 5
  Intra: 3 Inter: 0 External: 2 (Type1 0/Type2 2)
  Equal-cost multi-path: 0
  Destination          Options   Area      Cost Type2 Cost
  Next Hop Router      Outgoing Interface
*IA 2001:db8:1::/64    ----- 10.0.0.1    0 0
  ::                   ve 10
*E2 2001:db8:2::/64    ----- 0.0.0.0     10 0
  fe80::2e0:52ff:fe00:10  ve 10
*IA 2001:db8:3::/64    V6E---R-- 0.0.0.0    11 0
  fe80::2e0:52ff:fe00:10  ve 10
*IA 2001:db8:4::/64    ----- 0.0.0.0     10 0
  ::                   ve 11
*E2 2001:db8:5::/64    ----- 0.0.0.0     10 0
  fe80::2e0:52ff:fe00:10  ve 10
```

Configuring an OSPFv3 distribution list using an IPv6 prefix list as input

The following example illustrates how to use an IPv6 prefix list to filter OSPFv3 routes.

To specify an IPv6 prefix list called filterOspfRoutes that denies route 2001:db8:2::/64, enter the following commands.

```
device(config)# ipv6 prefix-list filterOspfRoutes seq 5 deny 2001:db8:2::/64
device(config)# ipv6 prefix-list filterOspfRoutes seq 7 permit ::/0 ge 1 le 128
```

Syntax: **ipv6 prefix-list name [seq seq-value] [description string] {deny | permit} ipv6-addr/mask-bits [ge ge-value] [le le-value]**

To configure a distribution list that applies the filterOspfRoutes prefix list globally.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# distribute-list prefix-list filterOspfRoutes in
```

Syntax: **[no] distribute-list prefix-list name in [ethernet unit/slot/port | ve num | loopback num]**

After this distribution list is configured, route 2001:db8:2::/64 would be omitted from the OSPFv3 route table.

```
device# show ipv6 ospf route
Current Route count: 4
  Intra: 3 Inter: 0 External: 1 (Type1 0/Type2 1)
  Equal-cost multi-path: 0
  Destination          Options   Area      Cost Type2 Cost
  Next Hop Router      Outgoing Interface
```

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```
*IA 2001:db8:1::/64          ----- 10.0.0.1      0 0
  ::                           ve 10
*IA 2001:db8:3::/64          V6E---R-- 0.0.0.0    11 0
  fe80::2e0:52ff:fe00:10    ve 10
*IA 2001:db8:4::/64          ----- 0.0.0.0      10 0
  ::                           ve 11
*E2 2001:db8:5::/64          ----- 0.0.0.0      10 0
  fe80::2e0:52ff:fe00:10    ve 10
```

The following commands specify an IPv6 prefix list called filterOspfRoutesVe that denies route 2001:db8:3::/64.

```
device(config)# ipv6 prefix-list filterOspfRoutesVe seq 5 deny 2001:db8:3::/64
device(config)# ipv6 prefix-list filterOspfRoutesVe seq 10 permit ::/0 ge 1 le 128
```

The following commands configure a distribution list that applies the filterOspfRoutesVe prefix list to routes pointing to virtual interface 10.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# distribute-list prefix-list filterOspfRoutesVe in ve 10
```

After this distribution list is configured, route 2001:db8:3::/64, pointing to virtual interface 10, would be omitted from the OSPFv3 route table.

```
device# show ipv6 ospf route
Current Route count: 4
  Intra: 3 Inter: 0 External: 1 (Type1 0/Type2 1)
  Equal-cost multi-path: 0
  Destination          Options   Area        Cost Type2 Cost
  Next Hop Router      Outgoing Interface
*IA 2001:db8:1::/64    ----- 10.0.0.1      0 0
  ::                   ve 10
*E2 2001:db8:2::/64    ----- 0.0.0.0      10 0
  fe80::2e0:52ff:fe00:10  ve 10
*IA 2001:db8:4::/64    ----- 0.0.0.0      10 0
  ::                   ve 11
*E2 2001:db8:5::/64    ----- 0.0.0.0      10 0
  fe80::2e0:52ff:fe00:10  ve 10
```

Configuring an OSPFv3 distribution list using a route map as input

The following commands configure a route map that matches internal routes.

```
device(config)# route-map allowInternalRoutes permit 10
device(config-routemap allowInternalRoutes)# match route-type internal
```

The following commands configure a distribution list that applies the allowInternalRoutes route map globally to OSPFv3 routes.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# distribute-list route-map allowinternalroutes in
```

Syntax: [no] distribute-list route-map name in

After this distribution list is configured, the internal routes would be included, and the external routes would be omitted from the OSPFv3 route table.

```
device# show ipv6 ospf route
Current Route count: 3
  Intra: 3 Inter: 0 External: 0 (Type1 0/Type2 0)
  Equal-cost multi-path: 0
  Destination          Options   Area        Cost Type2 Cost
  Next Hop Router      Outgoing Interface
*IA 2001:db8:3001::/64    ----- 10.0.0.1      0 0
  ::                   ve 10
*IA 2001:db8:3015::/64    V6E---R-- 0.0.0.0    11 0
  fe80::2e0:52ff:fe00:10  ve 10
*IA 2001:db8:3020::/64    ----- 0.0.0.0      10 0
  ::                   ve 11
```

Configuring an OSPFv3 distribution list using a route map that uses a prefix list

When you configure route redistribution into OSPFv3 using a route map that uses a prefix list, the device supports both **permit** and **deny** statements in the route map and **permit** statements only in the prefix list. Therefore, the action to permit or deny is determined by the route map, and the conditions for the action are contained in the prefix list. The following shows an example configuration.

```
device(config)# route-map v64 deny 10
device(config-routemap v64)# match ipv6 next-hop prefix-list ospf-filter5
device(config-routemap v64)# route-map v64 deny 11
device(config-routemap v64)# match ipv6 address prefix-list ospf-filter2
device(config-routemap v64)# route-map v64 permit 12
device(config-routemap v64)# exit
device(config)# ipv6 prefix-list ospf-filter2 seq 15 permit 2001:DB8:2001:102::/64 ge 65 le 96
device(config)# ipv6 prefix-list ospf-filter5 seq 15 permit fe80::2e0:52ff:fe00:100/128
```

In this example the prefix lists, ospf-filter2 and ospf-filter5 , contain a range of IPv6 routes and one host route to be denied, and the route map v64 defines the deny action.

NOTE

The default action rule for **route-map** is to deny all routes that are not explicitly permitted. If you configure a "deny" route map but want to permit other routes that do not match the rule, configure an "empty" permit route map. For example,

```
device(config)# route-map abc deny 10
device(config-routemap abc)# match metric 20
device(config-routemap abc)# route-map abc permit 20
```

Without the last line in the above example, all routes would be denied.

Configuring default route origination

When the Ruckus device is an OSPFv3 Autonomous System Boundary Router (ASBR), you can configure it to automatically generate a default external route into an OSPFv3 routing domain. This feature is called "default route origination" or "default information origination."

By default, the Ruckus device does not advertise the default route into the OSPFv3 domain. If you want the device to advertise the OSPF default route, you must explicitly enable default route origination.

When you enable OSPFv3 default route origination, the device advertises a type 5 default route that is flooded throughout the AS (except stub areas).

The device advertises the default route into OSPF even if OSPF route redistribution is not enabled, and even if the default route is learned through an IBGP neighbor. The router will not, however, originate default if the active default route is learned from an OSPF router in the same domain.

NOTE

The Ruckus device does not advertise the OSPFv3 default route, regardless of other configuration parameters, unless you explicitly enable default route origination.

If default route origination is enabled and you disable it, the default route originated by the device is flushed. Default routes generated by other OSPFv3 routers are not affected. If you re-enable the feature, the feature takes effect immediately and thus does not require you to reload the software.

For example, to create and advertise a default route with a metric of 2 and as a type 1 external route, enter the following command.

```
device(config-ospf6-router)# default-information-originate always metric 2 metric-type type1
```

Syntax: [no] **default-information-originate** [**always**] [**metric value**] [**metric-type type**]

The **always** keyword originates a default route regardless of whether the device has learned a default route. This option is disabled by default.

The **metric value** parameter specifies a metric for the default route. If this option is not used, the value of the **default-metric** command is used for the route.

The **metric-type type** parameter specifies the external link type associated with the default route advertised into the OSPF routing domain. The *type* can be one of the following:

- 1 - Type 1 external route
- 2 - Type 2 external route

If you do not use this option, the default redistribution metric type is used for the route type.

NOTE

If you specify a metric and metric type, the values are used even if you do not use the **always** option.

To disable default route origination, enter the **no** form of the command.

Modifying Shortest Path First timers

The Ruckus device uses the following timers when calculating the shortest path for OSPFv3 routes:

- SPF delay - When the Ruckus device receives a topology change, the software waits before it starts a Shortest Path First (SPF) calculation. By default, the software waits 5 seconds. You can configure the SPF delay to a value from 0 through 65535 seconds. If you set the SPF delay to 0 seconds, the software immediately begins the SPF calculation after receiving a topology change.
- SPF hold time - The device waits a specific amount of time between consecutive SPF calculations. By default, it waits 10 seconds. You can configure the SPF hold time to a value from 0 through 65535 seconds. If you set the SPF hold time to 0 seconds, the software does not wait between consecutive SPF calculations.

You can set the SPF delay and hold time to lower values to cause the device to change to alternate paths more quickly if a route fails. Note that lower values for these parameters require more CPU processing time.

You can change one or both of the timers.

NOTE

If you want to change only one of the timers, for example, the SPF delay timer, you must specify the new value for this timer as well as the current value of the SPF hold timer, which you want to retain. The device does not accept only one timer value.

NOTE

If you configure SPF timers between 0-100, they will default to 0 and be displayed incorrectly in the running configuration.

To change the SPF delay to 10 seconds and the SPF hold to 20 seconds, enter the following command.

```
device(config-ospf6-router)# timers spf 10 20
```

Syntax: [no] **timers spf delay hold-time**

For the *delay* and *hold-time* parameters, specify a value from 0 through 65535 seconds.

To set the timers back to their default values, enter the **no** version of this command.

Modifying administrative distance

The Ruckus device can learn about networks from various protocols, including BGP4+, RIPng, and OSPFv3. Consequently, the routes to a network may differ depending on the protocol from which the routes were learned. By default, the administrative distance for OSPFv3 routes is 110.

The device selects one route over another based on the source of the route information. To do so, the device can use the administrative distances assigned to the sources. You can influence the device's decision by changing the default administrative distance for OSPFv3 routes.

Configuring administrative distance based on route type

You can configure a unique administrative distance for each type of OSPFv3 route. For example, you can use this feature to influence the Ruckus device to prefer a static route over an OSPF inter-area route and to prefer OSPF intra-area routes to static routes.

The distance you specify influences the choice of routes when the device has multiple routes to the same network from different protocols. The device prefers the route with the lower administrative distance.

You can specify unique default administrative distances for the following OSPFv3 route types:

- Intra-area routes
- Inter-area routes
- External routes

The default for all of these OSPFv3 route types is 110.

NOTE

This feature does not influence the choice of routes within OSPFv3. For example, an OSPF intra-area route is always preferred over an OSPF inter-area route, even if the intra-area route's distance is greater than the inter-area route's distance.

For example, to change the default administrative distances for intra-area routes to 80, inter-area routes to 90, and external routes to 100, enter the following commands.

```
device(config-ospf6-router)# distance intra-area 80
device(config-ospf6-router)# distance inter-area 90
device(config-ospf6-router)# distance external 100
```

Syntax: [no] **distance {external | inter-area | intra-area}** *distance*

The **external**, **inter-area**, and **intra-area** keywords specify the route type for which you are changing the default administrative distance.

The *distance* parameter specifies the new distance for the specified route type. You can specify a value from 1 through 255.

To reset the administrative distance of a route type to its system default, enter the **no** form of this command.

Configuring the OSPFv3 LSA pacing interval

The Ruckus device paces OSPFv3 LSA refreshes by delaying the refreshes for a specified time interval instead of performing a refresh each time an individual LSA's refresh timer expires. The accumulated LSAs constitute a group, which the device refreshes and sends out together in one or more packets.

The pacing interval, which is the interval at which the Ruckus device refreshes an accumulated group of LSAs, is configurable to a range from 10 through 1800 seconds (30 minutes). The default is 240 seconds (four minutes). Thus, every four minutes, the device refreshes the group of accumulated LSAs and sends the group together in the same packets.

The pacing interval is inversely proportional to the number of LSAs the Ruckus device is refreshing and aging. For example, if you have approximately 10,000 LSAs, decreasing the pacing interval enhances performance. If you have a very small database (40 - 100 LSAs), increasing the pacing interval to 10 - 20 minutes might enhance performance only slightly.

To change the OSPFv3 LSA pacing interval to two minutes (120 seconds), enter the following command.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# timers lsa-group-pacing 120
```

Syntax: [no] **timers lsa-group-pacing** *seconds*

The *seconds* parameter specifies the number of seconds and can be from 10 through 1800 (30 minutes). The default is 240 seconds (four minutes).

To restore the pacing interval to its default value, use the **no** form of the command.

Modifying exit overflow interval

If a database overflow condition occurs on the Ruckus device, the device eliminates the condition by removing entries that originated on the device. The exit overflow interval allows you to set how often a device checks to see if the overflow condition has been eliminated. The default value is 0. If the configured value of the database overflow interval is 0, then the device never leaves the database overflow condition.

For example, to modify the exit overflow interval to 60 seconds, enter the following command.

```
device(config-ospf6-router)# database-overflow-interval 60
```

Syntax: **database-overflow-interval** *seconds*

The *seconds* parameter can be a value from 0 through 86400 seconds (24 hours).

To reset the exit overflow interval to its system default, enter the **no** form of this command.

Modifying external link state database limit

By default, the link state database can hold a maximum of 2000 entries for external (type 5) LSAs. You can change the maximum number of entries from 500 - 8000. After changing this limit, make sure to save the running-config file and reload the software. The change does not take effect until you reload or reboot the software.

For example, to change the maximum number entries from the default of 2000 to 3000, enter the following command.

```
device(config-ospf6-router)# external-lsdb-limit 3000
```

Syntax: **external-lsdb-limit** *entries*

The *entries* parameter can be a numerical value from 500 through 8000 seconds.

To reset the maximum number of entries to its system default, enter the **no** form of this command.

Setting all OSPFv3 interfaces to the passive state

You can set all the Open Shortest Path First Version 3 (OSPFv3) interfaces to the default passive state using the **default-passive-interface** command. When you configure the interfaces as passive, the interfaces drop all the OSPFv3 control packets.

To set all the OSPFv3 interfaces to passive, enter the following commands.

```
device# configure terminal
device(config)# ipv6 router ospf vrf A
device(config-ospf6-router-vrf-A)# default-passive-interface
```

Syntax: [no] **default-passive-interface**

Modifying OSPFv3 interface defaults

OSPFv3 has interface parameters that you can configure. For simplicity, each of these parameters has a default value. No change to these default values is required except as needed for specific network configurations.

You can modify the default values for the following OSPF interface parameters:

- **cost:** Indicates the overhead required to send a packet across an interface. You can modify the cost to differentiate between 100 Mbps and 1000 Mbps (1 Gbps) links. The command syntax is **ipv6 ospf cost number**. The default cost is calculated by dividing 100 million by the bandwidth. For 10 Mbps links, the cost is 10. The cost for both 100 Mbps and 1000 Mbps links is 1, because the speed of 1000 Mbps was not in use at the time the OSPF cost formula was devised.
- **dead-interval:** Indicates the number of seconds that a neighbor router waits for a hello packet from the device before declaring the router down. The command syntax is **ipv6 ospf dead-interval seconds**. The value can be from 1 through 2147483647 seconds. The default is 40 seconds.
- **hello-interval:** Represents the length of time between the transmission of hello packets. The command syntax is **ipv6 ospf hello-interval seconds**. The value can be from 1 through 65535 seconds. The default is 10 seconds.
- **instance:** Indicates the number of OSPFv3 instances running on an interface. The command syntax is **ipv6 ospf instance number**. The value can be from 0 through 255. The default is 1.
- **MTU-ignore:** Allows you to disable a check that verifies the same MTU is used on an interface shared by neighbors. The command syntax is **ipv6 ospf mtu-ignore**. By default, the mismatch detection is enabled.
- **network:** Allows you to configure the OSPF network type. The command syntax is **ipv6 ospf network [point-to-multipoint]**. The default setting of the parameter depends on the network type.
- **passive:** When you configure an OSPF interface to be passive, that interface does not send or receive OSPF route updates. This option affects all IPv6 subnets configured on the interface. The command syntax is **ipv6 ospf passive**. By default, all OSPF interfaces are active and thus can send and receive OSPF route information. Since a passive interface does not send or receive route information, the interface is in effect a stub network.
- **active:** When you configure an OSPFv3 interface to be active, that interface sends or receives all the control packets and forms the adjacency. By default, the **ipv6 ospf active** command is disabled. Whenever you configure the OSPFv3 interfaces to be passive using the **default-passive-interface** command, all the OSPFv3 interfaces stop sending and receiving control packets. To send and receive packets over specific interfaces, you can use the **ipv6 ospf active** command.
- **priority:** Allows you to modify the priority of an OSPF router. The priority is used when selecting the designated router (DR) and backup designated routers (BDRs). The command syntax is **ipv6 ospf priority number**. The value can be from 0 through 255. The default is 1. If you set the priority to 0, the router does not participate in DR and BDR election.
- **retransmit-interval:** The time between retransmissions of LSAs to adjacent routers for an interface. The command syntax is **ipv6 ospf retransmit-interval seconds**. The value can be from 0 through 3600 seconds. The default is 5 seconds.

- **Transmit-delay:** The time it takes to transmit Link State Update packets on this interface. The command syntax is **ipv6 ospf transmit-delayseconds**. The range is 0 through 3600 seconds. The default is 1 second.

Disabling or re-enabling event logging

OSPFv3 supports the logging of OSPFv3 events. The log-status change command controls the generation of all OSPFv3 logs. You can disable or re-enable the logging of events related to OSPFv3, such as neighbor state changes and database overflow conditions. By default, the Ruckus device does not log these events.

To disable the logging of events, enter the following command.

```
device(config-ospf6-router)# no log-status-change
```

Syntax: [no] log-status-change

To re-enable the logging of events, enter the following command.

```
device(config-ospf6-router)# log-status-change
```

IPsec for OSPFv3

IPSec secures OSPFv3 communications by authenticating and encrypting each IP packet of a communication session.

IPsec is available for OSPFv3 traffic only and only for packets that are “for-us”. A for-us packet is addressed to one of the IPv6 addresses on the device or to an IPv6 multicast address. Packets that are just forwarded by the line card do not receive IPsec scrutiny.

Ruckus devices support the following components of IPsec for IPv6-addressed packets:

- Authentication through Encapsulating Security Payload (ESP) in transport mode
- HMAC-SHA1-96 as the authentication algorithm
- Manual configuration of keys
- Configurable rollover timer

IPsec can be enabled on the following logical entities:

- Interface
- Area
- Virtual link

With respect to traffic classes, this implementation of IPSec uses a single security association (SA) between the source and destination to support all traffic classes and so does not differentiate between the different classes of traffic that the DSCP bits define.

IPsec on a virtual link is a global configuration. Interface and area IPsec configurations are more granular.

Among the entities that can have IPsec protection, the interfaces and areas can overlap. The interface IPsec configuration takes precedence over the area IPsec configuration when an area and an interface within that area use IPsec. Therefore, if you configure IPsec for an interface and an area configuration also exists that includes this interface, the interface's IPsec configuration is used by that interface. However, if you disable IPsec on an interface, IPsec is disabled on the interface even if the interface has its own, specific authentication.

For IPsec, the system generates two types of databases. The *security association database* (SAD) contains a security association for each interface or one global database for a virtual link. Even if IPsec is configured for an area, each interface that uses the area's IPsec still has its own security association in the SAD. Each SA in the SAD is a generated entry that is based on your specifications

of an authentication protocol (ESP in the current release), destination address, and a security policy index (SPI). The SPI number is user-specified according to the network plan. Consideration for the SPI values to specify must apply to the whole network.

The system-generated security policy databases (SPDs) contain the security policies against which the system checks the for-us packets. For each for-us packet that has an ESP header, the applicable security policy in the security policy database (SPD) is checked to see if this packet complies with the policy. The IPsec task drops the non-compliant packets. Compliant packets continue on to the OSPFv3 task.

Configuring IPsec for OSPFv3

This section describes how to configure IPsec for an interface, area, and virtual link. It also describes how to change the key rollover timer if necessary and how to disable IPsec on a particular interface for special purposes.

By default, OSPFv3 IPsec authentication is disabled. The following IPsec parameters are configurable:

- ESP security protocol
- Authentication
- HMAC-SHA1-96 authentication algorithm
- Security parameter index (SPI)
- A 40-character key using hexadecimal characters
- An option for not encrypting the keyword when it appears in **show** command output
- Key rollover timer
- Specifying the key add remove timer

NOTE

In the current release, certain keyword parameters must be entered even though only one keyword choice is possible for that parameter. For example, the only authentication algorithm in the current release is HMAC-SHA1-96, but you must nevertheless enter the keyword for this algorithm. Also, ESP currently is the only authentication protocol, but you must still enter the **esp** keyword. This section describes all keywords.

IPsec for OSPFv3 considerations

The IPsec component generates security associations and security policies based on certain user-specified parameters. The parameters are described with the syntax of each command in this section. User-specified parameters and their relation to system-generated values are as follows:

- **Security association:** based on your entries for *security policy index (SPI)*, *destination address*, and *security protocol* (currently ESP), the system creates a security association for each interface or virtual link.
- **Security policy database:** based on your entries for SPI, *source address*, *destination addresses*, and *security protocol*, the system creates a security policy database for each interface or virtual link.
- You can configure the same SPI and key on multiple interfaces and areas, but they still have unique IPsec configurations because the SA and policies are added to each separate security policy database (SPD) that is associated with a particular interface. If you configure an SA with the same SPI in multiple places, the rest of the parameters associated with the SA—such as key, cryptographic algorithm, and security protocol, and so on—must match. If the system detects a mismatch, it displays an error message.
- IPsec authentication for OSPFv3 requires the use of multiple SPDs, one for each interface. A virtual link has a separate, global SPD. The authentication configuration on a virtual link must be different from the authentication configuration for an area or interface, as required by RFC4552. The interface number is used to generate a non-zero security policy

database identifier (SPDID), but for the global SPD for a virtual link, the system-generated SPDID is always zero. As a hypothetical example, the SPD for interface eth 1/1/1 might have the system-generated SPDID of 1, and so on.

- If you change an existing key, you must also specify a different SPI value. For example, in an interface context where you intend to change a key, you must type a different SPI value—which occurs before the key parameter on the command line—before you type the new key.
- The old key is active for twice the current configured key-rollover-interval for the inbound direction. In the outbound direction, the old key remains active for a duration equal to the key-rollover-interval. If the key-rollover-interval is set to 0, the new key immediately takes effect for both directions.

Interface and area IPsec considerations

This section describes the precedence of interface and area IPsec configurations.

If you configure an interface IPsec by using the **ipv6 ospf authentication** command in the context of a specific interface, that interface's IPsec configuration overrides the area configuration of IPsec.

If you configure IPsec for an area, all interfaces that utilize the area-wide IPsec (where interface-specific IPsec is not configured) nevertheless receive an SPD entry (and SPDID number) that is unique for the interface.

The area-wide SPI that you specify is a constant for all interfaces in the area that use the area IPsec, but the use of different interfaces results in an SPDID and an SA that are unique to each interface. The security policy database depends partly on the source IP address, so a unique SPD for each interface results.

Considerations for IPsec on virtual links

The IPsec configuration for a virtual link is global, so only one security association database and one security policy database exist for virtual links if you choose to configure IPsec for virtual links.

The virtual link IPsec SAs and policies are added to all interfaces of the transit area for the outbound direction. For the inbound direction, IPsec SAs and policies for virtual links are added to the global database.

NOTE

The security association (SA), security protocol index (SPI), security protocol database (SPD), and key have mutual dependencies, as the subsections that follow describe.

Specifying the key rollover timer

Configuration changes for authentication takes effect in a controlled manner through the key rollover procedure as specified in RFC 4552, Section 10.1. The key rollover timer controls the timing of the existing configuration changeover. The key rollover timer can be configured in the IPv6 router OSPF context, as the following example illustrates.

```
device(config-ospf6-router)# key-rollover-interval 200
```

Syntax: key-rollover-interval time

The range for the key-rollover-interval is 0 through 14400 seconds. The default is 300 seconds.

Specifying the key add remove timer

The **key-add-remove** timer is used in an environment where interoperability with other vendors is required on a specific interface. This parameter is used to determine the interval time when authentication addition and deletion will take effect.

The **key-add-remove-interval** timer can be used to set the required value globally, or on a specific interface as needed. Interface configuration takes preference over system level configuration.

By default, the **key-add-remove-interval** is set to 300 seconds to smoothly interoperate with Brocade routers.

To set the **key-add-remove-interval** globally to 100 seconds, enter the following commands:

```
device(config-ospf6-router)# key-add-remove-interval 100
```

To set the **key-add-remove-interval** to 100 seconds on a specific interface, enter the following command:

```
device(config-if-e1000-1/1/10)#ipv6 ospf authentication ipsec key-add-remove-interval 100
```

Syntax: [no] ipv6 ospf authentication ipsec key-add-remove-interval range

The **no** form of this command sets the key-add-remove-interval back to a default of 300 seconds.

The **ipv6** command is available in the configuration interface context for a specific interface.

The **ospf** keyword identifies OSPFv3 as the protocol to receive IPsec security.

The **authentication** keyword enables authentication.

The **ipsec** keyword specifies IPsec as the authentication protocol.

The **range** is a value between 0 and 14400 seconds.

This command is not set by default and **key-add-remove-interval** is set to the same value as **key-rollover-interval**.

NOTE

This command will not resolve the issue completely on a network where Brocade Routers running software that does not support **key-add-remove-interval** (earlier versions of NetIron R05.3.00) and other vendor's routers are present. In this case, disabling and enabling the interface or setting **key-rollover-interval** to 0 will resolve the issue.

Configuring IPsec on a interface

For IPsec to work, the IPsec configuration must be the same on all the routers to which an interface connects.

For multicast, IPsec does not need or use a specific destination address, the destination address is "do not care," and this status is reflected by the lone pair of colons (::) for destination address in the **show** command output.

To configure IPsec on an interface, proceed as in the following example.

NOTE

The IPsec configuration for an interface applies to the inbound and outbound directions. Also, the same authentication parameters must be used by all devices on the network to which the interface is connected, as described in section 7 of RFC 4552.

```
device(config-if-e1000-1/1/2)# ipv6 ospf auth ipsec spi 429496795 esp sha1  
abcdef12345678900987654321fedcba12345678
```

Syntax: [no] ipv6 ospf authentication ipsec spi spi-num esp sha1 [no-encrypt] key

The **no** form of this command deletes IPsec from the interface.

The **ipv6** command is available in the configuration interface context for a specific interface.

The **ospf** keyword identifies OSPFv3 as the protocol to receive IPsec security.

The **authentication** keyword enables authentication.

The **ipsec** keyword specifies IPsec as the authentication protocol.

The **spi** keyword and the *spi-num* variable specify the security parameter that points to the security association. The near-end and far-end values for *spi-num* must be the same. The range for *spi-num* is decimal 256 through 4294967295.

The mandatory **esp** keyword specifies ESP (rather than authentication header) as the protocol to provide packet-level security. In the current release, this parameter can be **esp** only.

The **sha1** keyword specifies the HMAC-SHA1-96 authentication algorithm. This mandatory parameter can be only the **sha1** keyword in the current release.

Including the optional **no-encrypt** keyword means that when you display the IPsec configuration, the key is displayed in its unencrypted form and also saved as unencrypted.

The *key* variable must be 40 hexadecimal characters. To change an existing key, you must also specify a different SPI value. You cannot just change the key without also specifying a different SPI, too. For example, in an interface context where you intend to change a key, you must type a different SPI value -- which occurs before the key parameter on the command line -- before you type the new key.

If **no-encrypt** is not entered, then the key will be encrypted. This is the default. The system adds the following in the configuration to indicate that the key is encrypted:

- encrypt = the key string uses proprietary simple cryptographic 2-way algorithm
- encryptb64 = the key string uses proprietary base64 cryptographic 2-way algorithm

This example results in the configuration shown in the screen output that follows. Note that because the optional **no-encrypt** keyword was omitted, the display of the key has the encrypted form by default.

```
interface ethernet 1/1/2
enable
ip address 10.3.3.1/8
ipv6 address 2001:db8:3::1/64
ipv6 ospf area 1
ipv6 ospf authentication ipsec spi 429496795 esp sha1 encryptb64 $ITJkQG5HWnw4M09tWVd
```

Configuring IPsec for an area

This application of the **area** command (for IPsec) applies to all of the interfaces that belong to an area unless an interface has its own IPsec configuration. The interface IPsec can be operationally disabled if necessary.) To configure IPsec for an area in the IPv6 router OSPF context, proceed as in the following example.

```
device(config-ospf6-router)# area 2 auth ipsec spi 400 esp sha1 abcef12345678901234fedcba098765432109876
```

Syntax: [no] area *area-id* authentication ipsec *spi* *spi-num* esp sha1 [no-encrypt] *key*

The **no** form of this command deletes IPsec from the area.

The **area** command and the *area-id* variable specify the area for this IPsec configuration. The *area-id* can be an integer in the range 0 through 2,147,483,647 or have the format of an IP address.

The **authentication** keyword specifies that the function to specify for the area is packet authentication.

The **ipsec** keyword specifies that IPsec is the protocol that authenticates the packets.

The **spi** keyword and the *spi-num* variable specify the index that points to the security association. The near-end and far-end values for *spi-num* must be the same. The range for *spi-num* is decimal 256 through 4294967295.

The mandatory **esp** keyword specifies ESP (rather than authentication header) as the protocol to provide packet-level security. In the current release, this parameter can be **esp** only.

The **sha1** keyword specifies the HMAC-SHA1-96 authentication algorithm. This mandatory parameter can be only the **sha1** keyword in the current release.

Including the optional **no-encrypt** keyword means that the 40-character key is not encrypted upon either its entry or its display. The key must be 40 hexadecimal characters.

If **no-encrypt** is not entered, then the key will be encrypted. This is the default. The system adds the following in the configuration to indicate that the key is encrypted:

- encrypt = the key string uses proprietary simple cryptographic 2-way algorithm
- encryptb64 = the key string uses proprietary base64 cryptographic 2-way algorithm

The configuration in the preceding example results in the configuration for area 2 that is illustrated in the following.

```
ipv6 router ospf
area 0
area 1
area 2
area 2 auth ipsec spi 400 esp sha1 abcef12345678901234fedcba098765432109876
```

Configuring IPsec for a virtual link

IPsec on a virtual link has a global configuration.

To configure IPsec on a virtual link, enter the IPv6 router OSPF context of the CLI and proceed as the following example illustrates. (Note the **no-encrypt** option in this example.)

```
device(config-ospf6-router)# area 1 vir 10.2.2.2 auth ipsec spi 360 esp sha1 no-encrypt
1234567890098765432112345678990987654321
```

Syntax: [no] area area-id virtual nbr-id authentication ipsec spi spi-num esp sha1 [no-encrypt] key

The **no** form of this command deletes IPsec from the virtual link.

The **area** command and the *area-id* variable specify the area is to be configured. The *area-id* can be an integer in the range 0 through 2,147,483,647 or have the format of an IP address.

The **virtual** keyword indicates that this configuration applies to the virtual link identified by the subsequent variable *nbr-id*. The variable *nbr-id* is in dotted decimal notation of an IP address.

The **authentication** keyword specifies that the function to specify for the area is packet authentication.

The **ipsec** keyword specifies that IPsec is the protocol that authenticates the packets.

The **spi** keyword and the *spi-num* variable specify the index that points to the security association. The near-end and far-end values for *spi-num* must be the same. The range for *spi-num* is decimal 256 through 4294967295.

The mandatory **esp** keyword specifies ESP (rather than authentication header) as the protocol to provide packet-level security. In the current release, this parameter can be **esp** only.

The **sha1** keyword specifies the HMAC-SHA1-96 authentication algorithm. This mandatory parameter can be only the **sha1** keyword in the current release.

Including the optional **no-encrypt** keyword means that the 40-character key is not encrypted in **show** command displays. If **no-encrypt** is not entered, then the key will be encrypted. This is the default. The system adds the following in the configuration to indicate that the key is encrypted:

- encrypt = the key string uses proprietary simple cryptographic 2-way algorithm
- encryptb64 = the key string uses proprietary base64 cryptographic 2-way algorithm

This example results in the following configuration.

```
area 1 virtual-link 10.2.2.2
area 1 virtual-link 10.2.2.2 authentication ipsec spi 360 esp sha1 no-encrypt 12
34567890098765432112345678990987654321
```

Disabling IPsec on an interface

For the purpose of troubleshooting, you can operationally disable IPsec on an interface by using the **ipv6 ospf authentication ipsec disable** command in the CLI context of a specific interface. This command disables IPsec on the interface whether its IPsec configuration is the area's IPsec configuration or is specific to that interface. The output of the **show ipv6 ospf interface command** shows the current setting for the disable command.

To disable IPsec on an interface, go to the CLI context of the interface and proceed as in the following example.

```
device(config-if-e10000-1/1/2)# ipv6 ospf auth ipsec disable
```

Syntax: [no] ipv6 ospf authentication ipsec disable

The **no** form of this command restores the area and interface-specific IPsec operation.

Changing the key rollover timer

Configuration changes for authentication takes effect in a controlled manner through the key rollover procedure as specified in RFC 4552, Section 10.1. The key rollover timer controls the timing of the configuration changeover. The key rollover timer can be configured in the IPv6 router OSPF context, as the following example illustrates.

```
device(config-ospf6-router)# key-rollover-interval 200
```

Syntax: key-rollover-interval time

The range for the key-rollover-interval is 0 through 14400 seconds. The default is 300 seconds.

Clearing IPsec statistics

This section describes the **clear ipsec statistics** command for clearing statistics related to IPsec. The command resets to 0 the counters (which you can view as a part of IP Security Packet Statistics). The counters hold IPsec packet statistics and IPsec error statistics. The following example illustrates the **show ipsec statistics** output.

```
device# show ipsec statistics
          IPSecurity Statistics
secEspCurrentInboundSAs 1      ipsecEspTotalInboundSAs: 2
secEspCurrentOutboundSA 1      ipsecEspTotalOutboundSAs: 2
          IPSecurity Packet Statistics
secEspTotalInPkts: 20      ipsecEspTotalInPktsDrop: 0
secEspTotalOutPkts: 84
          IPSecurity Error Statistics
secAuthenticationErrors 0
secReplayErrors: 0      ipsecPolicyErrors: 13
secOtherReceiveErrors: 0      ipsecSendErrors: 0
secUnknownSpiErrors: 0
```

To clear the statistics, enter the **clear ipsec statistics** command as in the following example.

```
device# clear ipsec statistics
```

Syntax: clear ipsec statistics

This command takes no parameters.

Configuring OSPFv3 Graceful Restart Helper mode

To enable the graceful restart (GR) helper capability, use the **graceful-restart helper** command in the OSPFv6 interface mode. Graceful restart for OSPFv3 helper mode is enabled by default.

```
device(config-ospf6-router)# graceful-restart helper strict-lsa-checking
```

Syntax: [no] graceful-restart helper {disable | strict-lsa-checking}

The **disable** keyword is used to disable the graceful-restart helper capability. By default, it is enabled.

The **strict-lsa-checking** keyword is used to enable the graceful-restart helper device to terminate restart supporting any topology change. By default, it is disabled.

TABLE 70 OSPFv3 area information fields

Task	Configuration example
Disabling graceful-restart-helper on a device	<pre>device(config-ospf6-router)#graceful-restart helper disable</pre> <p>NOTE Graceful restart for OSPFv3 helper mode is enabled by default.</p>
Enabling graceful-restart-helper on a device	<pre>device(config-ospf6-router)#no graceful-restart helper disable</pre>
Enabling LSA checking option on the helper	<pre>device(config-ospf6-router)#graceful-restart helper strict-lsa-checking</pre>
Enabling graceful-restart-helper per VRF	<pre>device(config-ospf6-router-vrf-red)#graceful- restart helper strict-lsa-checking</pre>
NOTE Graceful-restart-helper option can be enabled or disabled per VRF in OSPFv3. If configured outside VRF, then it is applicable to the default VRF instance of OSPFv3.	

Configuring OSPFv3 Non-stop routing (NSR)

In graceful restart, the restarting neighbors need to help build the routing information during the failover, but the graceful restart helper may not be supported by all devices in a network. Hence to eliminate this dependency, the non-stop routing (NSR) feature is supported on Brocade devices. NSR does not require support from neighboring devices to perform hitless failover. NSR does not support IPv6-over-IPv4 tunnel and virtual link, so traffic loss is expected while performing hitless failover.

To enable NSR for OSPFv3, use the **nonstop-routing** command in the OSPFv6 interface mode.

```
device(config)# ipv6 router ospf
device(config-ospf6-router)# nonstop-routing
```

To disable NSR for OSPFv3, use the **no** form of the **nonstop-routing** command.

Syntax: [no] nonstop-routing

Displaying OSPFv3 information

You can display the information for the following OSPFv3 parameters:

- Areas
- Link state databases
- Interfaces
- Memory usage
- Neighbors

OSPFv3

Displaying OSPFv3 information

- **Redistributed routes**
- **Routes**
- **SPF**
- **Virtual links**
- **Virtual neighbors**
- **IPsec**
- **key-add-remove interval**

General OSPFv3 configuration information

To indicate whether the Ruckus device is operating as ASBR or not, enter the following command at any CLI level.

```
device# show ipv6 ospf
OSPFv3 Process number 0 with Router ID 0xc0a862d5(192.168.98.213)
  Running 0 days 2 hours 55 minutes 36 seconds
  Number of AS scoped LSAs is 4
  Sum of AS scoped LSAs Checksum is 18565
  External LSA Limit is 250000
  Database Overflow Interval is 10
  Database Overflow State is NOT OVERFLOWED
  Route calculation executed 15 times
  Pending outgoing LSA count 0
  Authentication key rollover interval 300 seconds
  Number of areas in this router is 3
  Router is operating as ABR
  Router is operating as ASBR, Redistribute: CONNECTED RIP
  High Priority Message Queue Full count: 0
  Graceful restart helper is enabled, strict lsa checking is disabled
  Nonstop Routing is disabled
```

The output of the **show ipv6 ospf** command indicates if the Ruckus device is operating as ASBR. If the device is not operating as ASBR, then there is no information about redistribution in the output.

Displaying OSPFv3 area information

To display global OSPFv3 area information for the device, enter the following command at any CLI level.

```
device# show ipv6 ospf area 400
Area 400:
  Authentication: Not Configured
  Active interface(s) attached to this area: None
  Inactive interface(s) attached to this area: ve 20  ve 30
  Number of Area scoped LSAs is 311
  Sum of Area LSAs Checksum is 9e8fff
  Statistics of Area 400:
    SPF algorithm executed 10 times
    SPF last updated: 5920 sec ago
    Current SPF node count: 1
      Router: 1 Network: 0
      Maximum of Hop count to nodes: 0
```

Syntax: **show ipv6 ospf area [area-id]**

You can specify the *area-id* parameter in the following formats:

- As an IPv4 address, for example, 192.168.1.1.
- As a numerical value from 0 through 2,147,483,647.

The *area-id* parameter restricts the display to the specified OSPF area.

TABLE 71 show ipv6 ospf area output descriptions

This field	Displays
Area	The area number.
Interface attached to this area	The device interfaces attached to the area.
Number of Area scoped LSAs is <i>N</i>	Number of LSAs (<i>N</i>) with a scope of the specified area.
SPF algorithm executed is <i>N</i>	The number of times (<i>N</i>) the OSPF Shortest Path First (SPF) algorithm is executed within the area.
SPF last updated	The interval in seconds that the SPF algorithm was last executed within the area.
Current SPF node count	The current number of SPF nodes in the area.
Router	Number of router LSAs in the area.
Network	Number of network LSAs in the area.
Indx	The row number of the entry in the routers's OSPF area table.
Statistics of Area	The number of the area whose statistics are displayed.
Maximum hop count to nodes.	The maximum number of hop counts to an SPF node within the area.

Displaying OSPFv3 database information

You can display a summary of the device's link state database or detailed information about a specified LSA type.

To display a summary of a device's link state database, enter the following command at any CLI level.

```
device# show ipv6 ospf database
LSA Key - Rtr:Router Net:Network Inap:InterPrefix Inar:InterRouter
          Extn:ASEExternal Grp:GroupMembership Typ7:Type7 Link:Link
          Iap:IntraPrefix Grc:Grace
Area ID      Type LSID      Adv Rtr      Seq(Hex) Age  Cksum Len Sync
0.0.0.200    Link 897     192.168.98.213 80000007 1277 9044 64 Yes
0.0.0.200    Link 136     192.168.98.111 80000007 582  fb0b 64 Yes
0.0.0.200    Link 2049    192.168.98.213 80000006 1277 381a 64 Yes
0.0.0.200    Link 1156    192.168.98.111 80000007 582  cf38 64 Yes
0.0.0.200    Link 2052    192.168.98.213 80000004 799  5b06 64 Yes
0.0.0.200    Rtr  0       192.168.98.111 800002ea 823  cb7b 56 Yes
0.0.0.200    Rtr  0       192.168.98.213 800001c7 799  8402 56 Yes
0.0.0.200    Net  1156    192.168.98.111 80000004 823  b2d2 32 Yes
0.0.0.200    Net  136     192.168.98.111 80000008 823  aed2 32 Yes
N/A          Extn 0000021d 10.223.223.223   800000a8 1319 441e 32 Yes
```

Syntax: **show ipv6 ospf database [advrtr *ipv4-address* | as-external [advrtr *ipv4-address* | link-id *number*] | extensive | inter-prefix [advrtr *ipv4-address* | link-id *number*] | inter-router [advrtr *ipv4-address* | link-id *number*] | intra-prefix [advrtr *ipv4-address* | link-id *number*] | link [advrtr *ipv4-address* | link-id *number*] | link-id *number* | network [advrtr *ipv4-address* | link-id *number*] | router [advrtr *ipv4-address* | link-id *number*]]]**

The **advrtr *ipv4-address*** parameter displays detailed information about the LSAs for a specified advertising router only.

The **as-external** keyword displays detailed information about the AS externals LSAs only.

The **extensive** keyword displays detailed information about all LSAs in the database.

The **inter-prefix** keyword displays detailed information about the inter-area prefix LSAs only.

The **inter-router** keyword displays detailed information about the inter-area router LSAs only.

The **intra-prefix** keyword displays detailed information about the intra-area prefix LSAs only.

The **link** keyword displays detailed information about the link LSAs only.

The **link-id *number*** parameter displays detailed information about the specified link LSAs only.

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The **network number** displays detailed information about the network LSAs only.

The **router number** displays detailed information about the router LSAs only.

The **scope area-id** parameter displays detailed information about the LSAs for a specified area, AS, or link.

TABLE 72 show ipv6 ospf database output descriptions

This field	Displays
Area ID	The OSPF area in which the device resides.
Type	Type of LSA. LSA types can be the following: <ul style="list-style-type: none"> Rtr - Router LSAs (Type 1). Net - Network LSAs (Type 2). Inap - Inter-area prefix LSAs for ABRs (Type 3). Inar - Inter-area router LSAs for ASBRs (Type 4). Extn - AS external LSAs (Type 5). Link - Link LSAs (Type 8). Iap - Intra-area prefix LSAs (Type 9).
LS ID	The ID of LSA in Decimal.
Adv Rtr	The device that advertised the route.
Seq(Hex)	The sequence number of the LSA. The OSPF neighbor that sent the LSA stamps it with a sequence number to enable the device and other OSPF routers to determine which LSA for a given route is the most recent.
Age	The age of the LSA, in seconds.
Chksum	A checksum for the LSA packet. The checksum is based on all the fields in the packet except the age field. The device uses the checksum to verify that the packet is not corrupted.
Len	The length, in bytes, of the LSA.
Sync	Sync status with the slave management processor (MP).

To display the **show ipv6 ospf database advr** command output, enter the following command at any CLI level.

```
device# show ipv6 ospf database advr 192.168.98.111
LSA Key - Rtr:Router Net:Network Inap:InterPrefix Inar:InterRouter
          Extn:ASEExternal Grp:GroupMembership Typ7:Type7 Link:Link
          Iap:IntraPrefix Grc:Grace
Area ID      Type LSID      Adv Rtr      Seq(Hex) Age   Cksum Len   Sync
0.0.0.200    Link 136     192.168.98.111 80000007 634   fb0b   64   Yes
      Router Priority: 1
      Options: V6E---R--
      LinkLocal Address: fe80::768e:f8ff:fe3e:1800
      Number of Prefix: 1
      Prefix Options:
      Prefix: 5100::193:213:111:0/112
```

To display the **show ipv6 ospf database as-external** command output, enter the following command at any CLI level.

```
device# show ipv6 ospf database as-external
LSA Key - Rtr:Router Net:Network Inap:InterPrefix Inar:InterRouter
          Extn:ASEExternal Grp:GroupMembership Typ7:Type7 Link:Link
          Iap:IntraPrefix Grc:Grace
Area ID      Type LSID      Adv Rtr      Seq(Hex) Age   Cksum Len   Sync
N/A         Extn 2       192.168.98.213 80000004 895   6e5e   44   Yes
      Bits: E--
      Metric: 0
      Prefix Options:
      Referenced LSType: 0
      Prefix: 5100:213:213:0:192:213:1:0/112
LSA Key - Rtr:Router Net:Network Inap:InterPrefix Inar:InterRouter
          Extn:ASEExternal Grp:GroupMembership Typ7:Type7 Link:Link
```

```

Iap:IntraPrefix Grc:Grace
Area ID      Type LSID      Adv Rtr      Seq(Hex) Age  Cksum Len  Sync
N/A          Extn 1        192.168.98.190 80001394 643  1cc9   28   Yes
  Bits: E--
  Metric: 1
  Prefix Options:
  Referenced LSType: 0
  Prefix: ::/0
LSA Key - Rtr:Router Net:Network Inap:InterPrefix Inar:InterRouter
  Extn:ASExternal Grp:GroupMembership Typ7:Type7 Link:Link
  Iap:IntraPrefix Grc:Grace
Area ID      Type LSID      Adv Rtr      Seq(Hex) Age  Cksum Len  Sync
N/A          Extn 2        192.168.98.71 80000258 132  a3ff   32   Yes
  Bits: E-T
  Metric: 1
  Prefix Options:
  Referenced LSType: 0
  Prefix: ::/0
  Tag: 1

```

To display detailed information about all LSAs in the database, enter the following command at any CLI level.

```

device# show ipv6 ospf database extensive
LSA Key - Rtr:Router Net:Network Inap:InterPrefix Inar:InterRouter
  Extn:ASExternal Grp:GroupMembership Typ7:Type7 Link:Link
  Iap:IntraPrefix Grc:Grace
Area ID      Type LS ID      Adv Rtr      Seq(Hex) Age  Cksum Len  Sync
0.0.0.200    Link 897     192.168.98.213 80000007 1432 9044 64   Yes
  Router Priority: 1
  Options: V6E---R--
  LinkLocal Address: fe80::214:ff:fe77:96ff
  Number of Prefix: 1
  Prefix Options:
  Prefix: 5100::193:213:111:0/112
LSA Key - Rtr:Router Net:Network Inap:InterPrefix Inar:InterRouter
  Extn:ASExternal Grp:GroupMembership Typ7:Type7 Link:Link
  Iap:IntraPrefix Grc:Grace
Area ID      Type LSID      Adv Rtr      Seq(Hex) Age  Cksum Len  Sync
0.0.0.200    Link 136     192.168.98.111 80000007 737  fb0b   64   Yes
  Router Priority: 1
  Options: V6E---R--
  LinkLocal Address: fe80::768e:f8ff:fe3e:1800
--More--, next page: Space, next line: Return key, quit: Control-c

```

NOTE

Portions of this display are truncated for brevity. The purpose of this display is to show all possible fields that might display rather than to show complete output.

The fields that display depend upon the LSA type as shown in the following.

TABLE 73 OSPFv3 detailed database information fields

This field	Displays
Router LSA (Type 1) (Rtr) Fields	
Capability Bits	A bit that indicates the capability of the device. The bit can be set to one of the following: B - The device is an area border router. E - The device is an AS boundary router. V - The device is a virtual link endpoint. W - The device is a wildcard multicast receiver.
Options	A 24-bit field that enables IPv6 OSPF routers to support the optional capabilities. When set, the following bits indicate the following: V6 - The device should be included in IPv6 routing calculations.

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Displaying OSPFv3 information

TABLE 73 OSPFv3 detailed database information fields (continued)

This field	Displays
	E - The device floods AS-external-LSAs as described in RFC 2740. MC - The device forwards multicast packets as described in RFC 1586. N - The device handles type 7 LSAs as described in RFC 1584. R - The originator is an active router. DC -The device handles demand circuits.
Type	The type of interface. Possible types can be the following: Point-to-point - A point-to-point connection to another router. Transit - A connection to a transit network. Virtual link - A connection to a virtual link.
Metric	The cost of using this router interface for outbound traffic.
Interface ID	The ID assigned to the router interface.
Neighbor Interface ID	The interface ID that the neighboring router has been advertising in hello packets sent on the attached link.
Neighbor Router ID	The router ID (IPv4 address) of the neighboring router that advertised the route. (By default, the router ID is the IPv4 address configured on the lowest numbered loopback interface. If the device does not have a loopback interface, the default router ID is the lowest numbered IPv4 address configured on the device.)
Network LSA (Type 2) (Net) Fields	
Options	A 24-bit field that enables IPv6 OSPF routers to support the optional capabilities. When set, the following bits indicate the following: V6 - The device should be included in IPv6 routing calculations. E - The device floods AS-external-LSAs as described in RFC 2740. MC - The device forwards multicast packets as described in RFC 1586. N - The device handles type 7 LSAs as described in RFC 1584. R - The originator is an active router. DC -The device handles demand circuits.
Attached Router	The address of the neighboring router that advertised the route.
Inter-Area Prefix LSA (Type 3) (Inap) Fields	
Metric	The cost of the route.
Prefix Options	An 8-bit field describing various capabilities associated with the prefix.
Prefix	The IPv6 prefix included in the LSA.
Inter-Area Router LSA (Type 4) (Inar) Fields	
Options	A 24-bit field that enables IPv6 OSPF routers to support the optional capabilities. When set, the following bits indicate the following: V6 - The device should be included in IPv6 routing calculations. E - The device floods AS-external-LSAs as described in RFC 2740. MC - The device forwards multicast packets as described in RFC 1586. N - The device handles type 7 LSAs as described in RFC 1584. R - The originator is an active router. DC -The device handles demand circuits.
Metric	The cost of the route.

TABLE 73 OSPFv3 detailed database information fields (continued)

This field	Displays
Destination Router ID	The ID of the router described in the LSA.
AS External LSA (Type 5) (Extn) Fields	
Bits	The bit can be set to one of the following: <ul style="list-style-type: none"> • E - If bit E is set, a Type 2 external metric. If bit E is zero, a Type 1 external metric. • F - A forwarding address is included in the LSA. • T - An external route tag is included in the LSA.
Metric	The cost of this route, which depends on bit E.
Prefix Options	An 8-bit field describing various capabilities associated with the prefix.
Referenced LS Type	If non-zero, an LSA with this LS type is associated with the LSA.
Prefix	The IPv6 prefix included in the LSA.
Link LSA (Type 8) (Link) Fields	
Router Priority	The router priority of the interface attaching the originating router to the link.
Options	The set of options bits that the router would like set in the network LSA that will be originated for the link.
Link Local Address	The originating router's link-local interface address on the link.
Number of Prefix	The number of IPv6 address prefixes contained in the LSA.
Prefix Options	An 8-bit field of capabilities that serve as input to various routing calculations: <ul style="list-style-type: none"> • NU - The prefix is excluded from IPv6 unicast calculations. • LA - The prefix is an IPv6 interface address of the advertising router. • MC - The prefix is included in IPv6 multicast routing calculations. • P - NSSA area prefixes are readvertised at the NSSA area border.
Prefix	The IPv6 prefix included in the LSA.
Intra-Area Prefix LSAs (Type 9) (lap) Fields	
Number of Prefix	The number of prefixes included in the LSA.
Referenced LS Type, Referenced LS ID	Identifies the router-LSA or network-LSA with which the IPv6 address prefixes are associated.
Referenced Advertising Router	The address of the neighboring router that advertised the route.
Prefix Options	An 8-bit field describing various capabilities associated with the prefix.
Metric	The cost of using the advertised prefix.
Prefix	The IPv6 prefix included in the LSA.
Number of Prefix	The number of prefixes included in the LSA.

Displaying IPv6 interface information

You can use the following command to display a summary of IPv6 Interface information.

```
device# show ipv6 interface
Type Codes - I:ISIS O:OSPF R:RIP
Interface  Stat/Prot IGPs IPv6 Address           VRF
eth 1/3/20   up/up      fe80::2c0:12ff:fe34:5073  default-vrf
              2001:db8:1000::1/64
              2001:db8:1000::/64 [Anycast]
```

Syntax: **show ipv6 interface [ethernet unit/slot/port | loopback number | tunnel number | ve number]**

The **ethernet**, **loopback**, **tunnel**, and **ve** parameters specify the interface for which to display information.

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If you specify an Ethernet interface, also specify the unit, slot and port numbers associated with the interface. If you specify a loopback, tunnel, or VE interface, also specify the number associated with the interface.

TABLE 74 show ipv6 interface output descriptions

Field	Description
Type Codes	Shows the routing protocol enabled on the interface. The routing protocol can be one of the following: <ul style="list-style-type: none"> • R - RIP • O - OSPF
Interface	Shows the type, unit, slot, and port number of the interface.
Stat/Port	Shows the status of the link and the protocol for the interface. The status can be one of the following: <ul style="list-style-type: none"> • Up • Down
IGPs	Shows the type of the Interior Gateway Protocols (IGPs) enabled on the interface.
IPv6 Address	Shows the link local IPv6 address configured for the interface.
VRF	Specifies the VRF to which the interface belongs.

Displaying IPv6 OSPFv3 interface information

IPv6 Interface information can be displayed in either a brief or full mode. The following sections describe the command to display these modes and the resulting output:

- Displaying IPv6 OSPFv3 Interface Information in Brief Mode
- Displaying IPv6 OSPFv3 Interface Information in Full Mode

Displaying IPv6 OSPFv3 interface information in brief mode

You can use the following command to display a summary of IPv6 Interface information.

```
device# show ipv6 ospf interface brief
Interface  Area      Status   Type Cost  State      Nbrs (F/C)
eth 1/1/1    0        up      BCST  1     DROther   1/1
loopback 1  0        up      BCST  1     Loopback  0/0
```

Syntax: **show ipv6 ospf interface brief**

TABLE 75 show ipv6 ospf interface brief output descriptions

This field	Displays
Number of Interfaces	Number of OSPFv3-enabled interfaces.
Interface	The interface type, and the unit, slot, and port number or number of the interface.
Area	The OSPF area configured on the interface.
Status	The status of the link and the protocol. Possible status include the following: <ul style="list-style-type: none"> • Up. • Down.
Type	The type of OSPFv3 circuit running on the interface. Possible types include the following: <ul style="list-style-type: none"> • BCST- Broadcast interface type

TABLE 75 show ipv6 ospf interface brief output descriptions (continued)

This field	Displays
	<ul style="list-style-type: none"> • P2P- Point-to-point interface type • UNK- The interface type is not known at this time
Cost	The overhead required to send a packet across an interface.
State	<p>The state of the interface. Possible states include the following:</p> <ul style="list-style-type: none"> • DR - The interface is functioning as the Designated Router for OSPFv3. • BDR - The interface is functioning as the Backup Designated Router for OSPFv3. • Loopback - The interface is functioning as a loopback interface. • P2P - The interface is functioning as a point-to-point interface. • Passive - The interface is up but it does not take part in forming an adjacency. • Waiting - The interface is trying to determine the identity of the BDR for the network. • None - The interface does not take part in the OSPF interface state machine. • Down - The interface is unusable. No protocol traffic can be sent or received on such a interface. • DR other - The interface is a broadcast or NBMA network on which another router is selected to be the DR.
Nbrs (F/C)	The number of adjacent neighbor routers. The number to the left of the "/" are the neighbor routers that are fully adjacent and the number to the right represents all adjacent neighbor routers.

Displaying IPv6 OSPFv3 interface information in full mode

You can display detailed information about all OSPFv3 interfaces by using the **show ipv6 ospf interface** command, as the following truncated example illustrates.

```
device# show ipv6 ospf interface
e 2/3/1 admin down, oper down, IPv6 enabled
  IPv6 Address:
    Area ID 0.0.0.200, Cost 1, Type BROADCAST
    MTU: 10178
    State DOWN, Transmit Delay 1 sec, Priority 1
    Timer intervals :
      Hello 10, Hello Jitter 10  Dead 40, Retransmit 5
e 4/3/1 admin up, oper up, IPv6 enabled
  IPv6 Address:
    fe80::214:ff:fe77:96ff
    5100::193:213:111:213/112
    5100::193:213:111:0/112
  Instance ID 0, Router ID 192.168.98.213
  Area ID 0.0.0.200, Cost 1, Type BROADCAST
  MTU: 10178
  State BDR, Transmit Delay 1 sec, Priority 1, Link-LSA Tx not suppressed
  Timer intervals :
    Hello 10, Hello Jitter 10  Dead 40, Retransmit 5
  Authentication Use: Enabled
  KeyRolloverTime(sec): Configured: 300 Current: 0
  KeyRolloverState: NotActive
  Outbound: None
  Inbound: None
  DR:192.168.98.111 BDR:192.168.98.213 Number of I/F scoped LSAs is 2
  DRElection: 1 times, DelayedLSAck: 23 times
```

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```
Neighbor Count = 1,   Adjacent Neighbor Count= 1
  Neighbor:
    192.168.98.111 (DR)
  Statistics of interface e 4/3/1:
    Type      tx        rx        tx-byte      rx-byte
  Unknown    0         0         0           0
  Hello     739       738      29556      29520
  DbDesc     2         2         236        2536
  LSReq      1         1         1444       88
  LSUpdate   344       258      71464      23256
  LSAck      30        291      6780       11396
  OSPF messages dropped,no authentication: 0
ve 17 admin up, oper up, IPv6 enabled
  IPv6 Address:
    fe80::214:ff:fe77:96ff
    5100::192:213:111:213/112
    5100::192:213:111:0/112
Instance ID 0, Router ID 192.168.98.213
Area ID 0.0.0.200, Cost 1, Type BROADCAST
MTU: 10178
State BDR, Transmit Delay 1 sec, Priority 1, Link-LSA Tx not suppressed
Timer intervals :
  Hello 10, Hello Jitter 10  Dead 40, Retransmit 5
Authentication Use: Enabled
  KeyRolloverTime(sec): Configured: 300 Current: 0
  KeyRolloverState: NotActive
  Outbound: None
  Inbound: None
DR:192.168.98.111 BDR:192.168.98.213 Number of I/F scoped LSAs is 2
DRElection: 1 times, DelayedLSAck: 7 times
Neighbor Count = 1,   Adjacent Neighbor Count= 1
  Neighbor:
    192.168.98.111 (DR)
  Statistics of interface ve 17 :
    Type      tx        rx        tx-byte      rx-byte
```

You can display detailed OSPFv3 information about a specific interface using the following command at any level of the CLI.

Syntax: **show ipv6 ospf interface [brief] [ethernet unit/slot/port] [loopback number] [tunnel number] [ve number]**

The **ethernet**, **loopback**, **tunnel**, and **ve** parameter specify the interface for which to display information. If you specify an Ethernet interface, also specify the port number associated with the interface. If you specify a loopback, tunnel, or VE interface, also specify the number associated with the interface.

TABLE 76 show ipv6 ospf interface output descriptions

This field	Displays
Interface status	The status of the interface. Possible status includes the following: <ul style="list-style-type: none">• Up.• Down.
Type	The type of OSPFv3 circuit running on the interface. Possible types include the following: <ul style="list-style-type: none">• BROADCAST• POINT TO POINT UNKNOWN• POINT TO POINT
IPv6 Address	The IPv6 address assigned to the interface.
Instance ID	An identifier for an instance of OSPFv3.
Router ID	The IPv4 address of the device. By default, the router ID is the IPv4 address configured on the lowest numbered loopback interface. If the device does not have a loopback interface, the default router ID is the lowest numbered IPv4 address configured on the device.
Area ID	The IPv4 address or numerical value of the area in which the interface belongs.

TABLE 76 show ipv6 ospf interface output descriptions (continued)

This field	Displays
Cost	The overhead required to send a packet through the interface.
default	Shows whether or not the default passive state is set.
State	<p>The state of the interface. Possible states include the following:</p> <ul style="list-style-type: none"> • DR - The interface is functioning as the Designated Router for OSPFv3. • BDR - The interface is functioning as the Backup Designated Router for OSPFv3. • Loopback - The interface is functioning as a loopback interface. • P2P - The interface is functioning as a point-to-point interface. • Passive - The interface is up but it does not take part in forming an adjacency. • Waiting - The interface is trying to determine the identity of the BDR for the network. • None - The interface does not take part in the OSPF interface state machine. • Down - The interface is unusable. No protocol traffic can be sent or received on such a interface. • DR other - The interface is a broadcast or NBMA network on which another router is selected to be the DR. • Active - The interface sends or receives all the OSPFv3 control packets, and forms the adjacency.
Transmit delay	The amount of time, in seconds, it takes to transmit Link State Updates packets on the interface.
Priority	The priority used when selecting the DR and the BDR. If the priority is 0, the interface does not participate in the DR and BDR election.
Timer intervals	The interval, in seconds, of the hello-interval, dead-interval, and retransmit-interval timers.
DR	The router ID (IPv4 address) of the DR.
BDR	The router ID (IPv4 address) of the BDR.
Number of I/F scoped LSAs	The number of interface LSAs scoped for a specified area, AS, or link.
DR Election	The number of times the DR election occurred.
Delayed LSA Ack	The number of the times the interface sent a delayed LSA acknowledgement.
Neighbor Count	The number of neighbors to which the interface is connected.
Adjacent Neighbor Count	The number of neighbors with which the interface has formed an active adjacency.
Neighbor	The router ID (IPv4 address) of the neighbor. This field also identifies the neighbor as a DR or BDR, if appropriate.
Interface statistics	<p>The following statistics are provided for the interface:</p> <ul style="list-style-type: none"> • Unknown - The number of Unknown packets transmitted and received by the interface. Also, the total number of bytes associated with transmitted and received Unknown packets. • Hello - The number of Hello packets transmitted and received by the interface. Also, the total number of bytes associated with transmitted and received Hello packets.

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TABLE 76 show ipv6 ospf interface output descriptions (continued)

This field	Displays
	<ul style="list-style-type: none"> • DbDesc - The number of Database Description packets transmitted and received by the interface. Also, the total number of bytes associated with transmitted and received Database Description packets. • LSReq - The number of link-state requests transmitted and received by the interface. Also, the total number of bytes associated with transmitted and received link-state requests. • LSUpdate - The number of link-state updates transmitted and received by the interface. Also, the total number of bytes associated with transmitted and received link-state requests. • LSAck - The number of link-state acknowledgements transmitted and received by the interface. Also, the total number of bytes associated with transmitted and received link-state acknowledgements.

Displaying OSPFv3 memory usage

To display information about OSPFv3 memory usage, enter the following command at any level of the CLI.

```
device# show ipv6 ospf memory
Total Dynamic Memory Allocated for this instance : 4296579 bytes
Memory Type          Size      Allocated  Max-alloc Alloc-Fails
MTYPE_OSPF6_AREA    471191    1          4          0
MTYPE_OSPF6_AREA_RANGE 29        0          16         0
MTYPE_OSPF6_SUMMARY_ADDRE 25        0          16         0
MTYPE_OSPF6_IF       280       1          64         0
MTYPE_OSPF6_NEIGHBOR 12502     1          32         0
MTYPE_OSPF6_ROUTE_NODE 21        1          4096       0
MTYPE_OSPF6_ROUTE_INFO 35        1          4096       0
MTYPE_OSPF6_PREFIX    20        0          16         0
MTYPE_OSPF6_LSA       129       3          4096       0
MTYPE_OSPF6_VERTEX    166       1          64         0
MTYPE_OSPF6_SPFTREE   44        1          2          0
MTYPE_OSPF6_NEXTHOP   28        2          256        0
MTYPE_OSPF6_EXTERNAL_INFO 40        0          4096       0
MTYPE_THREAD          32        5          1024       0
MTYPE_OSPF6_LINK_LIST 20        3098      20480      0
MTYPE_OSPF6_LINK_NODE 12        19         20480      0
MTYPE_OSPF6_LSA_RETRANSMI 6          3          8192       0
global memory pool for all instances
Memory Type          Size      Allocated  Max-alloc Alloc-Fails
MTYPE_OSPF6_TOP       61475     1          1          0
MTYPE_OSPF6_LSA_HDR   56        3          4          0
MTYPE_OSPF6_RMAP_COMPILED 0          0          0          0
MTYPE_OSPF6_OTHER     0          0          0          0
MTYPE_THREAD_MASTER   84        1          1          0
```

Syntax: show ipv6 ospf memory

TABLE 77 show ipv6 ospf memory output descriptions

This field	Displays
Total Dynamic Memory Allocated	A summary of the amount of dynamic memory allocated, in bytes, to OSPFv3.
Memory Type	The type of memory used by OSPFv3. (This information is for use by Ruckus technical support in case of a problem.)
Size	The size of a memory type.

TABLE 77 show ipv6 ospf memory output descriptions (continued)

This field	Displays
Allocated	The amount of memory currently allocated to a memory type.
Max-alloc	The maximum amount of memory that was allocated to a memory type.
Alloc-Fails	The number of times an attempt to allocate memory to a memory type failed.
Global memory pool for all instances	A summary of the amount of memory allocated from heap.

Displaying OSPFv3 neighbor information

You can display a summary of OSPFv3 neighbor information for the device or detailed information about a specified neighbor.

To display a summary of OSPFv3 neighbor information for the device, enter the following command at any CLI level.

```
device# show ipv6 ospf neighbor
Total number of neighbors in all states: 2
Number of neighbors in state Full : 2
RouterID      Pri State      DR          BDR          Interface [State]
192.168.98.111    1 Full       192.168.98.111  192.168.98.213  e 4/3/1      [BDR]
192.168.98.111    1 Full       192.168.98.111  192.168.98.213  ve 17        [BDR]
```

Syntax: **show ipv6 ospf neighbor [router-id *ipv4-address*]**

The **router-id *ipv4-address*** parameter displays only the neighbor entries for the specified router.

TABLE 78 show ipv6 ospf neighbor output descriptions

Field	Description
Router ID	The IPv4 address of the neighbor. By default, the router ID is the IPv4 address configured on the lowest numbered loopback interface. If the device does not have a loopback interface, the default router ID is the lowest numbered IPv4 address configured on the device.
Pri	The OSPFv3 priority of the neighbor. The priority is used during election of the DR and BDR.
State	The state between the device and the neighbor. The state can be one of the following: <ul style="list-style-type: none"> • Down • Attempt • Init • 2-Way • ExStart • Exchange • Loading • Full
DR	The router ID (IPv4 address) of the DR.
BDR	The router ID (IPv4 address) of the BDR.
Interface [State]	The interface through which the router is connected to the neighbor. The state of the interface can be one of the following: <ul style="list-style-type: none"> • DR - The interface is functioning as the Designated Router for OSPFv3. • BDR - The interface is functioning as the Backup Designated Router for OSPFv3.

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Displaying OSPFv3 information

TABLE 78 show ipv6 ospf neighbor output descriptions (continued)

Field	Description
	<ul style="list-style-type: none"> • Loopback - The interface is functioning as a loopback interface. • P2P - The interface is functioning as a point-to-point interface. • Passive - The interface is up but it does not take part in forming an adjacency. • Waiting - The interface is trying to determine the identity of the BDR for the network. • None - The interface does not take part in the OSPF interface state machine. • Down - The interface is unusable. No protocol traffic can be sent or received on such an interface. • DR other - The interface is a broadcast or NBMA network on which another router is selected to be the DR.

For example, to display detailed information about a neighbor with the router ID of 10.1.1.1, enter the **show ipv6 ospf neighbor router-id** command at any CLI level.

```
device# show ipv6 ospf neighbor router-id 1192.168.98.111
RouterID      Pri State     DR          BDR          Interface      [State]
192.168.98.111  1 Full      192.168.98.111  192.168.98.213  e 4/3/1       [BDR]
    Option: 00-00-13   QCount: 0   Timer: 73
    DbDesc bit for this neighbor: --m
    Nbr Ifindex of this router: 136
    Nbr DRDecision: DR 192.168.98.111, BDR 192.168.98.213
    Last received DbDesc: opt:xxxx ifmtu:0 bit:--s seqnum:0
    Number of LSAs in DbDesc retransmitting: 0
    Number of LSAs in SummaryList: 0
    Number of LSAs in RequestList: 0
    Number of LSAs in RetransList: 0
    SeqnumMismatch      0 times, BadLSReq      0 times
    OnewayReceived      0 times, InactivityTimer 0 times
    DbDescRetrans      0 times, LSReqRetrans 0 times
    LSUpdateRetrans    11 times
    LSAReceived        379 times, LSUpdateReceived 258 times
RouterID      Pri State     DR          BDR          Interface      [State]
192.168.98.111  1 Full      192.168.98.111  192.168.98.213  ve 17       [BDR]
    Option: 00-00-13   QCount: 0   Timer: 44
    DbDesc bit for this neighbor: --m
    Nbr Ifindex of this router: 1156
    Nbr DRDecision: DR 192.168.98.111, BDR 192.168.98.213
    Last received DbDesc: opt:xxxx ifmtu:0 bit:--s seqnum:0
    Number of LSAs in DbDesc retransmitting: 0
    Number of LSAs in SummaryList: 0
    Number of LSAs in RequestList: 0
    Number of LSAs in RetransList: 0
    SeqnumMismatch      0 times, BadLSReq      0 times
    OnewayReceived      0 times, InactivityTimer 0 times
    DbDescRetrans      0 times, LSReqRetrans 0 times
    LSUpdateRetrans    3 times
    LSAReceived        317 times, LSUpdateReceived 262 times
```

TABLE 79 show ipv6 ospf neighbor router-id output descriptions

Field	Description
Router ID	The IPv4 address of the neighbor. By default, the router ID is the IPv4 address configured on the lowest numbered loopback interface. If the device does not have a loopback interface, the default router ID is the lowest numbered IPv4 address configured on the device.

TABLE 79 show ipv6 ospf neighbor router-id output descriptions (continued)

Field	Description
Pri	The OSPFv3 priority of the neighbor. The priority is used during election of the DR and BDR.
State	The state between the device and the neighbor. The state can be one of the following: <ul style="list-style-type: none"> • Down • Attempt • Init • 2-Way • ExStart • Exchange • Loading • Full
DR	The router ID (IPv4 address) of the DR.
BDR	The router ID (IPv4 address) of the BDR.
Interface [State]	The interface through which the router is connected to the neighbor. The state of the interface can be one of the following: <ul style="list-style-type: none"> • DR - The interface is functioning as the Designated Router for OSPFv3. • BDR - The interface is functioning as the Backup Designated Router for OSPFv3. • Loopback - The interface is functioning as a loopback interface. • P2P - The interface is functioning as a point-to-point interface. • Passive - The interface is up but it does not take part in forming an adjacency. • Waiting - The interface is trying to determine the identity of the BDR for the network. • None - The interface does not take part in the OSPF interface state machine. • Down - The interface is unusable. No protocol traffic can be sent or received on such a interface. • DR other - The interface is a broadcast or NBMA network on which another router is selected to be the DR.
DbDesc bit	The Database Description packet, which includes 3 bits of information: <ul style="list-style-type: none"> • The first bit can be "i" or "-". "i" indicates the inet bit is set. "-" indicates the inet bit is not set. • The second bit can be "m" or "-". "m" indicates the more bit is set. "-" indicates the more bit is not set. • The third bit can be "m" or "s". An "m" indicates the master. An "s" indicates standby.
Index	The ID of the LSA from which the neighbor learned of the router.
DR Decision	The router ID (IPv4 address) of the neighbor's elected DR and BDR.
Last Received Db Desc	The content of the last database description received from the specified neighbor.
Number of LSAs in Db Desc retransmitting	The number of LSAs that need to be retransmitted to the specified neighbor.
Number of LSAs in Summary List	The number of LSAs in the neighbor's summary list.

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Displaying OSPFv3 information

TABLE 79 show ipv6 ospf neighbor router-id output descriptions (continued)

Field	Description
Number of LSAs in Request List	The number of LSAs in the neighbor's request list.
Number of LSAs in Retransmit List	The number of LSAs in the neighbor's retransmit list.
Seqnum Mismatch	The number of times sequence number mismatches occurred.
BadLSReq	The number of times the neighbor received a bad link-state request from the device.
One way received	The number of times a hello packet, which does not mention the router, is received from the neighbor. This omission in the hello packet indicates that the communication with the neighbor is not bidirectional.
Inactivity Timer	The number of times that the neighbor's inactivity timer expired.
Db Desc Retransmission	The number of times sequence number mismatches occurred.
LSReqRetrans	The number of times the neighbor retransmitted link-state requests to the device.
LSUpdateRetrans	The number of times the neighbor retransmitted link-state updates to the device.
LSA Received	The number of times the neighbor received LSAs from the device.
LS Update Received	The number of times the neighbor received link-state updates from the device.

Displaying routes redistributed into OSPFv3

You can display all IPv6 routes or a specified IPv6 route that the device has redistributed into OSPFv3.

To display all IPv6 routes that the device has redistributed into OSPFv3, enter the following command at any level of the CLI.

```
device# show ipv6 ospf redistribute route
Id      Prefix          Protocol Metric Type Metric
1      5100::192:213:163:0/112  Connect   Type-2    0
2      5100:213:213:0:192:213:1:0/112  Connect   Type-2    0
```

Syntax: show ipv6 ospf redistribute route [ipv6-prefix]

The *ipv6-prefix* parameter specifies an IPv6 network prefix. (You do not need to specify the length of the prefix.)

For example, to display redistribution information for the prefix 2001:db8::, enter the following command at any level of the CLI.

```
device# show ipv6 ospf redistribute route 2001:db8::
Id      Prefix          Protocol Metric Type Metric
1      2001:db8::/32     Static    Type-2    1
```

TABLE 80 show ipv6 ospf redistribute route output descriptions

This field	Displays
ID	An ID for the redistributed route.
Prefix	The IPv6 routes redistributed into OSPFv3.
Protocol	The protocol from which the route is redistributed into OSPFv3. Redistributed protocols can be the following: <ul style="list-style-type: none"> • BGP - BGP4+. • RIP - RIPng. • Static - IPv6 static route table. • Connected - A directly connected network.

TABLE 80 show ipv6 ospf redistribute route output descriptions (continued)

This field	Displays
Metric Type	The metric type used for routes redistributed into OSPFv3. The metric type can be the following: <ul style="list-style-type: none"> • Type-1 - Specifies a small metric (2 bytes). • Type-2 - Specifies a big metric (3 bytes).
Metric	The value of the default redistribution metric, which is the OSPF cost of redistributing the route into OSPFv3.

Displaying OSPFv3 route information

You can display the entire OSPFv3 route table for the device or only the route entries for a specified destination.

To display the entire OSPFv3 route table for the device, enter the following command at any level of the CLI.

```
device# show ipv6 ospf route
Current Route count: 309
  Intra: 304 Inter: 4 External: 1 (Type1 0/Type2 1)
  Equal-cost multi-path: 56
  OSPF Type: IA- Intra, OA - Inter, E1 - External Type1, E2 - External Type2
  Destination          Cost      E2Cost      Tag      Flags      Dis
E2 ::/0                2          1          0          00000003 110
  Next_Hop_Router
    fe80::768e:f8ff:fe3e:1800
    fe80::768e:f8ff:fe3e:1800
  Destination          Cost      E2Cost      Tag      Flags      Dis
IA 5100::192:61:1001:0/112 3          0          0          00000007 110
  Next_Hop_Router
    fe80::768e:f8ff:fe3e:1800
    fe80::768e:f8ff:fe3e:1800
  Destination          Cost      E2Cost      Tag      Flags      Dis
IA 5100::192:111:2:111/128 1          0          0          00000007 110
  Next_Hop_Router
    fe80::768e:f8ff:fe3e:1800
    fe80::768e:f8ff:fe3e:1800
  Destination          Cost      E2Cost      Tag      Flags      Dis
IA 5100::192:111:3:111/128 1          0          0          00000007 110
  Next_Hop_Router
    fe80::768e:f8ff:fe3e:1800
--More--, next page: Space, next line: Return key, quit: Control-c
```

Syntax: show ipv6 ospf routes [ipv6-prefix]

The *ipv6-prefix* parameter specifies a destination IPv6 prefix. (You do not need to specify the length of the prefix.) If you use this parameter, only the route entries for this destination are shown.

For example, to display route information for the destination prefix 2000::, enter the following command at any level of the CLI.

```
device# show ipv6 ospf routes 5100::192:111:42:111
Destination          Cost      E2Cost      Tag      Flags      Dis
IA 5100::192:111:42:111/128 1          0          0          00000007 110
  Next_Hop_Router
    fe80::768e:f8ff:fe3e:1800
    fe80::768e:f8ff:fe3e:1800
```

TABLE 81 OSPFv3 route information

This field	Displays
Current Route Count (Displays with the entire OSPFv3 route table only)	The number of route entries currently in the OSPFv3 route table.

OSPFv3

Displaying OSPFv3 information

TABLE 81 OSPFv3 route information (continued)

This field	Displays
Intra/Inter/External (Type1/Type2) (Displays with the entire OSPFv3 route table only)	The breakdown of the current route entries into the following route types: <ul style="list-style-type: none"> • Inter - The number of routes that pass into another area. • Intra - The number of routes that are within the local area. • External1 - The number of type 1 external routes. • External2 - The number of type 2 external routes.
Equal-cost multi-path (Displays with the entire OSPFv3 route table only)	The number of equal-cost routes to the same destination in the OSPFv3 route table. If load sharing is enabled, the device equally distributes traffic among the routes.
Destination	The IPv6 prefixes of destination networks to which the device can forward IPv6 packets. "*IA" indicates the next router is an intra-area router.
Cost	The type 1 cost of this route.
E2 Cost	The type 2 cost of this route.
Tag	The route tag for this route.
Flags	Flags associated with this route.
Dis	Administrative Distance for this route.
Next-Hop Router	The IPv6 address of the next router a packet must traverse to reach a destination.
Outgoing Interface	The router interface through which a packet must traverse to reach the next-hop router.
Adv_Router	The IP address of the advertising router.

Displaying OSPFv3 SPF information

You can display the following OSPFv3 SPF information:

- SPF node information
- SPF node information for a specified area.
- SPF table for a specified area.
- SPF tree for a specified area.

Enter the command at any level of the CLI to display SPF information in a node.

```
device# show ipv6 ospf spf node
SPF node for Area 0.0.0.200
SPF node 192.168.98.213, cost: 0, hops: 0
nexthops to node:
parent nodes:
child nodes: 192.168.98.111:136 192.168.98.111:1156
SPF node 192.168.98.111:136, cost: 1, hops: 1
nexthops to node: :: e 4/3/1
parent nodes: 192.168.98.213
child nodes: 192.168.98.111:0
SPF node 192.168.98.111:1156, cost: 1, hops: 1
nexthops to node: :: ve 17
parent nodes: 192.168.98.213
child nodes: 192.168.98.111:0
SPF node 192.168.98.111:0, cost: 1, hops: 2
nexthops to node: fe80::768e:f8ff:fe3e:1800 e 4/3/1
fe80::768e:f8ff:fe3e:1800 ve 17
parent nodes: 192.168.98.111:136 192.168.98.111:1156
child nodes:
SPF node for Area 400
```

```

SPF node 192.168.98.213, cost: 0, hops: 0
nexthops to node:
parent nodes:
child nodes:
SPF node for Area 0.0.0.0
SPF node 192.168.98.213, cost: 0, hops: 0
nexthops to node:
parent nodes:
child nodes: 192.168.98.111:0
SPF node 192.168.98.111:0, cost: 1, hops: 1
nexthops to node: 5100::192:113:111:111 VLink 1
parent nodes: 192.168.98.213
child nodes: 192.168.98.61:5 192.168.98.190:1551 192.168.98.112:643
SPF node 192.168.98.61:5, cost: 2, hops: 2
nexthops to node: 5100::192:113:111:111 VLink 1
parent nodes: 192.168.98.111:0
child nodes: 192.168.98.61:0
SPF node 192.168.98.190:1551, cost: 2, hops: 2
nexthops to node: 5100::192:113:111:111 VLink 1
--More--, next page: Space, next line: Return key,

```

For example, to display information about SPF nodes in area 0, enter the **show ipv6 ospf spf node area** command at any level of the CLI.

```

device# show ipv6 ospf spf node area 0
SPF node for Area 0
SPF node 10.223.223.223, cost: 0, hops: 0
nexthops to node:
parent nodes:
child nodes: 10.223.223.223:88
SPF node 10.223.223.223:88, cost: 1, hops: 1
nexthops to node: :: ethe 1/3/2
parent nodes: 10.223.223.223
child nodes: 10.1.1.1:0
SPF node 10.1.1.1:0, cost: 1, hops: 2
nexthops to node: fe80::2e0:52ff:fe91:bb37 ethe 1/3/2
parent nodes: 10.223.223.223:88
child nodes:

```

Syntax: **show ipv6 ospf spf node area [area-id]**

The **node** keyword displays SPF node information.

The **area area-id** parameter specifies a particular area. You can specify the *area-id* in the following formats:

- As an IPv4 address; for example, 192.168.1.1.
- As a numerical value from 0 through 2,147,483,647.

TABLE 82 show ipv6 ospf spf node area output descriptions

This field	Displays
SPF node	Each SPF node is identified by its device ID (IPv4 address). If the node is a child node, it is additionally identified by an interface on which the node can be reached appended to the router ID in the format <i>router-id :interface-id</i> .
Cost	The cost of traversing the SPF node to reach the destination.
Hops	The number of hops needed to reach the parent SPF node.
Next Hops to Node	The IPv6 address of the next hop-router or the router interface through which to access the next-hop router.
Parent Nodes	The SPF node's parent nodes. A parent node is an SPF node at the highest level of the SPF tree, which is identified by its router ID.
Child Nodes	The SPF node's child nodes. A child node is an SPF node at a lower level of the SPF tree, which is identified by its router ID and interface on which the node can be reached.

OSPFv3

Displaying OSPFv3 information

For example, to display the SPF table for area 0, enter the following command at any level of the CLI.

```
device# show ipv6 ospf spf table area 0
SPF table for Area 0.0.0.200
  Destination      Bits Options  Cost   Nexthop           Interface
R 192.168.98.111  --V-B V6E---R-  1    fe80::768e:f8ff:fe3e:1800 e 4/3/1
R 192.168.98.111  --V-B V6E---R-  1    fe80::768e:f8ff:fe3e:1800 ve 17
N 192.168.98.111[136] ----- V6E---R-  1    ::                         e 4/3/1
N 192.168.98.111[1156] ----- V6E---R-  1    ::                         ve 17
SPF table for Area 400
  Destination      Bits Options  Cost   Nexthop           Interface
SPF table for Area 0.0.0.0
  Destination      Bits Options  Cost   Nexthop           Interface
R 192.168.98.71   ---E- V6E---RD  4    fe80::768e:f8ff:fe3e:1800 e 4/3/1
R 192.168.98.71   ---E- V6E---RD  4    fe80::768e:f8ff:fe3e:1800 ve 17
R 192.168.98.190  ---E- V6E---R-  2    fe80::768e:f8ff:fe3e:1800 e 4/3/1
R 192.168.98.190  ---E- V6E---R-  2    fe80::768e:f8ff:fe3e:1800 ve 17
```

Syntax: **show ipv6 ospf spf table area *area-id***

The **table** parameter displays the SPF table.

The **area *area-id*** parameter specifies a particular area. You can specify the *area-id* in the following formats:

- As an IPv4 address, for example, 192.168.1.1.
- As a numerical value from 0 through 2,147,483,647.

TABLE 83 **show ipv6 ospf spf table area output descriptions**

This field	Displays
Destination	The destination of a route, which is identified by the following: <ul style="list-style-type: none">• "R", which indicates the destination is a router. "N", which indicates the destination is a network.• An SPF node's device ID (IPv4 address). If the node is a child node, it is additionally identified by an interface on which the node can be reached appended to the router ID in the format <i>router-id :interface-id</i> .
Bits	A bit that indicates the capability of the device. The bit can be set to one of the following: <ul style="list-style-type: none">• B - The device is an area border router.• E - The device is an AS boundary router.• V - The device is a virtual link endpoint.• W - The device is a wildcard multicast receiver.
Options	A 24-bit field that enables IPv6 OSPF routers to support the optional capabilities. When set, the following bits indicate the following: V6 - The router should be included in IPv6 routing calculations. E - The router floods AS-external-LSAs as described in RFC 2740. MC - The router forwards multicast packets as described in RFC 1586. N - The router handles type 7 LSAs as described in RFC 1584. R - The originator is an active router. DC -The router handles demand circuits.
Cost	The cost of traversing the SPF node to reach the destination.
Next hop	The IPv6 address of the next hop-router.
Interface	The router interface through which to access the next-hop router.

For example, to display the SPF tree for area 0, enter the following command at any level of the CLI.

```
device# show ipv6 ospf spf tree area 0
  SPF tree for Area 0
  +- 10.223.223.223 cost 0
    +- 10.223.223.223:88 cost 1
      +- 10.1.1.1:0 cost 1
```

Syntax: **show ipv6 ospf spf tree area *area-id***

The **tree** keyword displays the SPF table.

The **area *area-id*** parameter specifies a particular area. You can specify the *area-id* in the following formats:

- As an IPv4 address; for example, 192.168.1.1.
- As a numerical value from 0 through 2,147,483,647.

In this sample output, consider the SPF node with the router ID 10.223.223.223 to be the top (root) of the tree and the local router. Consider all other layers of the tree (10.223.223.223:88 and 10.1.1.1:0) to be destinations in the network. Therefore, traffic destined from router 10.223.223.223 to router 10.1.1.1:0 must first traverse router 10.223.223.223:88.

Displaying OSPFv3 GR Helper mode information

Run the **show ipv6 ospf** command to display information about the graceful restart helper mode

```
device# (config-ospf6-router)#show ipv6 ospf
OSPFv3 Process number 0 with Router ID 0xa19e0eb(10.25.224.235)
  Running 0 days 0 hours 0 minutes 26 seconds
  Number of AS scoped LSAs is 0
  Sum of AS scoped LSAs Checksum is 0
  External LSA Limit is 250000
  Database Overflow Interval is 10
  Database Overflow State is NOT OVERFLOWED
  Route calculation executed 0 times
  Pending outgoing LSA count 0
  Authentication key rollover interval 300 seconds
  Number of areas in this router is 0
  High Priority Message Queue Full count: 0
  Graceful restart helper is enabled, strict lsa checking is disabled
  Nonstop-routing is ENABLED
```

Displaying OSPFv3 NSR information

Run the **show ipv6 ospf** command to display information about the NSR support.

```
device# (config-ospf6-router)#show ipv6 ospf
OSPFv3 Process number 0 with Router ID 0xa19e0eb(10.25.224.235)
  Running 0 days 0 hours 0 minutes 26 seconds
  Number of AS scoped LSAs is 0
  Sum of AS scoped LSAs Checksum is 0
  External LSA Limit is 250000
  Database Overflow Interval is 10
  Database Overflow State is NOT OVERFLOWED
  Route calculation executed 0 times
  Pending outgoing LSA count 0
  Authentication key rollover interval 300 seconds
  Number of areas in this router is 0
  High Priority Message Queue Full count: 0
  Graceful restart helper is enabled, strict lsa checking is disabled
  Nonstop-routing is ENABLED
```

OSPFv3

Displaying OSPFv3 information

Displaying IPv6 OSPF virtual link information

To display OSPFv3 virtual link information on a Ruckus device, enter the **show ipv6 ospf virtual-link** command at any level of the CLI.

```
device# show ipv6 ospf virtual-link
Transit Area ID Router ID      Interface Address          State
0.0.0.200       192.168.98.111  5100::192:213:111:213    P2P
  Timer intervals(sec) :
    Hello 10, Hello Jitter 10, Dead 40, Retransmit 5, TransmitDelay 1
  DelayedLSAck: 65 times
  Authentication: Not Configured
  Statistics:
    Type   tx      rx      tx-byte     rx-byte
    Unknown 0        0        0           0
    Hello   819     816     32760      32640
    DbDesc  10       11      300        11008
    LSReq   6        0       6492       0
    LSUpdate 1579   1161    138284     101488
    LSAck   65      52      29340      29532
    OSPF messages dropped, no authentication: 0
  Neighbor: State: Full Address: 5100::192:113:111:111 Interface: e 4/3/1
```

Syntax: **show ipv6 ospf virtual-link**

TABLE 84 **show ipv6 ospf virtual-link output descriptions**

This field	Displays
Index	An index number associated with the virtual link.
Transit Area ID	The ID of the shared area of two ABRs that serves as a connection point between the two routers.
Router ID	Router ID of the router at the other end of the virtual link (virtual neighbor).
Interface Address	The local address used to communicate with the virtual neighbor.
State	The state of the virtual link. Possible states include the following: <ul style="list-style-type: none">• P2P - The link is functioning as a point-to-point interface.• DOWN - The link is down.

Displaying OSPFv3 virtual neighbor information

To display OSPFv3 virtual neighbor information for the device, enter the following command at the enabled level of the CLI.

```
device# show ipv6 ospf virtual-neighbor
Index Router ID      Address          State      Interface
1      10.14.14.14   2001:db8:44:44::4  Full       eth 1/1/8
          Option: 00-00-00  QCount: 0      Timer: 408
2      10.14.14.14   2001:db8:44:44::4  Full       tunnel 256
          Option: 00-00-00  QCount: 0      Timer: 43
```

Syntax: **show ipv6 ospf virtual-neighbor [brief]**

The **brief** option results in an output that omits the Option, QCount, and Timer fields.

TABLE 85 **show ipv6 ospf virtual-neighbor output descriptions**

This field	Displays
Index	An index number associated with the virtual neighbor.
Router ID	IPv4 address of the virtual neighbor.
Address	The IPv6 address to be used for communication with the virtual neighbor.

TABLE 85 show ipv6 ospf virtual-neighbor output descriptions (continued)

This field	Displays
State	The state between the device and the virtual neighbor. The state can be one of the following: <ul style="list-style-type: none"> • Down • Attempt • Init • 2-Way • ExStart • Exchange • Loading • Full
Interface	The interface type.
Option	The bits set in the virtual-link hello or database descriptors.
QCount	The number of packets that are in the queue and ready for transmission. If the system is stable, this number should always be 0.
Timer	A timer that counts down until a hello packet should arrive. If "timers" elapses and a hello packet has not arrived, the VL neighbor is declared to be down.

IPsec examples

This section contains examples of IPsec configuration and the output from the IPsec-specific **show** commands. In addition, IPsec-related information appears in general **show** command output for interfaces and areas.

The **show** commands that are specific to IPsec are:

- **show ipsec sa**
- **show ipsec policy**
- **show ipsec statistics**

The other **show** commands with IPsec-related information are:

- **show ipv6 ospf area**
- **show ipv6 ospf interface**
- **show ipv6 ospf vrf**

Showing IPsec security association information

The **show ipsec sa** command displays the IPsec security association databases, as follows.

```
device# show ipsec sa
IPSEC Security Association Database (Entries:8)
SPID(vrf:if) Dir Encap SPI Destination AuthAlg EncryptAlg
1:ALL in ESP 512 2001:db8:1::1 sha1 Null
1:e1/1/1 out ESP 302 :: sha1 Null
1:e1/1/1 in ESP 302 FE80::
1:e1/1/1 out ESP 512 2001:db8:1::2 sha1 Null
2:ALL in ESP 512 2001:db8:1::1 sha1 Null
2:e1/1/2 out ESP 302 :: sha1 Null
2:e1/1/2 in ESP 302 FE80::
2:e1/1/2 out ESP 512 2001:db8:1::2 sha1 Null
```

Syntax: show ipsec sa

Showing IPsec policy

The **show ipsec policy** command displays the database for the IPsec security policies. The fields for this **show** command output appear in the screen output example that follows. However, you should understand the layout and column headings for the display before trying to interpret the information in the example screen.

Each policy entry consists of two categories of information:

- The policy information
- The SA used by the policy

The policy information line in the screen begins with the heading Ptype and also has the headings Dir, Proto, Source (Prefix:TCP/UDP Port), and Destination (Prefix:TCP/UDPPort). The SA line contains the SPDID, direction, encapsulation (always ESP in the current release), the user-specified SPI.

```
device# show ipsec policy
IPSEC Security Policy Database(Entries:8)
PType  Dir Proto Source(Prefix:TCP/UDP Port)
        Destination(Prefix:TCP/UDPPort)
SA: SPDID(vrf:if) Dir Encap SPI      Destination
use   in  OSPF  FE80::/10:any
      ::/0:any
SA: 2:e1/1/2    in  ESP   302       FE80::
use   out OSPF  FE80::/10:any
      ::/0:any
SA: 2:e1/1/2    out ESP   302       ::
use   in  OSPF  FE80::/10:any
      ::/0:any
SA: 1:e1/1/1    in  ESP   302       FE80::
use   out OSPF  FE80::/10:any
      ::/0:any
SA: 1:e1/1/1    out ESP   302       ::
use   in  OSPF  2001:db8:1:1::1/128:any
      2001:db8:1:1::2/128:any
SA: 1:ALL       in  ESP   512       2001:db8:1:1::2
use   out OSPF  2001:db8:1:1::2/128:any
      2001:db8:1:1::1/128:any
SA: 1:e1/1/1    out ESP   512       2001:db8:1:1::1
use   in  OSPF  35:1:1::1/128:any
      10:1:1::2/128:any
SA: 2:ALL       in  ESP   512       10:1:1::2
```

Syntax: show ipsec policy

TABLE 86 show ipsec policy output descriptions

This field	Displays
PType	This field contains the policy type. Of the existing policy types, only the "use" policy type is supported, so each entry can have only "use."
Dir	The direction of traffic flow to which the IPsec policy is applied. Each direction has its own entry.
Proto	The only possible routing protocol for the security policy in the current release is OSPFv3.
Source	The source address consists of the IPv6 prefix and the TCP or UDP port identifier.
Destination	<p>The destination address consists of the IPv6 prefix. Certain logical elements have a bearing on the meaning of the destination address and its format, as follows:</p> <p>For IPsec on an interface or area, the destination address is shown as a prefix of 0xFE80 (link local). The solitary ":" (no prefix) indicates a "do not-care" situation because the connection is multicast. In this</p>

TABLE 86 show ipsec policy output descriptions (continued)

This field	Displays
	case, the security policy is enforced without regard for the destination address. For a virtual link (SPDID = 0), the address is required.

TABLE 87 SA used by the policy

This field	Displays
SA	This heading points at the SA-related headings for information used by the security policy. Thereafter, on each line of this part of the IPsec entry (which alternates with lines of policy information, "SA:" points at the fields under those SA-related headings. The remainder of this table describes each of the SA-related items.
SPDID	The security policy database identifier (SPDID) consists of two parts; the first part is an VRF id and the second part is an interface ID. The SPDID 0/ALL is a global database for the default VRF that applies to all interfaces.
Dir	The Dir field is either "in" for inbound or "out" for outbound.
Encap	The type of encapsulation in the current release is ESP.
SPI	Security parameter index.
Destination	The IPv6 address of the destination endpoint. From the standpoint of the near interface and the area, the destination is not relevant and therefore appears as ::/0:any. For a virtual link, both the inbound and outbound destination addresses are relevant.

Showing IPsec statistics

The **show ipsec statistics** command displays the error and other counters for IPsec, as this example shows.

```
device# show ipsec statistics
      IPSecurity Statistics
secEspCurrentInboundSAs 1          ipsecEspTotalInboundSAs: 2
secEspCurrentOutboundSA 1          ipsecEspTotalOutboundSAs: 2
      IPSecurity Packet Statistics
secEspTotalInPkts:    19          ipsecEspTotalInPktsDrop: 0
secEspTotalOutPkts:   83
      IPSecurity Error Statistics
secAuthenticationErrors 0
secReplayErrors:        0          ipsecPolicyErrors:       13
secOtherReceiveErrors:  0          ipsecSendErrors:        0
secAuthenticationErrors 0
secReplayErrors:        0          ipsecPolicyErrors:       13
secOtherReceiveErrors:  0          ipsecSendErrors:        0
secUnknownSpiErrors:    0
```

Syntax: show ipsec statistics

This command takes no parameters.

OSPFv3

Displaying OSPFv3 information

Displaying IPsec configuration for an area

The **show ipv6 ospf area** command includes information about IPsec for one area or all areas. In the following example, the IPsec information is in bold. IPsec is enabled in the first area (area 0) in this example but not in area 3. Note that in area 3, the IPsec key was specified as not encrypted.

```
device(config-ospf6-router)# show ipv6 ospf area
  Authentication: Configured
  KeyRolloverTime(sec): Configured: 25 Current: 20
  KeyRolloverState: Active,Phase1
  Current: None
  New: SPI:400, ESP, SHA1
    Key:$Z|83OmYW{QZ|83OmYW{QZ|83OmYW{QZ|83OmYW{Q
  Interface attached to this area: eth 1/1/1
  Number of Area scoped LSAs is 6
  Sum of Area LSAs Checksum is 0004f7de
  Statistics of Area 0:
    SPF algorithm executed 6 times
    SPF last updated: 482 sec ago
    Current SPF node count: 1
      Router: 1 Network: 0
      Maximum of Hop count to nodes: 0
  Area 3:
    Authentication: Not Configured
    Interface attached to this area:
    Number of Area scoped LSAs is 3
```

Syntax: **show ipv6 ospf area [area-id]**

The *area-id* parameter restricts the display to the specified OSPF area. You can specify the *area-id* parameter in the following formats:

- An IPv4 address
- A numerical value in the range 0 through 2,147,483,647

TABLE 88 show ipv6 ospf area output descriptions

This field	Displays
Authentication	This field shows whether or not authentication is configured. If this field says "Not Configured," the IPsec-related fields (bold in example screen output) are not displayed at all.
KeyRolloverTime	The number of seconds between each initiation of a key rollover. This field shows the configured and current times.
KeyRolloverState	Can be: Not active: key rollover is not active. Active phase 1: rollover is in its first interval. Active phase 2: rollover is in its second interval.
Current	Shows current SPI, authentication algorithm (currently ESP only), encryption algorithm (currently SHA1 only), and the current key.
New	Shows new SPI (if changed), authentication algorithm (currently ESP only), encryption algorithm (currently SHA1 only), and the new key.
Old	Shows old SPI (if changed), authentication algorithm (currently ESP only), encryption algorithm (currently SHA1 only), and the old key.

Displaying IPsec for an interface

To see IPsec configuration for a particular interface or all interfaces, use the **show ipv6 ospf interface** command as in the following example. IPsec information appears in bold.

```
device# show ipv6 ospf interface
eth 1/1/3 is down, type BROADCAST
    Interface is disabled
eth 1/1/8 is up, type BROADCAST
  IPv6 Address:
    2001:db8:18:18:18::1/64
    2001:db8:18:18::/64
  Instance ID 255, Router ID 10.1.1.1
  Area ID 1, Cost 1
  State BDR, Transmit Delay 1 sec, Priority 1
  Timer intervals :
    Hello 10, Hello Jitter 10  Dead 40, Retransmit 5
Authentication: Enabled
  KeyRolloverTime(sec) : Configured: 30 Current: 0
KeyRolloverState: NotActive
  Outbound: SPI:121212, ESP, SHA1
    Key:1234567890123456789012345678901234567890
  Inbound: SPI:121212, ESP, SHA1
    Key:1234567890123456789012345678901234567890
DR:10.2.2.2 BDR:10.1.1.1 Number of I/F scoped LSAs is 2
DRElection: 1 times, DelayedLSAck: 83 times
Neighbor Count = 1, Adjacent Neighbor Count= 1
  Neighbor:
    10.2.2.2 (DR)
  Statistics of interface eth 1/1/8:
    Type      tx        rx        tx-byte      rx-byte
    Unknown   0         0         0           0
    Hello     1415     1408     56592       56320
    DbDesc    3         3         804         804
    LSReq    1         1         28          28
    LSUpdate 193     121     15616       9720
    LSAck    85       109     4840       4924
OSPF messages dropped,no authentication: 0
```

Syntax: **show ipv6 ospf interface [ethernet unit/slot/port | loopback number | tunnel number | ve number]**

TABLE 89 **show ipv6 ospf interface output descriptions**

This field	Displays
Authentication	This field shows whether or not authentication is configured. If this field says "Not Configured," the IPsec-related fields (bold in example screen output) are not displayed at all.
KeyRolloverTime	The number of seconds between each initiation of a key rollover. This field shows the configured and current times.
KeyRolloverState	Can be: Not active: key rollover is not active. Active phase 1: rollover is in its first interval. Active phase 2: rollover is in its second interval.
Current	Shows current SPI, authentication algorithm (currently ESP only), encryption algorithm (currently SHA1 only), and the current key.
New (Inbound or Outbound)	Shows new SPI (if changed), authentication algorithm (currently ESP only), encryption algorithm (currently SHA1 only), and the new key.
Old (Inbound or Outbound)	Shows old SPI (if changed), authentication algorithm (currently ESP only), encryption algorithm (currently SHA1 only), and the old key.
OSPF messages dropped	Shows the number of packets dropped because the packets failed authentication (for any reason).

OSPFv3

Displaying OSPFv3 information

Displaying IPsec for a virtual link

To display IPsec for a virtual link, run the **show ipv6 ospf virtual-link brief** or **show ipv6 ospf virtual-link** command, as the following examples illustrate.

```
device# show ipv6 ospf virtual-link brief
Index Transit Area ID Router ID           Interface Address      State
1       1             10.14.14.14        2001:db8::1:1:1::1    P2P

device# show ipv6 ospf virtual-link
Transit Area ID Router ID           Interface Address      State
1             10.14.14.14        2001:db8:1:1:1:1::1    P2P
  Timer intervals(sec) :
    Hello 10, Hello Jitter 10, Dead 40, Retransmit 5, TransmitDelay 1
  DelayedLSAck: 5 times
  Authentication: Configured
  KeyRolloverTime(sec): Configured: 10 Current: 0
  KeyRolloverState: NotActive
  Outbound: SPI:100004, ESP, SHA1
    Key:1234567890123456789012345678901234567890
  Inbound: SPI:100004, ESP, SHA1
    Key:1234567890123456789012345678901234567890
  Statistics:
    Type      tx        rx      tx-bytes      rx-bytes
    Unknown   0         0        0            0
    Hello     65        65      2600          2596
    DbDesc    4         4        2752          2992
    LSReq     1         1        232           64
    LSUpdate  11        5        1040          1112
    LSAck     5         8        560           448
    OSPF messages dropped, no authentication: 0
  Neighbor: State: Full Address: 2001:db8:44:44::4 Interface: eth 1/2/2
```

Syntax: show ipv6 ospf virtual-link [brief]

The optional **brief** keyword limits the display to the Transit, Area ID, Router ID, Interface Address, and State fields for each link.

Changing a key

In this example, the key is changed. Note that the SPI value is changed from 300 to 310 to comply with the requirement that the SPI is changed when the key is changed.

Initial configuration command.

```
device(config-if-e1000-1/1/3)# ipv6 ospf auth ipsec spi 300 esp sha1
no-encrypt 12345678900987655431234567890aabbcdddef
```

Command for changing the key.

```
device(config-if-e1000-1/1/3)# ipv6 ospf auth ipsec spi 310 esp sha1
no-encrypt 9898989800987655431234567890aabbcdddef
```

Displaying IPv6 OSPF information for a VRF

To display IPv6 OSPF information for a VRF or all VRF interfaces, use the **show ipv6 ospf vrf** command as in the following example.

```
device# show ipv6 ospf vrf red
OSPF V3 Process number 0 with Router ID 0x10020202(10.2.2.2)
Running 0 days 0 hours 5 minutes 49 seconds
Number of AS scoped LSAs is 0
Sum of AS scoped LSAs Checksum is 00000000
External LSA Limit is 250000
Database Overflow Interval is 10
Database Overflow State is NOT OVERFLOWED
Route calculation executed 0 times
```

```
Pending outgoing LSA count 0
Authentication key rollover interval 30 seconds
Number of areas in this router is 4
High Priority Message Queue Full count: 0
Graceful restart helper is enabled, strict lsa checking is disabled
Nonstop Routing is enabled
```

Syntax: **show ipv6 ospf vrf vrf-name [area area-id | virtual-links]**

The *vrf-name* parameter specifies the VRF that you want the OSPF area information for.

The *area-id* parameter shows information for the specified area.

The *virtual-link* parameter displays the entry that corresponds to the IP address you enter.

Use the **show ipv6 ospf vrf** command to display the currently selected IPv6 global address for use by the Virtual Links in each transit area.

```
device# show ipv6 ospf vrf red area
Area 3:
Authentication: Not Configured
Interface attached to this area:
Number of Area scoped LSAs is 3
Sum of Area LSAs Checksum is 0001a6c4
Statistics of Area 3:
SPF algorithm executed 3 times
SPF last updated: 302 sec ago
Current SPF node count: 1
Router: 1 Network: 0
Maximum of Hop count to nodes: 0
Area 2:
Authentication: Not Configured
Interface attached to this area:
Number of Area scoped LSAs is 3
Sum of Area LSAs Checksum is 000192d6
Statistics of Area 2:
SPF algorithm executed 3 times
SPF last updated: 302 sec ago
Current SPF node count: 1
Router: 1 Network: 0
Maximum of Hop count to nodes: 0
Area 1:
Authentication: Not Configured
Interface attached to this area: eth 1/1/1
Number of Area scoped LSAs is 6
Sum of Area LSAs Checksum is 00046630
Statistics of Area 1:
SPF algorithm executed 3 times
SPF last updated: 302 sec ago
Current SPF node count: 3
Router: 2 Network: 1
Maximum of Hop count to nodes: 2
Global IPv6 Address used by Virtual Links in this area:10:1:1::2
Area 0.0.0.0 :
Authentication: Not Configured
Interface attached to this area: VLink 1
Number of Area scoped LSAs is 6
Sum of Area LSAs Checksum is 0002cc53
Statistics of Area 0.0.0.0:
SPF algorithm executed 3 times
SPF last updated: 302 sec ago
Current SPF node count: 2
Router: 2 Network: 0
Maximum of Hop count to nodes: 1
```

Syntax: **show ipv6 ospf vrf vrf-name [area area-id | virtual-links]**

OSPFv3

OSPFv3 clear commands

Use the **show ipv6 ospf vrf *vrf-name* neighbor** command to display the currently selected neighbor for use by the Virtual Links in each transit area.

```
device# show ipv6 ospf vrf red neighbor
Total number of neighbors in all states: 1
Number of neighbors in state Full : 1
Type      tx          rx          tx-byte    rx-byte
Unknown   0           0           0          0
Hello     32          32          1276       1280
DbDesc    2           2           116        116
LSReq     1           1           52         52
LSUpdate  2           2           184        200
LSAck     2           2           112        112
OSPF messages dropped,no authentication: 0
Neighbor: State: Full Address: 2001:db8:1::1 Interface: eth 1/1/1
```

OSPFv3 clear commands

The following OSPFv3 clear commands are supported.

Clearing all OSPFv3 data

You can use the **clear ipv6 ospf all** command to clear all OSPF data by disabling and enabling the OSPFv3 processes as shown in the following.

```
device# clear ipv6 ospf all
```

Syntax: **clear ipv6 ospf all**

Clearing OSPFv3 data in a VRF

You can use the **clear ipv6 ospf vrf** command to clear anything in a specific vrf as shown in the following.

```
device# clear ipv6 ospf vrf abc all
device# clear ipv6 ospf vrf abc traffic
```

Syntax: **clear ipv6 ospf vrf *vrfname***

Clearing all OSPFv3 packet counters

You can use the **clear ipv6 ospf traffic** command to clear all OSPFv3 packet counters as shown in the following.

```
device# clear ipv6 ospf traffic
```

Syntax: **clear ipv6 ospf traffic**

Scheduling Shortest Path First (SPF) calculation

You can use the **clear ipv6 ospf force-spf** command to perform the SPF calculation without clearing the OSPF database, as shown in the following.

```
device# clear ipv6 ospf force-spf
```

Syntax: **clear ipv6 ospf force-spf**

Clearing all redistributed routes from OSPFv3

You can use the **clear ipv6 ospf redistribution** command to clear all redistributed routes from OSPF, as shown in the following.

```
device# clear ipv6 ospf redistribution
```

Syntax: **clear ipv6 ospf redistribution**

Clearing OSPFv3 neighbors

You can use the **clear ipv6 ospf neighbor** command to delete and relearn OSPF neighbors, as shown in the following:

- Clearing all OSPF Neighbors
- Clearing OSPF Neighbors Attached to a Specified Interface

Clearing all OSPF neighbors

You can use the **clear ipv6 ospf neighbor all** command to delete and relearn all OSPF neighbors, as shown in the following.

```
device# clear ipv6 ospf neighbor all
```

Syntax: **clear ipv6 ospf neighborall**

Clearing OSPF neighbors attached to a specified interface

You can use the **clear ipv6 ospf neighbor interface** command to delete and relearn the OSPF neighbors attached to a specified interface, as shown in the following.

```
device# clear ipv6 ospf neighbor interface ethernet 1/1/1
```

Syntax: **clear ipv6 ospf neighbor interface [ethernet unit/slot/port | ve port-no | tunnel tunnel-port] [nbr-id]**

Specify the interface options as shown in the following options.

ethernet unit/slot/port - clears OSPF neighbors on the specified Ethernet interface.

ve port-no - clears OSPF neighbors on the specified virtual interface.

tunnel tunnel-port - clears OSPF neighbors on the specified tunnel interface.

Specifying the **nbr-id** variable limits the **clear ipv6 ospf neighbor** command to an individual OSPF neighbor attached to the interface.

Clearing OSPFv3 counters

You can use the **ospf counts** command to clear OSPF neighbor's counters as described in the following:

- Clearing all OSPF Counters
- Clearing the OSPF Counters for a Specified Neighbor
- Clearing the OSPF Counters for a Specified Interface

Clearing all OSPFv3 counters

You can clear all OSPF counters using the **clear ipv6 ospf counts** command, as shown in the following.

```
device# clear ipv6 ospf counts
```

OSPFv3

OSPFv3 clear commands

Syntax: **clear ipv6 ospf counts**

Clearing OSPFv3 counters for a specified neighbor

You can clear all OSPF counters for a specified neighbor using the **clear ipv6 counts neighbor** command, as shown in the following.

```
device# clear ipv6 ospf counts neighbor 10.10.10.1
```

Syntax: **clear ipv6 ospf counts neighbor *nbr-id***

The *nbr-id* variable specifies the neighbor ID of the OSPF neighbor whose counters you want to clear.

Clearing OSPFv3 counters for a specified interface

You can clear all OSPFv3 counters for a specified interface using the **clear ipv6 counts neighbor interface** command, as shown in the following.

```
device# clear ipv6 ospf counts interface ethernet 1/3/1
```

Syntax: **clear ipv6 ospf counts neighbor [interface ethernet *unit/slot/port* | ve *port-no* | tunnel *tunnel-port*] [*nbr-id*]**

Specify the interface options as shown in the following options.

ethernet *unit/slot/port* - clears OSPFv3 counters for OSPFv3 neighbors on the specified Ethernet interface.

ve *port-no* - clears OSPFv3 counters for OSPFv3 neighbors on the specified virtual interface.

tunnel *tunnel-port* - clears OSPFv3 counters for OSPFv3 neighbors on the specified tunnel interface.

Using an *nbr-id* value limits the displayed output to an individual OSPFv3 neighbor attached to the interface.

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BGP4 overview

BGP4 is the standard Exterior Gateway Protocol (EGP) used on the Internet to route traffic between Autonomous Systems (AS) and to maintain loop-free routing. An AS is a collection of networks that share the same routing and administration characteristics. For example, a corporate Intranet consisting of several networks under common administrative control might be considered an AS. The networks in an AS can but do not need to run the same routing protocol to be in the same AS, nor do they need to be geographically close.

Devices within an AS can use different Interior Gateway Protocols (IGPs) such as RIP and OSPF to communicate with one another. However, for devices in different autonomous systems to communicate, they need to use an EGP. BGP4 is the standard EGP used by Internet devices and therefore is the EGP implemented on Brocade devices.

This is a simple example of two BGP4 ASs. Each AS contains three BGP4 devices. All of the BGP4 devices within an AS communicate using IBGP. BGP4 devices communicate with other autonomous systems using EBGP. Notice that each of the devices also is running an Interior Gateway Protocol (IGP). The devices in AS1 are running OSPF and the devices in AS2 are running RIP. The device can be configured to redistribute routes among BGP4, RIP, and OSPF. They also can redistribute static routes.

FIGURE 27 Example BGP4 autonomous systems



Relationship between the BGP4 route table and the IP route table

The device BGP4 route table can have multiple routes or paths to the same destination, which are learned from different BGP4 neighbors. A BGP4 neighbor is another device that also is running BGP4. BGP4 neighbors communicate using Transmission Control Protocol (TCP) port 179 for BGP4 communication. When you configure the device for BGP4, one of the configuration tasks you perform is to identify the device's BGP4 neighbors.

Although a device's BGP4 route table can have multiple routes to the same destination, the BGP4 protocol evaluates the routes and chooses only one to send to the IP route table. The route that BGP4 chooses and sends to the IP route table is the preferred route . This route is what the device advertises to other BGP4 neighbors. If the preferred route goes down, BGP4 updates the route information in the IP route table with a new BGP4 preferred route.

NOTE

If IP load sharing is enabled and you enable multiple equal-cost paths for BGP4, BGP4 can select more than one equal-cost path to a destination.

A BGP4 route consists of the following information:

- Network number (prefix) - A value made up of the network mask bits and an IP address; for example, 10.215.129.0/18 indicates a network mask of 18 bits applied to the IP address 10.215.129.0. When a BGP4 device advertises a route to one of its neighbors, it uses this format.
- AS-path - A list of the other autonomous systems through which a route passes. BGP4 devices can use the AS-path to detect and eliminate routing loops. For example, if a route received by a BGP4 device contains the AS that the device is in, the device does not add the route to its own BGP4 table. (The BGP4 RFCs refer to the AS-path as "AS_PATH", and RFC 4893 uses "AS4_PATH" in relation to AS4s.)
- Additional path attributes - A list of additional parameters that describe the route. The route MED and next hop are examples of these additional path attributes.

NOTE

The device re-advertises a learned best BGP4 route to the device's neighbors even when the software does not select that route for installation in the IP route table. This can happen if a route from another protocol, for example, OSPF, is preferred. The best BGP4 route is the route that BGP4 selects based on comparison of the BGP4 route path's attributes.

After a device successfully negotiates a BGP4 session with a neighbor (a BGP4 peer), the device exchanges complete BGP4 route tables with the neighbor. After this initial exchange, the device and all other RFC 1771-compliant BGP4 devices send UPDATE messages to inform neighbors of new, changed, or no longer feasible routes. BGP4 devices do not send regular updates. However, if configured to do so, a BGP4 device does regularly send KEEPALIVE messages to its peers to maintain BGP4 sessions with them if the device does not have any route information to send in an UPDATE message.

How BGP4 selects a path for a route (BGP best path selection algorithm)

When multiple paths for the same route prefix are known to a BGP4 device, the device uses the following algorithm to weigh the paths and determine the optimal path for the route. The optimal path depends on various parameters, which can be modified.

1. Is the next hop accessible through an Interior Gateway Protocol (IGP) route? If not, ignore the route.

NOTE

The device does not use the default route to resolve BGP4 next hop.

2. Use the path with the largest weight.
3. If the weights are the same, prefer the path with the largest local preference.
4. Prefer the route that was originated locally (by this BGP4 device).
5. If the local preferences are the same, prefer the path with the shortest AS-path. An AS-SET counts as 1. A confederation path length, if present, is not counted as part of the path length.

NOTE

This step can be skipped if **BGP4-as-path-ignore** is configured.

6. If the AS-path lengths are the same, prefer the path with the lowest origin type. From low to high, route origin types are valued as follows:
 - IGP is lowest.
 - EGP is higher than IGP but lower than INCOMPLETE.
 - INCOMPLETE is highest.
7. If the paths have the same origin type, prefer the path with the lowest MED.

If the routes were learned from the same neighboring AS, BGP4 compares the MEDs of two otherwise equivalent paths. This behavior is called deterministic MED. Deterministic MED is always enabled and cannot be disabled. You can also enable the device to always compare the MEDs, regardless of the AS information in the paths. To enable this comparison, enter the **always-compare-med** command at the BGP4 configuration level of the CLI. This option is disabled by default.

NOTE

By default, value 0 (most favorable) is used in MED comparison when the MED attribute is not present. The default MED comparison results in the device favoring the route paths that are missing their MEDs. You can use the **med-missing-as-worst** command to make the device regard a BGP4 route with a missing MED attribute as the least favorable path, when comparing the MEDs of the route paths.

NOTE

MED comparison is not performed for internal routes originated within the local AS or confederation unless the **compare-med-empty-aspath** command is configured.

8. Prefer routes in the following order:
 - Routes received through EBGP from a BGP4 neighbor outside of the confederation
 - Routes received through EBGP from a BGP4 device within the confederation OR Routes received through IBGP.
9. If all the comparisons above are equal, prefer the route with the lowest IGP metric to the BGP4 next hop. This is the closest internal path inside the AS to reach the destination.

10. If the internal paths also are the same and BGP4 load sharing is enabled, load share among the paths. Otherwise prefer the route that comes from the BGP4 device with the lowest device ID.

NOTE

Brocade devices support BGP4 load sharing among multiple equal-cost paths. BGP4 load sharing enables the device to balance traffic across the multiple paths instead of choosing just one path based on device ID. For EBGP routes, load sharing applies only when the paths are from neighbors within the same remote AS. EBGP paths from neighbors in different autonomous systems are not compared, unless multipath **multi-as** is enabled.

11. If the **compare-router ID** is enabled, prefer the path that comes from the BGP4 device with the lowest device ID. If a path contains originator ID attributes, then originator ID is substituted for the ROUTER ID in the decision.
12. Prefer the path with the minimum cluster list length.
13. Prefer the route that comes from the lowest BGP4 neighbor address.

BGP4 message types

BGP4 devices communicate with neighbors (other BGP4 devices) using the following types of messages:

- OPEN
- UPDATE
- KEEPALIVE
- NOTIFICATION
- ROUTE REFRESH

OPEN message

After a BGP4 device establishes a TCP connection with a neighboring BGP4 device, the devices exchange OPEN messages. An open message indicates the following:

- BGP4 version - Indicates the version of the protocol that is in use on the device. BGP4 version 4 supports Classless Interdomain Routing (CIDR) and is the version most widely used in the Internet. Version 4 also is the only version supported on devices.
- AS number - An autonomous system number (ASN) identifies the AS to which the BGP4 device belongs. The number can be up to four bytes.
- Hold Time - The number of seconds a BGP4 device will wait for an UPDATE or KEEPALIVE message (described below) from a BGP4 neighbor before assuming that the neighbor is not operational. BGP4 devices exchange UPDATE and KEEPALIVE messages to update route information and maintain communication. If BGP4 neighbors are using different Hold Times, the lowest Hold Time is used by the neighbors. If the Hold Time expires, the BGP4 device closes the TCP connection to the neighbor and clears any information it has learned and cached from the neighbor.

You can configure the Hold Time to be 0, in which case a BGP4 device will consider neighbors to always be up. For directly-attached neighbors, you can configure the device to immediately close the TCP connection to the neighbor and clear entries learned from an EBGP neighbor if the interface to that neighbor goes down. This capability is provided by the fast external fail over feature, which is disabled by default.

- BGP4 Identifier - The device ID. The BGP4 Identifier (device ID) identifies the BGP4 device to other BGP4 devices. The device use the same device ID for OSPF and BGP4. If you do not set a device ID, the software uses the IP address on the lowest numbered loopback interface configured on the device. If the device does not have a loopback interface, the default device ID is the lowest numbered IP address configured on the device.

- Parameter list - An optional list of additional parameters used in peer negotiation with BGP4 neighbors.

UPDATE message

After BGP4 neighbors establish a BGP4 connection over TCP and exchange their BGP4 routing tables, they do not send periodic routing updates. Instead, a BGP4 neighbor sends an update to a neighbor when it has a new route to advertise or routes have changed or become unfeasible. An UPDATE message can contain the following information:

- Network Layer Reachability Information (NLRI) - The mechanism by which BGP4 supports Classless Interdomain Routing (CIDR). An NLRI entry consists of an IP prefix that indicates a network being advertised by the UPDATE message. The prefix consists of an IP network number and the length of the network portion of the number. For example, an UPDATE message with the NLRI entry 10.215.129.0/18 indicates a route to IP network 10.215.129.0 with network mask 255.255.192.0. The binary equivalent of this mask is 18 consecutive one bits, thus "18" in the NLRI entry.
- Path attributes - Parameters that indicate route-specific information such as Autonomous System path information, route preference, next hop values, and aggregation information. BGP4 uses path attributes to make filtering and routing decisions.
- Unreachable routes - A list of routes that have been in the sending device BGP4 table but are no longer feasible. The UPDATE message lists unreachable routes in the same format as new routes: *IP address and CIDR prefix*.

KEEPALIVE message

BGP4 devices do not regularly exchange UPDATE messages to maintain BGP4 sessions. For example, if a device configured to perform BGP4 routing has already sent the latest route information to peers in UPDATE messages, the device does not send more UPDATE messages. Instead, BGP4 devices send KEEPALIVE messages to maintain BGP4 sessions. KEEPALIVE messages are 19 bytes long and consist only of a message header. They do not contain routing data.

BGP4 devices send KEEPALIVE messages at a regular interval, called the Keep Alive Time. The default Keep Alive Time is 60 seconds.

A parameter related to the Keep Alive Time is the Hold Time. The Hold Time for a BGP4 device determines how many seconds the device waits for a KEEPALIVE or UPDATE message from a BGP4 neighbor before deciding that the neighbor is not operational. The Hold Time is negotiated when BGP4 devices exchange OPEN messages, the lower Hold Time is then used by both neighbors. For example, if BGP4 device A sends a Hold Time of 5 seconds and BGP4 device B sends a Hold Time of 4 seconds, both devices use 4 seconds as the Hold Time for their BGP4 session. The default Hold Time is 180 seconds. Generally, the Hold Time is configured to three times the value of the Keep Alive Time.

If the Hold Time is 0, a BGP4 device assumes that a neighbor is alive regardless of how many seconds pass between receipt of UPDATE or KEEPALIVE messages.

NOTIFICATION message

When you close the BGP4 session with a neighbor, the device detects an error in a message received from the neighbor, or an error occurs on the device, the device sends a NOTIFICATION message to the neighbor. No further communication takes place between the BGP4 device that sent the NOTIFICATION and the neighbors that received the NOTIFICATION.

REFRESH message

BGP4 sends a REFRESH message to a neighbor to request that the neighbor resend route updates. This type of message can be useful if an inbound route filtering policy has been changed.

Grouping of RIB-out peers

To improve efficiency in the calculation of outbound route filters, the device groups BGP4 peers together based on their outbound policies. To reduce RIB-out memory usage, the device then groups the peers within an outbound policy group according to their RIB-out routes. All peers sharing a single RIB-out route (up to 32 peers per group) also share a single physical RIB-out entry, resulting in as much as a 30-fold memory usage reduction.

NOTE

RIB-out peer grouping is not shared between different VRFs or address families.

Implementation of BGP4

BGP4 is described in RFC 1771 and the latest BGP4 drafts. The Ruckus BGP4 implementation fully complies with RFC 1771. Ruckus BGP4 implementation also supports the following RFCs:

- RFC 1745 (OSPF Interactions)
- RFC 1997 (BGP Communities Attributes)
- RFC 2385 (TCP MD5 Signature Option)
- RFC 2439 (Route Flap Dampening)
- RFC 2796 (Route Reflection)
- RFC 2842 (Capability Advertisement)
- RFC 3065 (BGP4 Confederations)
- RFC 2858 (Multiprotocol Extensions)
- RFC 2918 (Route Refresh Capability)
- RFC 3392 (BGP4 Capability Advertisement)
- RFC 4893 BGP Support for Four-octet AS Number Space
- RFC 3682 Generalized TTL Security Mechanism, for eBGP Session Protection

BGP4 restart

BGP4 restart is a high-availability routing feature that minimizes disruption in traffic forwarding, diminishes route flapping, and provides continuous service during a system restart, switchover, failover, or hitless OS upgrade. During such events, routes remain available between devices. BGP4 restart operates between a device and its peers, and must be configured on each participating device.

Under normal operation, when a BGP4 device is restarted, the network is automatically reconfigured. Routes available through the restarting device are deleted when the device goes down, and are then rediscovered and added back to the routing tables when the device is back up and running. In a network with devices that regularly restart, performance can degrade significantly and limit the availability of network resources. BGP4 restart dampens the network response and limits route flapping by allowing routes to remain available between devices during a restart. BGP4 restart operates between a device and peers, and must be configured on each participating device.

BGP4 restart is enabled globally by default.

A BGP4 restart-enabled device advertises the capability to establish peering relationships with other devices. When a restart begins, neighbor devices mark all of the routes from the restarting device as stale, but continue to use the routes for the length of time specified by the restart timer. After the device is restarted, it begins to receive routing updates from the peers. When it

receives the end-of-RIB marker that indicates it has received all of the BGP4 route updates, it recomputes the new routes and replaces the stale routes in the route map with the newly computed routes. If the device does not come back up within the time configured for the purge timer, the stale routes are removed.

NOTE

BGP4 restart is supported in FSX 800, FSX 1600 devices with dual management modules, FCX switches in a stack and ICX switches in a stack. If the switch will function as a restart helper device only, a secondary management module is not required.

NOTE

A second management module must be installed for the device to function as a restart device. If the device functions as a restart helper device only, there is no requirement for a secondary management module.

The implementation of BGP4 Restart supports the following Internet Draft:

- Draft-ietf-idr-restart-10.txt: restart mechanism for BGP4

BGP4 Peer notification during a management module switchover

The BGP4 Peer notification process restores BGP4 adjacency quickly and allows packet forwarding between the newly active management module and the BGP4 peers. The handling of TCP packets with an MD5 digest prevents the silent dropping of TCP packets without triggering a RESET packet.

The BGP4 peer notification process operates effectively when implemented for the following processes that involve the intentional switching of the active status from one management module to another:

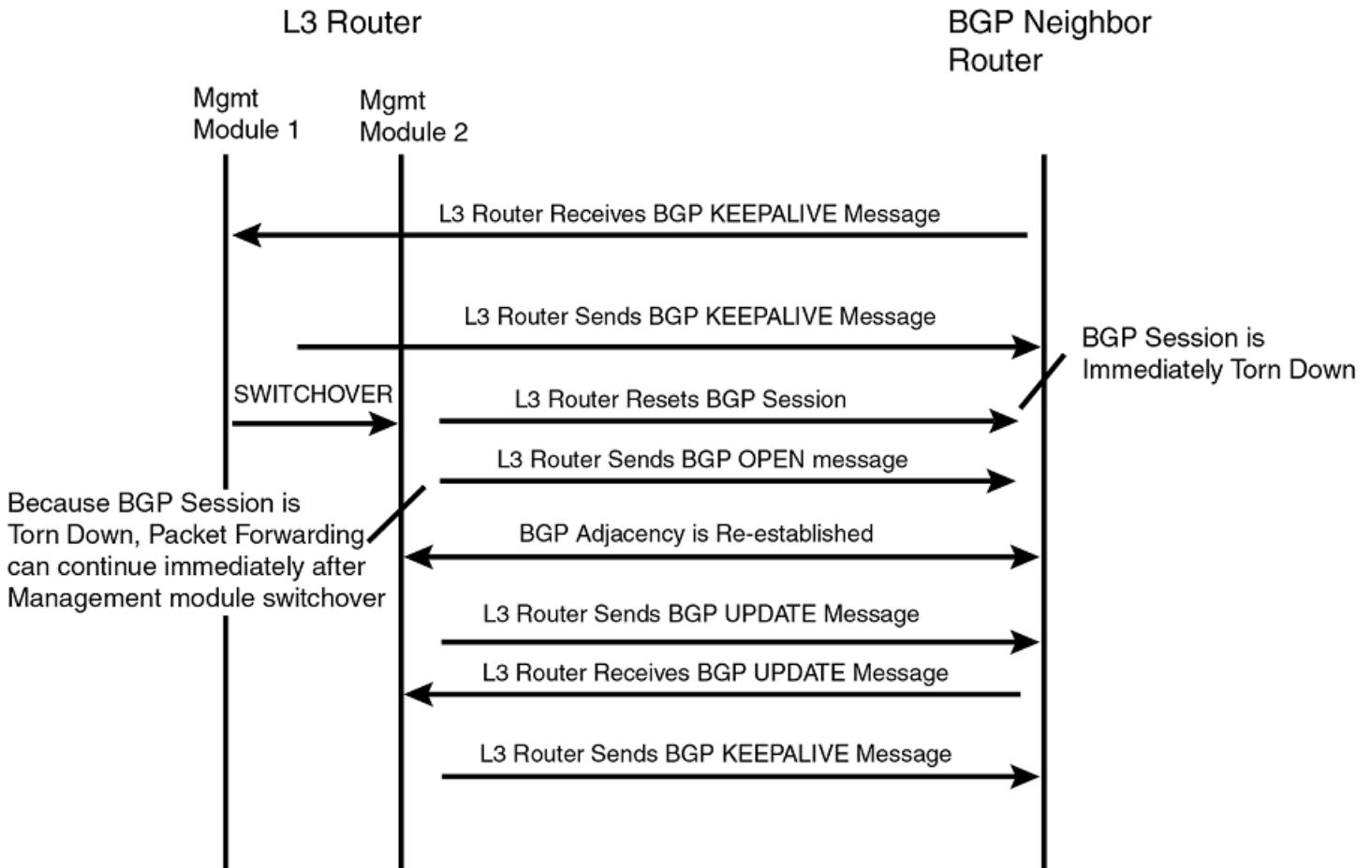
- System Reload - When a device undergoes the reload process, both management modules and all interface modules are rebooted. All BGP4 sessions are terminated BEFORE the system triggers the hardware reset.
- Switchover Requested by User - Switching over to a standby management module can be triggered by the **switchover**, **reset**, **reload**, and **hitless-reload** commands. When these commands are executed, the active management module resets the BGP4/TCP sessions with BGP4 neighbors before transferring control to the standby management module.

NOTE

Restart-enabled BGP4 sessions are not reset. The BGP4 restart protocol allows a BGP4 session to reconnect gracefully without going through the normal process.

This example describes the procedure used between the management modules in a device and a BGP4 neighbor device.

FIGURE 28 Management module switchover behavior for BGP4 peer notification



If the active management module fails due to a fault, the management module does not have the opportunity to reset BGP4 sessions with neighbors as described for intentional failovers. In this situation the management module will reboot, or the standby management module becomes the new active management module. Since the new active management module does not have the TCP/BGP4 information needed to reset the previous sessions, a remote BGP4 peer session is only reset when it sends a BGP4/TCP keep-alive packet to this device, or when the BGP4 hold-time expires.

To help reduce the reconnection time after a management module failover or system reload, if an incoming TCP packet contains an MD5 digest, and no matching TCP session is found, the device attempts to find a matching BGP4 peer based on the IP address. If a BGP4 peer configuration can be found, the device looks up the MD5 password configured for the peer, and uses it to send a RESET packet.

BGP4 neighbor local AS

This feature allows you to configure a device so that it adds a peer to an AS that is different from the AS to which it actually belongs. This feature is useful when an ISP is acquired by another ISP. In this situation, customers of the acquired ISP might not want to (or might not be able to) adjust their configuration to connect to the AS of the acquiring provider.

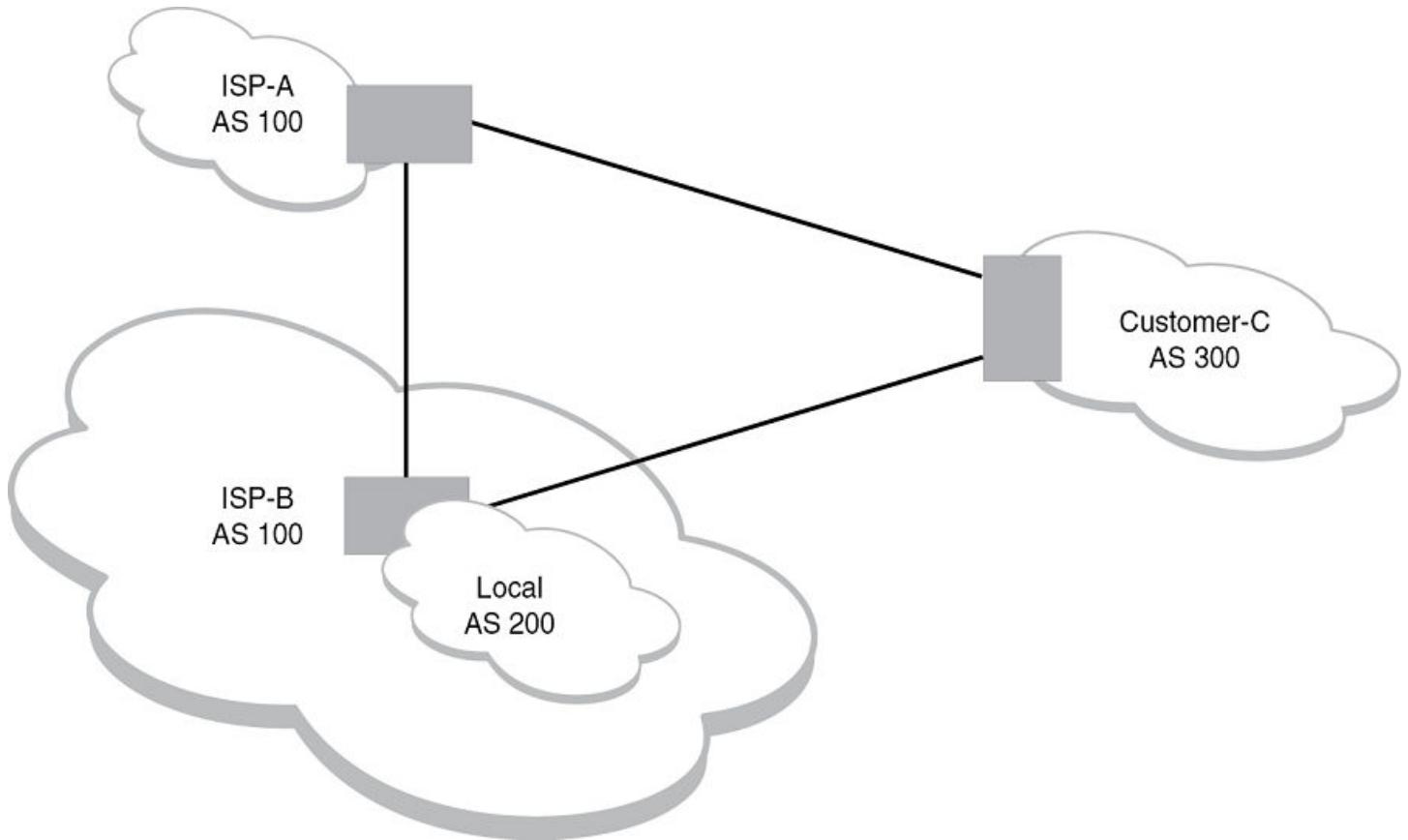
In this example, Customer C is connected to ISP-A which is in AS 100 and ISP-B which is in AS 200.

FIGURE 29 Example of customer connected to two ISPs



In the next example, ISP-A has purchased ISP-B. The AS associated with ISP-B changes to AS 100. If Customer C cannot or does not want to change their configuration or peering relationship with ISP-B, a peer with Local-AS configured with the value 200 can be established on ISP-B.

FIGURE 30 Example of Local AS configured on ISP-B



A Local AS is configured using the BGP4 **neighbor** command. To confirm that a Local AS has been configured, use the **show ip bgp neighbors** command.

Basic configuration and activation for BGP4

BGP4 is disabled by default. Follow the steps below to enable BGP4.

1. Enable the BGP4 protocol.
2. Set the local AS number.

NOTE

You must specify the local AS number for BGP4 to become functional.

3. Add each BGP4 neighbor (peer BGP4 device) and identify the AS the neighbor is in.
4. Save the BGP4 configuration information to the system configuration file.

For example, enter commands such as the following.

```
device> enable
device# configure terminal
device(config)# router bgp
BGP4: Please configure 'local-as' parameter in order to enable BGP4.
device(config-bgp)# local-as 10
device(config-bgp-router)#neighbor 10.157.23.99 remote-as 100
device(config-bgp)# write memory
```

Syntax: router bgp

The **router bgp** command enables the BGP4 protocol.

NOTE

By default, the Ruckus device ID is the IP address configured on the lowest numbered loopback interface. If the device does not have a loopback interface, the default device ID is the lowest numbered IP interface address configured on the device. If you change the device ID, all current BGP4 sessions, OSPF adjacencies, and OSPFv3 adjacencies are cleared.

NOTE

When BGP4 is enabled on a Ruckus device, you do not need to reset the system. The protocol is activated as soon as you enable it. The device begins a BGP4 session with a BGP4 neighbor when you add the neighbor.

Disabling BGP4

If you disable BGP4, the device removes all the running configuration information for the disabled protocol from the running configuration. To restore the BGP4 configuration, you must reload the software to load the BGP4 configuration from the startup configuration. When you save the startup configuration file after disabling the protocol, all of the BGP4 configuration information for the disabled protocol is removed from the startup configuration file.

The CLI displays a warning message such as the following.

```
device(config-bgp-router)# no router bgp
router bgp mode now disabled and runtime configuration is erased. All bgp config data will be lost when
writing to flash!
```

The Web Management Interface does not display a warning message.

If you are testing a BGP4 configuration and need to disable and re-enable the protocol, you should make a backup copy of the startup configuration file containing the BGP4 configuration information. If you remove the configuration information by saving the configuration after disabling the protocol, you can restore the BGP4 configuration by copying the backup copy of the startup configuration file onto the flash memory.

NOTE

To disable BGP4 without losing the BGP4 configuration information, remove the local AS (for example, by entering the **no local-as** command). When you remove the local AS, BGP4 retains the other configuration information but will not become operational until you reset the local AS.

BGP4 parameters

You can modify or set the following BGP4 parameters:

- Optional - Define the router ID. (The same router ID also is used by OSPF.)
- Required - Specify the local AS number.
- Optional - Add a loopback interface for use with neighbors.
- Required - Identify BGP4 neighbors.
- Optional - Change the Keep Alive Time and Hold Time.
- Optional - Change the update timer for route changes.
- Optional - Enable fast external failover.
- Optional - Specify a list of individual networks in the local AS to be advertised to remote autonomous systems using BGP4.
- Optional - Change the default local preference for routes.
- Optional - Enable the default route (default-information-originate).
- Optional - Enable use of a default route to resolve a BGP4 next-hop route.
- Optional - Change the default MED (metric).
- Optional - Enable next-hop recursion.
- Optional - Change the default administrative distances for EBGP, IBGP, and locally originated routes.
- Optional - Require the first AS in an Update from an EBGP neighbor to be the neighbor AS.
- Optional - Change MED comparison parameters.
- Optional - Disable comparison of the AS-Path length.
- Optional - Enable comparison of the device ID.
- Optional - Enable auto summary to summarize routes at an IP class boundary (A, B, or C).
- Optional - Aggregate routes in the BGP4 route table into CIDR blocks.
- Optional - Configure the device as a BGP4 route reflector.
- Optional - Configure the device as a member of a BGP4 confederation.
- Optional - Change the default metric for routes that BGP4 redistributes into RIP or OSPF.
- Optional - Change the parameters for RIP, OSPF, or static routes redistributed into BGP4.
- Optional - Change the number of paths for BGP4 load sharing.
- Optional - Change other load-sharing parameters
- Optional - Define BGP4 address filters.
- Optional - Define BGP4 AS-path filters.
- Optional - Define BGP4 community filters.
- Optional - Define IP prefix lists.
- Optional - Define neighbor distribute lists.

- Optional - Define BGP4 route maps for filtering routes redistributed into RIP and OSPF.
- Optional - Define route flap dampening parameters.

NOTE

When using the CLI, you set global level parameters at the BGP CONFIG level of the CLI. You can reach the BGP CONFIG level by entering the **router bgp** command at the global CONFIG level.

Some parameter changes take effect immediately while others do not take full effect until the device sessions with its neighbors are reset. Some parameters do not take effect until the device is rebooted.

Parameter changes that take effect immediately

The following parameter changes take effect immediately:

- Enable or disable BGP4.
- Set or change the local AS.
- Add neighbors.
- Change the update timer for route changes.
- Disable or enable fast external failover.
- Specify individual networks that can be advertised.
- Change the default local preference, default information originate setting, or administrative distance.
- Enable or disable use of a default route to resolve a BGP4 next-hop route.
- Enable or disable MED (metric) comparison.
- Require the first AS in an update from an EBGP neighbor to be the neighbor AS.
- Change MED comparison parameters.
- Disable comparison of the AS-Path length.
- Enable comparison of the device ID.
- Enable next-hop recursion.
- Change the default metric.
- Disable or re-enable route reflection.
- Configure confederation parameters.
- Disable or re-enable load sharing.
- Change the maximum number of load sharing paths.
- Change other load-sharing parameters.
- Define route flap dampening parameters.
- Add, change, or negate redistribution parameters (except changing the default MED as described in [Changing the default MED \(Metric\) used for route redistribution](#) on page 386).
- Add, change, or negate route maps (when used by the **network** command or a redistribution command).
- Aggregate routes.
- Apply maximum AS path limit settings for UPDATE messages.

Parameter changes that take effect after resetting neighbor sessions

The following parameter changes take effect only after the BGP4 sessions on the device are cleared, or reset using the "soft" clear option:

- Change the Hold Time or Keep Alive Time.
- Aggregate routes
- Add, change, or negate filter tables that affect inbound and outbound route policies.
- Apply maximum AS path limit settings to the RIB.

Parameter changes that take effect after disabling and re-enabling redistribution

The following parameter change takes effect only after you disable and then re-enable redistribution:

- Change the default MED (metric).

Memory considerations

BGP4 can handle a very large number of routes and therefore requires a lot of memory. For example, in a typical configuration with a single BGP4 neighbor, receiving a full internet route table, a BGP4 device may need to hold over a million routes. Many configurations, especially those involving more than one neighbor, can require the device to hold even more routes. Brocade devices provide dynamic memory allocation for BGP4 data. BGP4 devices automatically allocate memory when needed to support BGP4 neighbors, routes and route attribute entries. Dynamic memory allocation is performed automatically by the software and does not require a reload.

The following table lists the maximum total amount of system memory (DRAM) BGP4 can use. The maximum depends on the total amount of system memory on the device.

TABLE 90 Maximum memory usage

Platform	Maximum memory BGP4 can use
FSX with Management module with 1536 MB	1336 MB

The memory amounts listed in the table are for all BGP4 data, including routes received from neighbors, BGP route advertisements (routes sent to neighbors), and BGP route attribute entries. The routes sent to and received from neighbors use the most BGP4 memory. Generally, the actual limit to the number of neighbors, routes, or route attribute entries the device can accommodate depends on how many routes the device sends to and receives from the neighbors.

In some cases, where most of the neighbors do not send or receive a full BGP route table (about 80,000 routes), the memory can support a larger number of BGP4 neighbors. However, if most of the BGP4 neighbors send or receive full BGP route tables, the number of BGP neighbors the memory can support is less than in configurations where the neighbors send smaller route tables.

Memory configuration options obsoleted by dynamic memory

Devices that support dynamic BGP4 memory allocation do not require or even support static configuration of memory for BGP4 neighbors, routes, or route attributes. Consequently, the following CLI commands and equivalent Web management options are not supported on these devices:

- **max-neighbors num**
- **max-routes num**
- **max-attribute-entries num**

If you boot a device that has a startup-config file that contains these commands, the software ignores the commands and uses dynamic memory allocation for BGP4. The first time you save the device running configuration (running-config) to the startup-config file, the commands are removed from the file.

Basic configuration tasks required for BGP4

The following sections describe how to perform the configuration tasks that are required to use BGP4 on the Brocade device.

Enabling BGP4 on the device

When you enable BGP4 on the device, BGP4 is automatically activated. To enable BGP4 on the device, enter the following commands.

```
device# configure terminal
device(config)# router bgp
BGP4: Please configure 'local-as' parameter in order to enable BGP4.
device(config-bgp-router)# local-as 10
device(config-bgp-router)# neighbor 10.157.23.99 remote-as 100
device(config-bgp-router)# write memory
```

Changing the device ID

The OSPF and BGP4 protocols use device IDs to identify devices that are running the protocols. A device ID is a valid, unique IP address and sometimes is an IP address configured on the device. The device ID cannot be an IP address in use by another device.

By default, the device ID on a Brocade device is one of the following:

- If the device has loopback interfaces, the default device ID is the IP address on the lowest numbered loopback interface configured on the Brocade device. For example, if you configure loopback interfaces 1, 2, and 3 as follows, the default device ID is 10.9.9.9/24:
 - Loopback interface 1, 10.9.9.9/24
 - Loopback interface 2, 10.4.4.4/24
 - Loopback interface 3, 10.1.1.1/24
- If the device does not have any loopback interfaces, the default device ID is the lowest numbered IP interface address configured on the device.

NOTE

Brocade devices use the same device ID for both OSPF and BGP4. If the device is already configured for OSPF, you may want to use the device ID already assigned to the device rather than set a new one. To display the current device ID, enter the **show ip** command at any CLI level.

To change the device ID, enter a command such as the following.

```
device(config)# ip router-id 10.157.22.26
```

Syntax: [no] **ip router-id** *ip-addr*

The *ip-addr* can be any valid, unique IP address.

NOTE

You can specify an IP address used for an interface on the Ruckus device, but do not specify an IP address that is being used by another device.

Setting the local AS number

The local autonomous system number (ASN) identifies the AS in which the Ruckus BGP4 device resides.

To set the local AS number, enter commands such as the following.

```
device(config)# router bgp  
BGP4: Please configure 'local-as' parameter in order to enable BGP4.  
device(config-bgp)# local-as 10  
device(config-bgp)# write memory
```

Syntax: [no] **local-as** *num*

The *num* parameter specifies a local AS number in the range 1 through 4294967295. It has no default. AS numbers 64512 - 65535 are the well-known private BGP4 AS numbers and are not advertised to the Internet community.

Setting the local AS number for VRF instances

The local autonomous system (AS) number identifies the AS in which the BGP4 device resides.

You can assign different BGP AS numbers for each VRF instance. If you do not assign an AS number, the BGP VRF instances use the default BGP AS number, as in previous releases.

The **local-as** command is available under the "global BGP" CLI level and "address- family ipv4 unicast vrf" CLI level.

To set the local as number for a VRF, enter commands such as the following.

```
device(config-bgp)# address-family ipv4 unicast vrf vrf-name  
device(config-bgp)# local-as num
```

Syntax: [no] **local-as** *num*

The *num* parameter specifies a local AS number in the range 1 - 4294967295. It has no default. AS numbers 64512 - 65535 are the well-known private BGP4 AS numbers and are not advertised to the Internet community.

The configuration takes effect immediately and the BGP VRF instance is reset. All BGP peering within the VRF is reset, and take the new AS number.

The local AS number for the VRF instance, if configured, is displayed in the **show running-config** and **show ip bgp config** command output.

Enter the **show ip bgp config** command:

```
device# show ip bgp config  
Current BGP configuration:  
router bgp  
  local-as 100  
  neighbor 10.10.10.10 remote-as 200  
  
  address-family ipv4 unicast
```

Configuring BGP4 (IPv4)

Basic configuration tasks required for BGP4

```
exit-address-family  
address-family ipv6 unicast  
exit-address-family  
  
address-family ipv4 unicast vrf vrf_a  
local-as 300  
neighbor 10.111.111.111 remote-as 400  
exit-address-family
```

Adding a loopback interface

You can configure the device to use a loopback interface instead of a specific port or virtual routing interface to communicate with a BGP4 neighbor. A loopback interface adds stability to the network by working around route flap problems that can occur due to unstable links between the device and neighbors.

Loopback interfaces are always up, regardless of the states of physical interfaces. Loopback interfaces are especially useful for IBGP neighbors (neighbors in the same AS) that are multiple hops away from the device. When you configure a BGP4 neighbor on the device, you can specify whether the device uses the loopback interface to communicate with the neighbor. As long as a path exists between the device and the neighbor, BGP4 information can be exchanged. The BGP4 session is not associated with a specific link, but is instead associated with the virtual interfaces.

NOTE

If you configure the Ruckus device to use a loopback interface to communicate with a BGP4 neighbor, the peer IP address on the remote device pointing to your loopback address must be configured.

To add a loopback interface, enter commands such as the following.

```
device(config-bgp)# exit  
device(config)# int loopback 1  
device(config-lbif-1)# ip address 10.0.0.1/24
```

Syntax: [no] interface loopback num

The *num* value can be from 1 through the maximum number of loopback interfaces supported on the device.

Adding BGP4 neighbors

Because BGP4 does not contain a peer discovery process, for each BGP4 neighbor (peer), you must indicate the IP address and the AS number of each neighbor. Neighbors that are in different autonomous systems communicate using EBGP. Neighbors within the same AS communicate using IBGP.

NOTE

If the device has multiple neighbors with similar attributes, you can simplify configuration by configuring a peer group, then adding individual neighbors to it. The configuration steps are similar, except you specify a peer group name instead of a neighbor IP address when configuring the neighbor parameters, then add individual neighbors to the peer group.

NOTE

The device attempts to establish a BGP4 session with a neighbor as soon as you enter a command specifying the IP address of the neighbor. If you want to completely configure the neighbor parameters before the device establishes a session with the neighbor, you can administratively shut down the neighbor.

To add a BGP4 neighbor with an IP address 10.157.22.26, enter the following command.

```
device(config-bgp-router)# neighbor 10.157.22.26 remote-as 100
```

The neighbor *ip-addr* must be a valid IP address.

The **neighbor** command has additional parameters, as shown in the following syntax:

Syntax: **no neighbor** {*ip-addr* | *peer-group-name*} {[**activate**] [**advertisement-interval** *seconds*] [**allowas-in** *num*] [**capability as4** [**enable** | **disable**]] [**capability orf** *prefixlist* [**send** | **receive**]]] [**default-originate** [*route-map map-name*]] [**description** *string*] [**distribute-list** *in* | *out* *num,num,...* | *ACL-num localin* | *out*] [**ebgp-btsh**] [**ebgp-multipath** [*num*]]] [**enforce-first-as**] [**filter-list** *access-list-name* [*in* | *out*]]] [**local-as** *as-num* [**no-prepend**]]] [**maxas-limit** *in* [*num*] | **disable**] [**maximum-prefix** *num* [*threshold*]]] [**teardown**] [**next-hop-self**] [**password** *string*] [**peer-group** *group-name*] [**prefix-list** *string* *in* | *out*] [**remote-as** *as-number*] [**remove-private-as**] [**route-map** *in* | *out* *map-name*] [**route-reflector-client**] [**send-community**] [**shutdown** [**generate-rib-out**]]] [**soft-reconfiguration inbound**] [**timers** *keepalive num* *hold-time num*] [**unsuppress-map** *map-name*] [**update-source** *ip-addr* | **ethernet** *unit* | *slot* | *portnum* | **loopback** *num* | **ve** *num*] [**weight** *num*] [**send-label**]}

The *ip-addr* and *peer-group-name* parameters indicate whether you are configuring an individual neighbor or a peer group. If you specify a neighbor IP address, you are configuring that individual neighbor. If you specify a peer group name, you are configuring a peer group.

activate allows exchange of routes in the current family mode.

advertisement-interval *seconds* configures an interval in seconds over which the specified neighbor or peer group will hold all route updates before sending them. At the expiration of the timer, the routes are sent as a batch. The default value for this parameter is zero. Acceptable values are 0 to 3600 seconds.

NOTE

The device applies the advertisement interval only under certain conditions. The device does not apply the advertisement interval when sending initial updates to a BGP4 neighbor. As a result, the device sends the updates one immediately after another, without waiting for the advertisement interval.

allowas-in *num* disables the AS_PATH check function for routes learned from a specified location. BGP4 usually rejects routes that contain an AS number within an AS_PATH attribute to prevent routing loops.

capability as4 [**enable** | **disable**] enables the capability of processing AS4s. The optional keywords **enable** and **disable** specify whether the feature should be changed from its current state. For example, if this neighbor belongs to a peer group that is enabled for AS4s but you want to disable it on the current interface, use the command and include the **disable** keyword.

capability orf *prefixlist* [**send** | **receive**] configures cooperative device filtering. The **send** and **receive** parameters specify the support you are enabling:

- **send** - The device sends the IP prefix lists as Outbound Route Filters (ORFs) to the neighbor.
- **receive** - The device accepts filters as Outbound Route Filters (ORFs) from the neighbor.

If you do not specify either **send** or **receive**, both capabilities are enabled. The **prefixlist** parameter specifies the type of filter you want to send to the neighbor.

NOTE

The current release supports cooperative filtering only for filters configured using IP prefix lists.

default-originate [*route-map map-name*] configures the device to send the default route 0.0.0.0 to the neighbor. If you use the *route-map map-name* parameter, the route map injects the default route conditionally, based on the match conditions in the route map.

description *string* specifies a name for the neighbor. You can enter an alphanumeric text string up to 80 characters long.

distribute-list *in* | *out* *num,num,...* specifies a distribute list to be applied to updates to or from the specified neighbor. The **in** and **out** keywords specify whether the list is applied on updates received from the neighbor, or sent to the neighbor. The

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Basic configuration tasks required for BGP4

num,num,... parameter specifies the list of address-list filters. The device applies the filters in the order in which you list them and stops applying the filters in the distribute list when a match is found.

To use an IP ACL instead of a distribute list, you can specify **distribute-listACL-numin | out**. In this case, *ACL-num* is an IP ACL.

NOTE

By default, if a route does not match any of the filters, the device denies the route. To change the default behavior, configure the last filter as **permit any any**.

NOTE

The address filter must already be configured.

ebgp-btsh enables GTSM protection for the specified neighbor.

ebgp-multihop [*num*] specifies that the neighbor is more than one hop away and that the session type with the neighbor is EBGP-multihop. This option is disabled by default. The *num* parameter specifies the TTL you are adding for the neighbor. You can specify a number from 0 through 255. The default is 0. If you leave the EBGP TTL value set to 0, the software uses the IP TTL value.

enforce-first-as ensures, for this neighbor, that the first AS listed in the AS_SEQUENCE field of an AS path update message from EBGP neighbors is the AS of the neighbor that sent the update.

filter-list in | out num,num... specifies an AS-path filter list or a list of AS-path ACLs. The **in** and **out** keywords specify whether the list is applied on updates received from the neighbor or sent to the neighbor. If you specify **in** or **out**, the *num,num,...* parameter specifies the list of AS-path filters. The device applies the filters in the order in which you list them and stops applying the filters in the AS-path filter list when a match is found.

weight num specifies a weight that the device applies to routes received from the neighbor. You can specify a number from 0 through 65535.

Alternatively, you can specify **filter-list acl-num in | out | weight** to use an AS-path ACL instead of an AS-path filter list. In this case, *acl-num* is an AS-path ACL.

NOTE

By default, if an AS-path does not match any of the filters or ACLs, the device denies the route. To change the default behavior, configure the last filter or ACL as **permit any any**.

NOTE

The AS-path filter or ACL must already be configured.

local-as *as-num* assigns a local AS number with the value specified by the *as-num* variable to the neighbor being configured. The *as-num* has no default value. Its range is 1 - 4294967295.

NOTE

When the **local-as** option is used, the device automatically prepends the local AS number to the routes that are received from the EBGP peer; to disable this behavior, include the **no-prepend** keyword.

maxas-limit in num | disable specifies that the device discard routes that exceed a maximum AS path length received in UPDATE messages. You can specify a value from 0 - 300. The default value is 300. The **disable** keyword is used to stop a neighbor from inheriting the configuration from the peer-group or global and to the use system default value.

maximum-prefix num specifies the maximum number of IP network prefixes (routes) that can be learned from the specified neighbor or peer group . You can specify a value from 0 through 4294967295. The default is 0 (unlimited).

- The *num* parameter specifies the maximum number. The range is 0 through 4294967295. The default is 0 (unlimited).

- The *threshold* parameter specifies the percentage of the value you specified for the **maximum-prefix num**, at which you want the software to generate a Syslog message. You can specify a value from 1 (one percent) to 100 (100 percent). The default is 100.
- The **teardown** parameter tears down the neighbor session if the maximum-prefix limit is exceeded. The session remains shutdown until you clear the prefixes using the **clear ip bgp neighbor all** or **clear ip bgp neighbor** command, or change the maximum prefix configuration for the neighbor. The software also generates a Syslog message.

next-hop-self specifies that the device should list itself as the next hop in updates sent to the specified neighbor. This option is disabled by default.

password string specifies an MD5 password for securing sessions between the device and the neighbor. You can enter a string up to 80 characters long. The string can contain any alphanumeric characters and spaces if the words in the password are placed inside quotes.

NOTE

If you want the software to assume that the value you enter is the clear-text form, and to encrypt display of that form, do not enter 0 or 1. Instead, omit the encryption option and allow the software to use the default behavior. If you specify encryption option 1, the software assumes that you are entering the encrypted form of the password or authentication string. In this case, the software decrypts the password or string you enter before using the value for authentication. If you accidentally enter option 1 followed by the clear-text version of the password or string, authentication will fail because the value used by the software will not match the value you intended to use.

The system creates an MD5 hash of the password and uses it for securing sessions between the device and its neighbors. To display the configuration, the system uses a 2-way encoding scheme to be able to retrieve the original password that was entered.

By default, the password is encrypted. If you want the password to appear in clear text, insert a 0 between the password and the string.

```
device(config-bgp)# neighbor 10.157.22.26 password 0 marmalade
```

The system adds an encryption code followed by the encrypted text of the original password. For example, the following portion of the code has the encrypted code "2".

```
password 2 $IUA2PWC9LW9VIW9zVQ=="
```

One of the following may be displayed:

- 0 = the password is not encrypted and is in clear text
- 2 = the password uses proprietary base64 cryptographic 2-way algorithm

peer-group group-name assigns the neighbor to the specified peer group.

prefix-list string in | out specifies an IP prefix list. You can use IP prefix lists to control routes to and from the neighbor. IP prefix lists are an alternative method to AS-path filters. The **in** and **out** keywords specify whether the list is applied on updates received from the neighbor or sent to the neighbor. The filters can use the same prefix list or different prefix lists.

You must specify a prefix-list that matches an existing prefix-list entry. An implicit deny is applied to traffic that does not match any prefix-list entry. Use the **show ip prefix-list** command to view information about configured prefix-lists.

remote-as as-number specifies the AS in which the remote neighbor resides. The *as-number* has no default value. The range is 1 - 4294967295.

remove-private-as configures the device to remove private AS numbers from update messages the device sends to this neighbor. The device will remove AS numbers 64512 through 65535 (the well-known BGP4 private AS numbers) from the AS-path attribute in update messages the device sends to the neighbor. This option is disabled by default.

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Basic configuration tasks required for BGP4

route-map in | out map-name specifies a route map the device will apply to updates sent to or received from the specified neighbor. The **in** and **out** keywords specify whether the list is applied on updates received from the neighbor or sent to the neighbor.

NOTE

The route map must already be configured.

route-reflector-client specifies that this neighbor is a route-reflector client of the device. Use the parameter only if this device is going to be a route reflector. This option is disabled by default.

send-community enables sending the community attribute in updates to the specified neighbor. By default, the device does not send the community attribute.

shutdown administratively shuts down the session with this neighbor. Shutting down the session lets you configure the neighbor and save the configuration without actually establishing a session with the neighbor.

When a peer is put into the shutdown state, ribout routes are not produced for that peer. You can elect to produce ribout routes using the **generate-rib-out** option. This option is disabled by default.

soft-reconfiguration inbound enables the soft reconfiguration feature, which stores all the route updates received from the neighbor. If you request a soft reset of inbound routes, the software performs the reset by comparing the policies against the stored route updates, instead of requesting the neighbor BGP4 route table or resetting the session with the neighbor.

timers keep-alive num hold-time num overrides the global settings for the Keep Alive Time and Hold Time. For the Keep Alive Time, you can specify 0 - 65535 seconds. For the Hold Time, you can specify 0 or a number in the range 3 through 65535 (1 and 2 are not allowed). If you set the Hold Time to 0, the device waits indefinitely for messages from a neighbor without concluding that the neighbor is non-operational. The defaults for these parameters are the currently configured global Keep Alive Time and Hold Time.

unsuppress-map map-name removes route suppression from neighbor routes when those routes have been dampened due to aggregation.

update-source ip-addr | ethernetunit/slot/portnum | loopbacknum | venum configures the device to communicate with the neighbor through the specified interface. There is no default.

weight num specifies a weight a device will add to routes received from the specified neighbor. BGP4 prefers larger weights over smaller weights. The default weight is 0.

The **send-label** keyword enables IPv6 label capability for the IPv4 peers.

Removing route dampening from suppressed routes

You can selectively un-suppress specific routes that have been suppressed due to aggregation, and allow these routes to be advertised to a specific neighbor or peer group.

```
device(config-bgp) # aggregate-address 10.1.0.0 255.255.0.0 summary-only
device(config-bgp) # show ip bgp route 10.1.0.0/16 longer
Number of BGP Routes matching display condition : 2
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH S:SUPPRESSED F:FILTERED
      Prefix          Next Hop          Metric     LocPrf      Weight Status
      1    10.1.0.0/16        0.0.0.0           101       32768   BAL
AS_PATH:
      2    10.1.44.0/24        10.2.0.1           1        101       32768   BLS
AS_PATH:
```

In this example, the **aggregate-address** command configures an aggregate address of 10.1.0.0 255.255.0.0. and the **summary-only** parameter prevents the device from advertising more specific routes contained within the aggregate route.

Entering a **show ip bgp route** command for the aggregate address 10.1.0.0/16 shows that the more specific routes aggregated into 10.1.0.0/16 have been suppressed. In this case, the route to 10.1.44.0/24 has been suppressed. If you enter this command, the display shows that the route is not being advertised to the BGP4 neighbors.

```
device(config-bgp)# show ip bgp route 10.1.44.0/24
Number of BGP Routes matching display condition : 1
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH S:SUPPRESSED F:FILTERED
  Prefix          Next Hop          Metric      LocPrf      Weight Status
1   10.1.44.0/24       10.2.0.1        1           101        32768  BLS
AS_PATH:
Route is not advertised to any peers
```

To override the **summary-only** parameter and allow a specific route to be advertised to a neighbor, enter commands such as the following

```
device(config)# ip prefix-list Unsuppress1 permit 10.1.44.0/24
device(config)# route-map RouteMap1 permit 1
device(config-route-map RouteMap1)# exit
device(config)# router bgp
device(config-bgp)# neighbor 10.1.0.2 unsuppress-map RouteMap1
device(config-bgp)# clear ip bgp neighbor 10.1.0.2 soft-out
```

The **ip prefix-list** command configures an IP prefix list for network 10.1.44.0/24, which is the route you want to unsuppress. The next two commands configure a route map that uses the prefix list as input. The **neighbor** command enables the device to advertise the routes specified in the route map to neighbor 10.1.0.2. The **clear** command performs a soft reset of the session with the neighbor so that the device can advertise the unsuppressed route.

Syntax: [no] **neighbor** { *ip-addr* | *peer-group-name* } **unsuppress-map** *map-name*

The **show ip bgp route** command verifies that the route has been unsuppressed.

```
device(config-bgp)# show ip bgp route 10.1.44.0/24
Number of BGP Routes matching display condition : 1
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH S:SUPPRESSED F:FILTERED
  Prefix          Next Hop          MED LocPrf      Weight Status
1   10.1.44.0/24       10.2.0.1        1     101        32768  BLS
AS_PATH:
Route is advertised to 1 peers:
10.1.0.2(4)
```

Encrypting BGP4 MD5 authentication keys

When you configure a BGP4 neighbor or neighbor peer group, you can specify an MD5 authentication string to authenticate packets exchanged with the neighbor or peer group of neighbors.

For added security, by default, the software encrypts the display of the authentication string. The software also provides an optional parameter to disable encryption of the authentication string, on an individual neighbor or peer group basis. By default, MD5 authentication strings are displayed in encrypted format in the output of the following commands:

- **show running-config** (or **write terminal**)
- **show configuration**
- **show ip bgp config**

When encryption of the authentication string is enabled, the string is encrypted in the CLI regardless of the access level you are using.

When you save the configuration to the startup configuration file, the file contains the new BGP4 command syntax and encrypted passwords or strings.

Configuring BGP4 (IPv4)

Basic configuration tasks required for BGP4

NOTE

Ruckus recommends that you save a copy of the startup configuration file for each device you plan to upgrade.

Encryption example

The following commands configure a BGP4 neighbor and a peer group, and specify MD5 authentication strings (passwords) to authenticate packets exchanged with the neighbor or peer group.

```
device(config-bgp)# local-as 2
device(config-bgp)# neighbor xyz peer-group
device(config-bgp)# neighbor xyz password abc
device(config-bgp)# neighbor 10.10.200.102 peer-group xyz
device(config-bgp)# neighbor 10.10.200.102 password test
```

The BGP4 configuration commands appear in the following format as a result of the **show ip bgp configuration** command.

```
device# show ip bgp configuration
Current BGP configuration:
router bgp
  local-as 2
  neighbor xyz peer-group
  neighbor xyz password $b24tbw==
  neighbor 10.10.200.102 peer-group xyz
  neighbor 10.10.200.102 remote-as 1
  neighbor 10.10.200.102 password $on-o
```

In this output, the software has converted the commands that specify an authentication string into the new syntax (described below), and has encrypted display of the authentication strings.

Since the default behavior does not affect the BGP4 configuration itself but does encrypt display of the authentication string, the CLI does not list the encryption options.

Syntax: [no] **neighbor** { *ip-addr* | *peer-group-name* } **password** *string*

The *ip-addr* | *peer-group-name* parameter indicates whether you are configuring an individual neighbor or a peer group. If you specify the IP address of a neighbor, you are configuring that individual neighbor. If you specify a peer group name, you are configuring a peer group.

If you want the software to assume that the value you enter is the clear-text form and to encrypt the display of that form, do not enter 0 or 1. Instead, omit the encryption option and allow the software to use the default behavior. If you specify encryption option 1, the software assumes that you are entering the encrypted form of the password or authentication string. In this case, the software decrypts the password or string you enter before using the value for authentication. If you accidentally enter option 1 followed by the clear-text version of the password or string, authentication will fail because the value used by the software will not match the value you intended to use.

The **password** *string* parameter specifies an MD5 authentication string to secure sessions between the device and the neighbor. You can enter a string of up to 80 characters. The string can contain any alphanumeric characters, but must be placed inside quotes if it contains a space.

The system creates an MD5 hash of the password and uses it to secure sessions between the device and the neighbors. To display the configuration, the system uses a 2-way encoding scheme to retrieve the original password.

By default, password is encrypted. If you want the password to be in clear text, insert a 0 between **password** and *string*.

```
device(config-bgp)# neighbor 10.157.22.26 password admin
```

Displaying the authentication string

To display the authentication string, enter the following commands.

```
device(config)# enable password-display
device(config)# show ip bgp neighbors
```

The **enable password-display** command enables display of the authentication string, but only in the output of the **show ip bgp neighbors** command. String display is still encrypted in the startup configuration file and running configuration. Enter the command at the global CONFIG level of the CLI.

NOTE

The command also displays SNMP community strings in clear text, in the output of the **show snmp server** command.

Displaying neighbor information

To display IPv6 unicast route summary information, enter the **show ip bgp ipv6 summary** command:

```
device(config-bgp)# show ip bgp ipv6 summary
BGP4 Summary
Router ID: 10.1.1.1 Local AS Number: 1
Confederation Identifier: not configured
Confederation Peers:
Maximum Number of IP ECMP Paths Supported for Load Sharing: 1
Number of Neighbors Configured: 1, UP: 1
Number of Routes Installed: 1, Uses 86 bytes
Number of Routes Advertising to All Neighbors: 0 (0 entries)
Number of Attribute Entries Installed: 1, Uses 90 bytes
Neighbor Address AS# State Time Rt:Accepted Filtered Sent ToSend
192.168.1.2 2 ESTAB 0h 1m51s 1 0 0 0
```

Syntax: show ip bgp ipv6 summary

To display IPv6 unicast device information with respect to the IPv4 neighbor, enter the **show ip bgp ipv6 neighbors** command:

```
device(config-bgp)# show ip bgp ipv6 neighbors
Total number of BGP Neighbors: 1
1 IP Address: 192.168.1.2, AS: 2 (EBGP), RouterID: 10.1.1.2, VRF: default-vrf
State: ESTABLISHED, Time: 0h8m33s, KeepAliveTime: 60, HoldTime: 180
KeepAliveTimer Expire in 17 seconds, HoldTimer Expire in 135 seconds
UpdateSource: Loopback 1
RefreshCapability: Received
.....
Neighbor NLRI Negotiation:
Peer Negotiated IPV6 unicast capability
Peer configured for IPV6 unicast Routes
Neighbor AS4 Capability Negotiation:
TCP Connection state: ESTABLISHED, flags:00000033 (0,0)
```

Syntax: show ip bgp ipv6 neighbors [last-packet-with-error] [routes-summary] [ip-address]

The **neighbors** parameter provides details on TCP and BGP neighbor connections. The **last-packet-with-error** parameter displays the last packet received with error. The **routes-summary** parameter displays the routes summary.

The *ip-address* parameter is the neighbor IP address. The following sub-parameters are available for the *ip-address* parameter:

[advertised routes] [flap-statistics] [last-packet-with-error] [received] [received-routes] [rib-out-routes] [routes][routes-summary]

The **advertised-routes** parameter displays routes advertised to a neighbor. The **flap-statistics** parameter displays flap statistics for a neighbor. The **last-packet-with-error** parameter displays the last packet received with error. The **received** parameter displays the received ORF from neighbor. The **received-routes** parameter displays the received routes from neighbor. The **rib-**

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Basic configuration tasks required for BGP4

out-routes parameter displays RIB-out routes for a neighbor. The **routes** parameter displays routes learned from neighbor. The **routes-summary** parameter displays routes summary for a neighbor.

Clearing IPv6 route information

To clear IPv6 unicast route information with respect to IPv4 neighbors, enter the **clear ip bgp ipv6 neighbor** command.

Syntax: **clear ip bgp ipv6 [neighbor] [as-number | ipaddress | peer-group-name | all]**

The **dampening** parameter clears route flap dampening information. The **flap-statistics** parameter clears route flap statistics.

The **local** parameter clears local information. The **routes** parameter clears BGP routes. The **traffic** parameter clears BGP traffic counters. The **ipv6** parameter clears information for ipv6 address family. The **vpnv4** parameter clears information for VPNV4 address family. The **vrf** parameter clears information for a VRF instance.

The **neighbor** parameter has the following sub-parameters:

as-number identifies neighbors with the specified AS number, 1-4294967295. *ipaddress* identifies the neighbor IP address. *peer-group-name* clears the peer group name identified using ASCII string. *all* clears all BGP neighbors.

Adding a BGP4 peer group

A peer group is a set of BGP4 neighbors that share common parameters. The benefits of peer groups are:

- Simplified neighbor configuration - You can configure a set of neighbor parameters and then apply them to multiple neighbors. You do not need to configure the common parameters individually on each neighbor.
- Flash memory conservation - Using peer groups instead of individually configuring all the parameters for each neighbor requires fewer configuration commands in the startup configuration file.

You can perform the following tasks on a peer-group basis:

- Reset neighbor sessions
- Perform soft-outbound resets (the device updates outgoing route information to neighbors but does not entirely reset the sessions with those neighbors)
- Clear BGP4 message statistics
- Clear error buffers

Peer group parameters

You can set all neighbor parameters in a peer group. When you add a neighbor to the peer group, the neighbor receives all the parameter settings you set in the group, except parameter values you have explicitly configured for the neighbor. If you do not set a neighbor parameter in the peer group and the parameter also is not set for the individual neighbor, the neighbor uses the default value.

Peer group configuration rules

The following rules apply to peer group configuration:

- You must configure a peer group before you can add neighbors to the peer group.
- If you remove a parameter from a peer group, the value for that parameter is reset to the default for all the neighbors within the peer group, unless you have explicitly set that parameter on individual neighbors. In this case, the value you set on the individual neighbors applies to those neighbors, while the default value applies to neighbors for which you have not explicitly set the value.

NOTE

If you enter a command to remove the remote AS parameter from a peer group, the software makes sure that the peer group does not contain any neighbors. If the peer group contains neighbors, the software does not allow you to remove the remote AS so that the neighbors in the peer group that are using the remote AS do not lose connectivity to the device.

You can override neighbor parameters that do not affect outbound policy on an individual neighbor basis:

- If you do not specify a parameter for an individual neighbor, the neighbor uses the value in the peer group.
- If you set the parameter for the individual neighbor, that value overrides the value you set in the peer group.
- If you add a parameter to a peer group that already contains neighbors, the parameter value is applied to neighbors that do not already have the parameter explicitly set. If a neighbor has the parameter explicitly set, the explicitly set value overrides the value you set for the peer group.
- If you remove the setting for a parameter from a peer group, the value for that parameter changes to the default value for all the neighbors in the peer group that do not have that parameter individually set.

Configuring a peer group

To configure a peer group, enter commands such as the following at the BGP4 configuration level.

```
device(config-bgp-router)# neighbor PeerGroup1 peer-group
device(config-bgp-router)# neighbor PeerGroup1 description "EastCoast Neighbors"
device(config-bgp-router)# neighbor PeerGroup1 remote-as 100
device(config-bgp-router)# neighbor PeerGroup1 distribute-list out 1
device(config-bgp-router)# neighbor PeerGroup1 capability as4 enable|disable
```

The commands in this example configure a peer group called "PeerGroup1" and set the following parameters for the peer group:

- A description, "EastCoast Neighbors"
- A remote AS number, 100
- A distribute list for outbound traffic
- The capability of PeerGroup1 to utilize a four-byte AS number

The software applies these parameters to each neighbor you add to the peer group. You can override the description parameter for individual neighbors. If you set the description parameter for an individual neighbor, the description overrides the description configured for the peer group.

Syntax: `neighbor peer-group-name peer-group`

The `peer-group-name` parameter specifies the name of the group and can be up to 80 characters long. The name can contain special characters and internal blanks. If you use internal blanks, you must use quotation marks around the name. For example, the command **neighbor "My Three Peers"** peer-group is valid, but the command **neighbor My Three Peers** peer-group is not valid.

Syntax: [no] `neighbor ip-addr | peer-group-name [advertisement-interval num] [default-originate [route-map map-name]] [description string] [distribute-list { in | out } num,num... | ACL-num in | out] [ebgp-multihop [num]] [filter-list in | out num,num... | acl-num | out | weight] [maxas-limit in [num | disable]] [maximum-prefix num [threshold] [teardown]] [next-hop-self] [password string] [prefix-list string in | out] remote-as as-number] [remove-private-as] [route-map-in | out map-name] [route-reflector-client] [send-community] [soft-reconfiguration inbound] [shutdown] [timers keep-alive num hold-time num] [update-source loopback num ethernet unit/slot/port | loopback num | ve num] [weight num] [local-as as-num]`

The `ip-addr` and `peer-group-name` parameters indicate whether you are configuring a peer group or an individual neighbor. You can specify a peer group name or IP address with the **neighbor** command. If you specify a peer group name, you are configuring

Configuring BGP4 (IPv4)

Basic configuration tasks required for BGP4

a peer group. If you specify a neighbor IP address, you are configuring that individual neighbor. Use the *ip-addr* parameter if you are configuring an individual neighbor instead of a peer group.

The remaining parameters are the same ones supported for individual neighbors.

Applying a peer group to a neighbor

After you configure a peer group, you can add neighbors to the group. When you add a neighbor to a peer group, you are applying all the neighbor attributes specified in the peer group to the neighbor.

To add neighbors to a peer group, enter commands such as the following.

```
device(config-bgp-router) # neighbor 192.168.1.12 peer-group PeerGroup1  
device(config-bgp-router) # neighbor 192.168.2.45 peer-group PeerGroup1  
device(config-bgp-router) # neighbor 192.168.3.69 peer-group PeerGroup1
```

The commands in this example add three neighbors to the peer group "PeerGroup1". As members of the peer group, the neighbors automatically receive the neighbor parameter values configured for the peer group. You also can override the parameters on an individual neighbor basis. For neighbor parameters not specified for the peer group, the neighbors use the default values.

Syntax: [no] **neighbor** *ip-addr* **peer-group** *peer-group-name*

The *ip-addr* parameter specifies the IP address of the neighbor.

The *peer-group-name* parameter specifies the peer group name.

NOTE

You must add the peer group before you can add neighbors to it.

Administratively shutting down a session with a BGP4 neighbor

You can prevent the device from starting a BGP4 session with a neighbor by administratively shutting down the neighbor. This option is very useful for situations in which you want to configure parameters for a neighbor, but are not ready to use the neighbor. You can shut the neighbor down as soon as you have added it to the device, configure the neighbor parameters, then allow the device to reestablish a session with the neighbor by removing the shutdown option from the neighbor.

When you apply the option to shut down a neighbor, the option takes place immediately and remains in effect until you remove it. If you save the configuration to the startup configuration file, the shutdown option remains in effect even after a software reload.

The software also contains an option to end the session with a BGP4 neighbor and clear the routes learned from the neighbor. Unlike this clear option, the option for shutting down the neighbor can be saved in the startup configuration file and can prevent the device from establishing a BGP4 session with the neighbor even after reloading the software.

NOTE

If you notice that a particular BGP4 neighbor never establishes a session with the device, check the running configuration and startup configuration files for that device to see whether the configuration contains a command that is shutting down the neighbor. The neighbor may have been shut down previously by an administrator.

To shut down a BGP4 neighbor, enter commands such as the following.

```
device(config) # router bgp  
device(config-bgp-router) # neighbor 10.157.22.26 shutdown  
device(config-bgp-router) # write memory
```

Syntax: [no] **neighbor** *ip-addr* **shutdown** [**generate-rib-out**]

The *ip-addr* parameter specifies the IP address of the neighbor.

Optional BGP4 configuration tasks

The following sections describe how to perform optional BGP4 configuration tasks.

Changing the Keep Alive Time and Hold Time

The Keep Alive Time specifies how frequently the device will send KEEPALIVE messages to its BGP4 neighbors. The Hold Time specifies how long the device will wait for a KEEPALIVE or UPDATE message from a neighbor before concluding that the neighbor is dead. When the device concludes that a BGP4 neighbor is dead, the device ends the BGP4 session and closes the TCP connection to the neighbor.

The default Keep Alive time is 60 seconds. The default Hold Time is 180 seconds.

NOTE

Generally, you should set the Hold Time to three times the value of the Keep Alive Time.

NOTE

You can override the global Keep Alive Time and Hold Time on individual neighbors.

To change the Keep Alive Time to 30 and Hold Time to 90, enter the following command.

```
device(config-bgp-router) # timers keep-alive 30 hold-time 90
```

Syntax: [no] **timers keep-alive num hold-time num**

For each keyword, *num* indicates the number of seconds. The Keep Alive Time can be 0 - 65535. The Hold Time can be 0 or 3 - 65535 (1 and 2 are not allowed). If you set the Hold Time to 0, the device waits indefinitely for messages from a neighbor without concluding that the neighbor is dead.

Changing the BGP4 next-hop update timer

By default, the device updates the BGP4 next-hop tables and affected BGP4 routes five seconds after IGP route changes. You can change the update timer to a value from 1 through 30 seconds.

To change the BGP4 update timer value to 15 seconds, for example, enter the **update-time** command at the BGP configuration level of the CLI.

```
device(config-bgp-router) # update-time 15
```

Syntax: [no] **update-time secs**

The *secs* parameter specifies the number of seconds and can be from 0 through 30. The default is 5. The value of 0 permits fast BGP4 convergence for situations such as link-failure or IGP route changes. Setting the value to 0 starts the BGP4 route calculation in sub-second time. All other values from 1 through 30 are still calculated in seconds.

Enabling fast external failover

BGP4 devices rely on KEEPALIVE and UPDATE messages from neighbors to signify that the neighbors are alive. For BGP4 neighbors that are two or more hops away, such messages are the only indication that the BGP4 protocol has concerning the alive state of the neighbors. As a result, if a neighbor becomes non-operational, the device waits until the Hold Time expires or the TCP connection fails before concluding that the neighbor is not operational and closing its BGP4 session and TCP connection with the neighbor.

The device waits for the Hold Time to expire before ending the connection to a directly-attached BGP4 neighbor that becomes non-operational.

For directly-attached neighbors, the device immediately senses loss of a connection to the neighbor from a change of state of the port or interface that connects the device to the neighbor. For directly-attached EBGP neighbors, the device uses this information to immediately close the BGP4 session and TCP connection to locally attached neighbors that become non-operational.

NOTE

The fast external failover feature applies only to directly attached EBGP neighbors. The feature does not apply to IBGP neighbors.

To enable fast external failover, enter the following command.

```
device(config-bgp-router) # fast-external-fallover
```

To disable fast external failover again, enter the following command.

```
device(config-bgp-router) # no fast-external-fallover
```

Syntax: [no] **fast-external-fallover**

Changing the maximum number of paths for BGP4 Multipath load sharing

Multipath load sharing enables the device to balance traffic to a route across multiple equal-cost paths of the same route type (EBGP or IBGP).

To configure the device to perform BGP4 Multipath load sharing:

- Enable IP load sharing if it is disabled.
- Set the maximum number of BGP4 load sharing paths. The default maximum number is 1, which means no BGP4 load sharing takes place by default.

NOTE

The maximum number of BGP4 load sharing paths cannot be greater than the maximum number of IP load sharing paths.

How Multipath load sharing affects route selection

During evaluation of multiple paths to select the best path to a given destination (for installment in the IP route table), the device performs a final comparison of the internal paths. The following events occur when load sharing is enabled or disabled:

- When load sharing is disabled, the device prefers the path with the lower device ID if the **compare-routerid** command is enabled.
- When load sharing and BGP4 Multipath load sharing are enabled, the device balances the traffic across multiple paths instead of choosing just one path based on device ID.

Refer to [How BGP4 selects a path for a route \(BGP best path selection algorithm\)](#) on page 357 for a description of the BGP4 algorithm.

When you enable IP load sharing, the device can load-balance BGP4 or OSPF routes across up to four equal paths by default. You can change the number load sharing paths to a value from 2 through 8.

How Multipath load sharing works

Multipath load sharing is performed in round-robin fashion and is based on the destination IP address only. The first time the device receives a packet destined for a specific IP address, the device uses a round-robin algorithm to select the path that was not used for the last newly learned destination IP address. Once the device associates a path with a particular destination IP address, the device will always use that path as long as the device contains the destination IP address in its cache.

NOTE

The device does not perform source routing. The device is concerned only with the paths to the next-hop devices, not the entire paths to the destination hosts.

A BGP4 destination can be learned from multiple BGP4 neighbors, leading to multiple BGP4 paths to reach the same destination. Each of the paths may be reachable through multiple IGP paths (multiple OSPF or RIP paths). In this case, the software installs all the multiple equal-cost paths in the BGP4 route table, up to the maximum number of BGP4 equal-cost paths allowed. The IP load sharing feature then distributes traffic across the equal-cost paths to the destination.

If an IGP path used by a BGP4 next-hop route path installed in the IP route table changes, then the BGP4 paths and IP paths are adjusted accordingly. For example, if one of the OSPF paths to reach the BGP4 next hop goes down, the software removes this path from the BGP4 route table and the IP route table. Similarly, if an additional OSPF path becomes available to reach the BGP4 next-hop device for a particular destination, the software adds the additional path to the BGP4 route table and the IP route table.

Changing the maximum number of shared BGP4 paths

To change the maximum number of BGP4 shared paths, enter commands such as the following.

```
device(config)# router bgp  
device(config-bgp-router)# maximum-paths 4  
device(config-bgp-router)# write memory
```

Syntax: [no] maximum-paths num | use-load-sharing

The *number* parameter specifies the maximum number of paths across which the device can balance traffic to a given BGP4 destination. The *number* value range is 2 through 8 and the default is 1.

When the **use-load-sharing** option is used in place of the *number* variable, the maximum IP ECMP path value is determined solely by the value configured using the **ip load-sharing** command.

Customizing BGP4 Multipath load sharing

By default, when BGP4 Multipath load sharing is enabled, both IBGP and EBGP paths are eligible for load sharing, while paths from different neighboring autonomous systems are not eligible. You can change load sharing to apply only to IBGP or EBGP paths, or to support load sharing among paths from different neighboring autonomous systems.

To enable load sharing of IBGP paths only, enter the following command at the BGP4 configuration level of the CLI.

```
device(config-bgp-router)# multipath ibgp
```

To enable load sharing of EBGP paths only, enter the following command at the BGP4 configuration level of the CLI.

```
device(config-bgp-router) # multipath ebgp
```

To enable load sharing of paths from different neighboring autonomous systems, enter the following command at the BGP4 configuration level of the CLI.

```
device(config-bgp) # multipath multi-as
```

Syntax: [no] multipath ebgp | ibgp | multi-as

The **ebgp**, **bgp**, and **multi-as** parameters specify the change you are making to load sharing:

- **ebgp** - Multipath load sharing applies only to EBGP paths. Multipath load sharing is disabled for IBGP paths.
- **ibgp** - Multipath load sharing applies only to IBGP paths. Multipath load sharing is disabled for EBGP paths.
- **multi-as** - Multipath load sharing is enabled for paths from different autonomous systems.

By default, load sharing applies to EBGP and IBGP paths, and does not apply to paths from different neighboring autonomous systems.

Enhancements to BGP4 Multipath load sharing

Enhancements to BGP4 Multipath load sharing allows support for load sharing of BGP4 routes in IP ECMP even if the BGP4 Multipath load sharing feature is not enabled through the **use-load-sharing** option to the **maximum-paths** command. Using the following commands, you can also set separate values for IBGP and EBGP multipath load sharing.

To set the number of equal-cost multipath IBGP routes or paths that will be selected, enter commands such as the following.

```
device(config) # router bgp  
device(config-bgp) # maximum-paths ibgp
```

Syntax: [no] maximum-paths ibgp *number*

The *number* variable specifies the number of equal-cost multipath IBGP routes that will be selected. The range is 2 to 8. If the value is set to 1, BGP4 level equal-cost multipath is disabled for IBGP routes.

To set the number of equal-cost multipath EBGP routes or paths that will be selected, enter commands such as the following.

```
device(config) # router bgp  
device(config-bgp) # maximum-paths ebgp
```

Syntax: [no] maximum-paths ebgp *num*

The *number* variable specifies the number of equal-cost multipath EBGP routes that will be selected. The range is 2 to 8. If the value is set to 1, BGP4 level equal-cost multipath is disabled for EBGP routes.

Specifying a list of networks to advertise

By default, the device sends BGP4 routes only for the networks you either identify with the **network** command or are redistributed into BGP4 from OSPF, RIP, or connected routes.

NOTE

The exact route must exist in the IP route table before the device can create a local BGP4 route.

To configure the device to advertise network 10.157.22.0/24, enter the following command.

```
device(config-bgp-router) # network 10.157.22.0 255.255.255.0
```

Syntax: [no] network *ip-addr ip-mask* [route-map** *map-name*] | [**weight** *num*] | [**backdoor**]**

The *ip-addr* is the network number and the *ip-mask* specifies the network mask.

The **route-map** *map-name* parameter specifies the name of the route map you want to use to set or change BGP4 attributes for the network you are advertising. The route map must already be configured. If it is not, the default action is to deny redistribution.

The **weight** *num* parameter specifies a weight to be added to routes to this network.

The **backdoor** parameter changes the administrative distance of the route to this network from the EBGP administrative distance (20 by default) to the Local BGP4 weight (200 by default), tagging the route as a backdoor route. Use this parameter when you want the device to prefer IGP routes such as RIP or OSPF routes over the EBGP route for the network.

Specifying a route map when configuring BGP4 network advertising

You can specify a route map when you configure a BGP4 network to be advertised. The device uses the route map to set or change BGP4 attributes when creating a local BGP4 route.

NOTE

You must configure the route map *before* you can specify the route map name in a BGP4 network configuration; otherwise, the route is not imported into BGP4.

To configure a route map, and use it to set or change route attributes for a network you define for BGP4 to advertise, enter commands such as the following.

```
device(config)# route-map set_net permit 1
device(config-routemap set_net)# set community no-export
device(config-routemap set_net)# exit
device(config)# router bgp
device(config-bgp)# network 10.100.1.0/24 route-map set_net
```

The first two commands in this example create a route map named "set_net" that sets the community attribute for routes that use the route map to "NO_EXPORT". The next two commands change the CLI to the BGP4 configuration level. The last command configures a network for advertising from BGP4, and associates the "set_net" route map with the network. When BGP4 originates the 10.100.1.0/24 network, BGP4 also sets the community attribute for the network to "NO_EXPORT".

Changing the default local preference

When the device uses the BGP4 algorithm to select a route to send to the IP route table, one of the parameters the algorithm uses is the local preference. Local preference indicates a degree of preference for a route relative to other routes. BGP4 neighbors can send the local preference value as an attribute of a route in an UPDATE message.

Local preference applies only to routes within the local AS. BGP4 devices can exchange local preference information with neighbors who also are in the local AS, but BGP4 devices do not exchange local preference information with neighbors in remote autonomous systems.

The default local preference is 100. For routes learned from EBGP neighbors, the default local preference is assigned to learned routes. For routes learned from IBGP neighbors, the local preference value is not changed for the route.

When the BGP4 algorithm compares routes on the basis of local preferences, the route with the higher local preference is chosen.

NOTE

To set the local preference for individual routes, use route maps.

To change the default local preference to 200, enter the following command.

```
device(config-bgp) # default-local-preference 200
```

Syntax: [no] **default-local-preference** *num*

The *num* parameter indicates the preference and can be a value from 0 - 4294967295.

Using the IP default route as a valid next-hop for a BGP4 route

By default, the device does not use a default route to resolve a BGP4 next-hop route. If the IP route lookup for the BGP4 next-hop does not result in a valid IGP route (including static or direct routes), the BGP4 next-hop is considered to be unreachable and the BGP4 route is not used.

In some cases, such as when the device is acting as an edge device, you can allow the device to use the default route as a valid next-hop. To do so, enter the following command at the BGP4 configuration level of the CLI.

```
device(config-bgp) # next-hop-enable-default
```

Syntax: [no] **next-hop-enable-default**

Changing the default MED (Metric) used for route redistribution

The Ruckus device can redistribute directly connected routes, static IP routes, RIP routes, and OSPF routes into BGP4. The MED (metric) is a global parameter that specifies the cost that will be applied to all routes by default when they are redistributed into BGP4. When routes are selected, lower metric values are preferred over higher metric values. The default BGP4 MED value is 0 and can be assigned a value from 0 through 4294967295.

NOTE

RIP and OSPF also have default metric parameters. The parameters are set independently for each protocol and have different ranges.

To change the default metric to 40, enter the following command.

```
device(config-bgp-router) # default-metric 40
```

Syntax: **default-metric** *num*

The *num* indicates the metric and can be a value from 0 through 4294967295.

Enabling next-hop recursion

For each BGP4 route learned, the device performs a route lookup to obtain the IP address of the next-hop for the route. A BGP4 route is eligible for addition in the IP route table only if the following conditions are true:

- The lookup succeeds in obtaining a valid next-hop IP address for the route.
- The path to the next-hop IP address is an IGP path or a static route path.

By default, the software performs only one lookup for the next-hop IP address for the BGP4 route. If the next-hop lookup does not result in a valid next-hop IP address, or the path to the next-hop IP address is a BGP4 path, the software considers the BGP4 route destination to be unreachable. The route is not eligible to be added to the IP route table.

The BGP4 route table can contain a route with a next-hop IP address that is not reachable through an IGP route, even though the device can reach a hop farther away through an IGP route. This can occur when the IGPs do not learn a complete set of IGP

routes, so the device learns about an internal route through IBGP instead of through an IGP. In this case, the IP route table will not contain a route that can be used to reach the BGP4 route destination.

To enable the device to find the IGP route to the next-hop gateway for a BGP4 route, enable recursive next-hop lookups. With this feature enabled, if the first lookup for a BGP4 route results in an IBGP path that originated within the same AS, rather than an IGP path or static route path, the device performs a lookup on the next-hop IP address for the next-hop gateway. If this second lookup results in an IGP path, the software considers the BGP4 route to be valid and adds it to the IP route table. Otherwise, the device performs another lookup on the next-hop IP address of the next-hop for the next-hop gateway, and so on, until one of the lookups results in an IGP route.

NOTE

You must configure a static route or use an IGP to learn the route to the EBGP multihop peer.

Enabling recursive next-hop lookups

The recursive next-hop lookups feature is disabled by default. To enable recursive next-hop lookups, enter the following command at the BGP4 configuration level of the CLI.

```
device(config-bgp-router) # next-hop-recursion
```

Syntax: [no] next-hop-recursion

Example when recursive route lookups are disabled

The output here shows the results of an unsuccessful next-hop lookup for a BGP4 route. In this case, next-hop recursive lookups are disabled. This example is for the BGP4 route to network 10.0.0.0/24.

```
device# show ip bgp route
Total number of BGP Routes: 5
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED S:STALE
      Prefix      Next Hop      MED      LocPrf      Weight      Status
1    0.0.0.0/0      10.1.0.2      0      100      0      BI
          AS PATH: 65001 4355 701 80
2    10.10.0.0/24      10.0.0.1      1      100      0      BI
          AS PATH: 65001 4355 1
3    10.40.0.0/24      10.1.0.2      0      100      0      BI
          AS PATH: 65001 4355 701 1 189
4    10.0.0.0/24      10.0.0.1      1      100      0      I
          AS PATH: 65001 4355 3356 7170 1455
5    10.25.0.0/24      10.157.24.1      1      100      0      I
          AS PATH: 65001 4355 701
```

In this example, the device cannot reach 10.0.0.0/24, because the next-hop IP address for the route is an IBGP route instead of an IGP route, and is considered unreachable by the device. The IP route table entry for the next-hop gateway for the BGP4 route's next-hop gateway (10.0.0.1/24) is shown here.

```
device# show ip route 10.0.0.1
Total number of IP routes: 37
      Network Address      NetMask      Gateway      Port      Cost      Type
      10.0.0.0          10.255.255.255      10.0.0.1      1/1      1      B
```

Since the route to the next-hop gateway is a BGP4 route, and not an IGP route, it cannot be used to reach 10.0.0.0/24. In this case, the device tries to use the default route, if present, to reach the subnet that contains the BGP4 route next-hop gateway.

```
device# show ip route 10.0.0.0/24
Total number of IP routes: 37
      Network Address      NetMask      Gateway      Port      Cost      Type
      0.0.0.0          0.0.0.0      10.0.0.202      1/1      1      S
```

Example when recursive route lookups are enabled

When recursive next-hop lookups are enabled, the device continues to look up the next-hop gateways along the route until the device finds an IGP route to the BGP4 route destination.

```
device# show ip bgp route
Total number of BGP Routes: 5
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:ISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED s:STALE
Prefix      Next Hop      MED      LocPrf      Weight Status
1   0.0.0.0/0    10.1.0.2    0        100        0        BI
      AS PATH: 65001 4355 701 80
2   10.10.0.0/24 10.0.0.1    1        100        0        BI
      AS PATH: 65001 4355 1
3   10.40.0.0/24 10.1.0.2    0        100        0        BI
      AS PATH: 65001 4355 701 1 189
4   10.0.0.0/24  10.0.0.1    1        100        0        BI
      AS PATH: 65001 4355 3356 7170 1455
5   10.25.0.0/24 10.157.24.1 1        100        0        I
      AS PATH: 65001 4355 701
```

The first lookup results in an IBGP route, to network 10.0.0.0/24.

```
device# show ip route 10.0.0.1
Total number of IP routes: 38
Network Address  NetMask      Gateway      Port      Cost      Type
10.0.0.0        255.255.255.0 10.0.0.1    1/1       1        B
AS PATH: 65001 4355 1
```

Since the route to 10.0.0.1/24 is not an IGP route, the device cannot reach the next hop through IP, and so cannot use the BGP4 route. In this case, since recursive next-hop lookups are enabled, the device next performs a lookup for the next-hop gateway to 10.0.0.1's next-hop gateway, 10.0.0.1.

```
device# show ip bgp route 10.0.0.0
Number of BGP Routes matching display condition : 1
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:ISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED s:STALE
Prefix      Next Hop      Metric      LocPrf      Weight Status
1   10.0.0.0/24 10.0.0.1    1        100        0        BI
      AS PATH: 65001 4355 1
```

The next-hop IP address for 10.0.0.1 is not an IGP route, which means the BGP4 route destination still cannot be reached through IP. The recursive next-hop lookup feature performs a lookup on the next-hop gateway for 10.0.0.1

```
device# show ip route 10.0.0.1
Total number of IP routes: 38
Network Address  NetMask      Gateway      Port      Cost      Type
10.0.0.0        255.255.255.0 0.0.0.0    1/1       1        D
AS PATH: 65001 4355 1 1
```

This lookup results in an IGP route that is a directly-connected route. As a result, the BGP4 route destination is now reachable through IGP, which means the BGP4 route can be added to the IP route table. The IP route table with the BGP4 route is shown here.

```
device# show ip route 10.0.0.0/24
Total number of IP routes: 38
Network Address  NetMask      Gateway      Port      Cost      Type
10.0.0.0        255.255.255.0 10.0.0.1    1/1       1        B
AS PATH: 65001 4355 1
```

The device can use this route because it has an IP route to the next-hop gateway. Without recursive next-hop lookups, this route would not be in the IP route table.

Changing administrative distances

BGP4 devices can learn about networks from various protocols, including the EBGP portion of BGP4, and IGPs such as OSPF and RIP, the routes to a network may differ depending on the protocol from which the routes were learned.

To select one route over another based on the source of the route information, the device can use the administrative distances assigned to the sources. The administrative distance is a protocol-independent metric that IP devices use to compare routes from different sources.

The device re-advertises a learned best BGP4 route to neighbors even when the route table manager does not also select that route for installation in the IP route table. The best BGP4 route is the BGP4 path that BGP4 selects based on comparison of the paths' BGP4 route parameters.

When selecting a route from among different sources (BGP4, OSPF, RIP, static routes, and so on), the software compares the routes on the basis of the administrative distance for each route. If the administrative distance of the paths is lower than the administrative distance of paths from other sources (such as static IP routes, RIP, or OSPF), the BGP4 paths are installed in the IP route table.

The default administrative distances on the device are:

- Directly connected - 0 (this value is not configurable)
- Static - 1 is the default and applies to all static routes, including default routes. This can be assigned a different value.
- EBGP - 20
- OSPF - 110
- RIP - 120
- IBGP - 200
- Local BGP4 - 200
- Unknown - 255 (the device will not use this route)

Lower administrative distances are preferred over higher distances. For example, if the device receives routes for the same network from OSPF and from RIP, the device will prefer the OSPF route by default. The administrative distances are configured in different places in the software. The device re-advertises a learned best BGP4 route to neighbors by default, regardless of whether the administrative distance for the route is lower than the administrative distances of other routes from different route sources to the same destination:

- To change the EBGP, IBGP, and Local BGP4 default administrative distances, refer to the instructions in this section.
- To change the default administrative distance for OSPF, RIP, refer to [Configuring a static BGP4 network](#) on page 439.
- To change the administrative distance for static routes, refer to the instructions in this section.

To change the default administrative distances for EBGP, IBGP, and Local BGP4, enter a command such as the following.

```
device(config-bgp-router) # distance 200 200 200
```

Syntax: [no] **distance** *external-distance* *internal-distance* *local-distance*

The *external-distance* sets the EBGP distance and can be a value from 1 through 255.

The *internal-distance* sets the IBGP distance and can be a value from 1 through 255.

The *local-distance* sets the Local BGP4 distance and can be a value from 1 through 255.

Requiring the first AS to be the neighbor AS

By default, the Ruckus device does not require the first AS listed in the AS_SEQUENCE field of an AS path update message from EBGP neighbors to be the AS of the neighbor that sent the update. However, you can enable the Ruckus device to have this requirement. You can enable this requirement globally for the device, or for a specific neighbor or peer group. This section describes how to enable this requirement.

When you configure the device to require that the AS an EBGP neighbor is in be the same as the first AS in the AS_SEQUENCE field of an update from the neighbor, the device accepts the update only if the AS numbers match. If the AS numbers do not match, the Ruckus device sends a notification message to the neighbor and closes the session. The requirement applies to all updates received from EBGP neighbors.

The hierarchy for enforcement of this feature is: a neighbor will try to use the enforce-first-as value if one is configured; if none is configured, the neighbor will try to use the configured value for a peer group. If neither configuration exists, enforcement is simply that of the global configuration (which is disabled by default).

To enable this feature globally, enter the **enforce-first-as** command at the BGP4 configuration level of the CLI.

```
device(config-bgp-router) # enforce-first-as
```

Syntax: [no] **enforce-first-as**

To enable this feature for a specific neighbor, enter the following command at the BGP4 configuration level.

```
device(config-bgp) # neighbor 10.1.1.1 enforce-first-as enable
```

Syntax: [no] **neighbor ip-address enforce-first-as [enable | disable]**

The *ip-address* value is the IP address of the neighbor.

When the first-as requirement is enabled, its status appears in the output of the **show running configuration** command. The optional last keyword choice of **enable** or **disable** lets you specify whether the output of the **show running configuration** command includes the configuration of the first-as requirement. This option allows the **show running configuration** command output to show what is actually configured.

To enable this feature for a peer group, enter the following command at the BGP4 configuration level.

```
device(config-bgp) # neighbor Peergroup1 enforce-first-as enable
```

Syntax: [no] **neighbor peer-group-name enforce-first-as [enable | disable]**

The *peer-group-name* value is the name of the peer group.

When the first-as requirement is enabled, its status appears in the output of the **show running configuration** command. The optional last keyword choice, that of **enable** or **disable**, lets you specify whether the output of the **show running configuration** command includes the configuration of the first-as requirement: this option helps the **show running** command output to show what you have actually configured.

The following example shows a running configuration with the first-as enforcement items (for global, peer group, and neighbor) in bold.

```
device(config) # router bgp
BGP4: Please configure 'local-as' parameter in order to enable BGP4.
device(config-bgp) # local-as 1

device(config-bgp) # enforce-first-as
device(config-bgp) # neighbor abc peer-group
device(config-bgp) # neighbor abc remote-as 2
device(config-bgp) # neighbor abc enforce-first-as disable
device(config-bgp) # neighbor 192.168.1.2 peer-group abc
device(config-bgp) # neighbor 192.168.1.2 enforce-first-as enable
```

Disabling or re-enabling comparison of the AS-Path length

AS-Path comparison is Step 5 in the algorithm that BGP4 uses to select the next path for a route. Comparison of the AS-Path length is enabled by default. To disable it, enter the following command at the BGP4 configuration level of the CLI.

```
device(config-bgp) # as-path-ignore
```

Syntax: [no] as-path-ignore

This command disables comparison of the AS-Path lengths of otherwise equal paths. When you disable AS-Path length comparison, the BGP4 algorithm shown in [How BGP4 selects a path for a route \(BGP best path selection algorithm\)](#) on page 357 skips from Step 4 to Step 6.

Enabling or disabling comparison of device IDs

Device ID comparison is Step 10 in the algorithm BGP4 uses to select the next path for a route.

NOTE

Comparison of device IDs is applicable only when BGP4 load sharing is disabled.

When device ID comparison is enabled, the path comparison algorithm compares the device IDs of the neighbors that sent the otherwise equal paths:

- If BGP4 load sharing is disabled (maximum-paths 1), the instructions in this section selects the path that came from the neighbor with the lower device ID.
- If BGP4 load sharing is enabled, the device load shares among the remaining paths. In this case, the device ID is not used to select a path.

NOTE

Device ID comparison is disabled by default.

To enable device ID comparison, enter the **compare-routerid** command at the BGP4 configuration level of the CLI.

```
device(config-bgp-router) # compare-routerid
```

Syntax: [no] compare-routerid

Configuring the device to always compare Multi-Exit Discriminators

A Multi-Exit Discriminator (MED) is a value that the BGP4 algorithm uses when it compares multiple paths received from different BGP4 neighbors in the same AS for the same route. In BGP4, a MED for a route is equivalent to its metric.

BGP4 compares the MEDs of two otherwise equivalent paths if and only if the routes were learned from the same neighboring AS. This behavior is called deterministic MED. Deterministic MED is always enabled and cannot be disabled.

You can enable the device to always compare the MEDs, regardless of the AS information in the paths. For example, if the device receives UPDATES for the same route from neighbors in three autonomous systems, the device can compare the MEDs of all the paths together instead of comparing the MEDs for the paths in each autonomous system individually.

To enable this comparison, enter the **always-compare-med** command at the BGP4 configuration level of the CLI. This option is disabled by default.

NOTE

By default, value 0 (most favorable) is used in MED comparison when the MED attribute is not present. The default MED comparison results in the device favoring route paths that do not have their MEDs. Use the **med-missing-as-worst** command to force the device to regard a BGP4 route with a missing MED attribute as the least favorable route, when comparing the MEDs of the routes.

NOTE

MED comparison is not performed for internal routes originated within the local AS or confederation unless the **compare-med-empty-aspath** command is configured.

To configure the device to always compare MEDs, enter the following command.

```
device(config-bgp-router) # always-compare-med
```

Syntax: [no] always-compare-med

The following BGP4 command directs BGP4 to take the MED value into consideration even if the route has an empty as-path path attribute.

```
device(config) # router bgp  
device(config-bgp-router) # compare-med-empty-aspath
```

Syntax: [no] compare-med-empty-aspath

Treating missing MEDs as the worst MEDs

By default, the device favors a lower MED over a higher MED during MED comparison. Since the device assigns the value 0 to a route path MED if the MED value is missing, the default MED comparison results in the device favoring the route paths that are missing their MEDs.

To change this behavior so that the device favors a route that has a MED over a route that is missing its MED, enter the following command at the BGP4 configuration level of the CLI.

```
device(config-bgp-router) # med-missing-as-worst
```

Syntax: [no] med-missing-as-worst

NOTE

This command affects route selection only when route paths are selected based on MED comparison. It is still possible for a route path that is missing its MED to be selected based on other criteria. For example, a route path with no MED can be selected if its weight is larger than the weights of the other route paths.

Configuring route reflection parameters

Normally, all the BGP4 devices within an AS are fully meshed. Since each device has an IBGP session with each of the other BGP4 devices in the AS, each IBGP device has a route for each IBGP neighbor. For large autonomous systems containing many IBGP devices, the IBGP route information in each fully-meshed IBGP device may introduce too much administrative overhead.

To avoid this overhead, you can organize your IGP devices into clusters:

- A cluster is a group of IGP devices organized into route reflectors and route reflector clients. You configure the cluster by assigning a cluster ID on the route reflector and identifying the IGP neighbors that are members of that cluster. All configuration for route reflection takes place on the route reflectors. Clients are unaware that they are members of a route reflection cluster. All members of the cluster must be in the same AS. The cluster ID can be any number from 1 - 4294967295, or an IP address. The default is the device ID expressed as a 32-bit number.

NOTE

If the cluster contains more than one route reflector, you need to configure the same cluster ID on all the route reflectors in the cluster. The cluster ID helps route reflectors avoid loops within the cluster.

- A route reflector is an IGP device configured to send BGP4 route information to all the clients (other BGP4 devices) within the cluster. Route reflection is enabled on all BGP4 devices by default but does not take effect unless you add route reflector clients to the device.
- A route reflector client is an IGP device identified as a member of a cluster. You identify a device as a route reflector client on the device that is the route reflector, not on the client. The client itself requires no additional configuration. In fact, the client does not know that it is a route reflector client. The client just knows that it receives updates from its neighbors and does not know whether one or more of those neighbors are route reflectors.

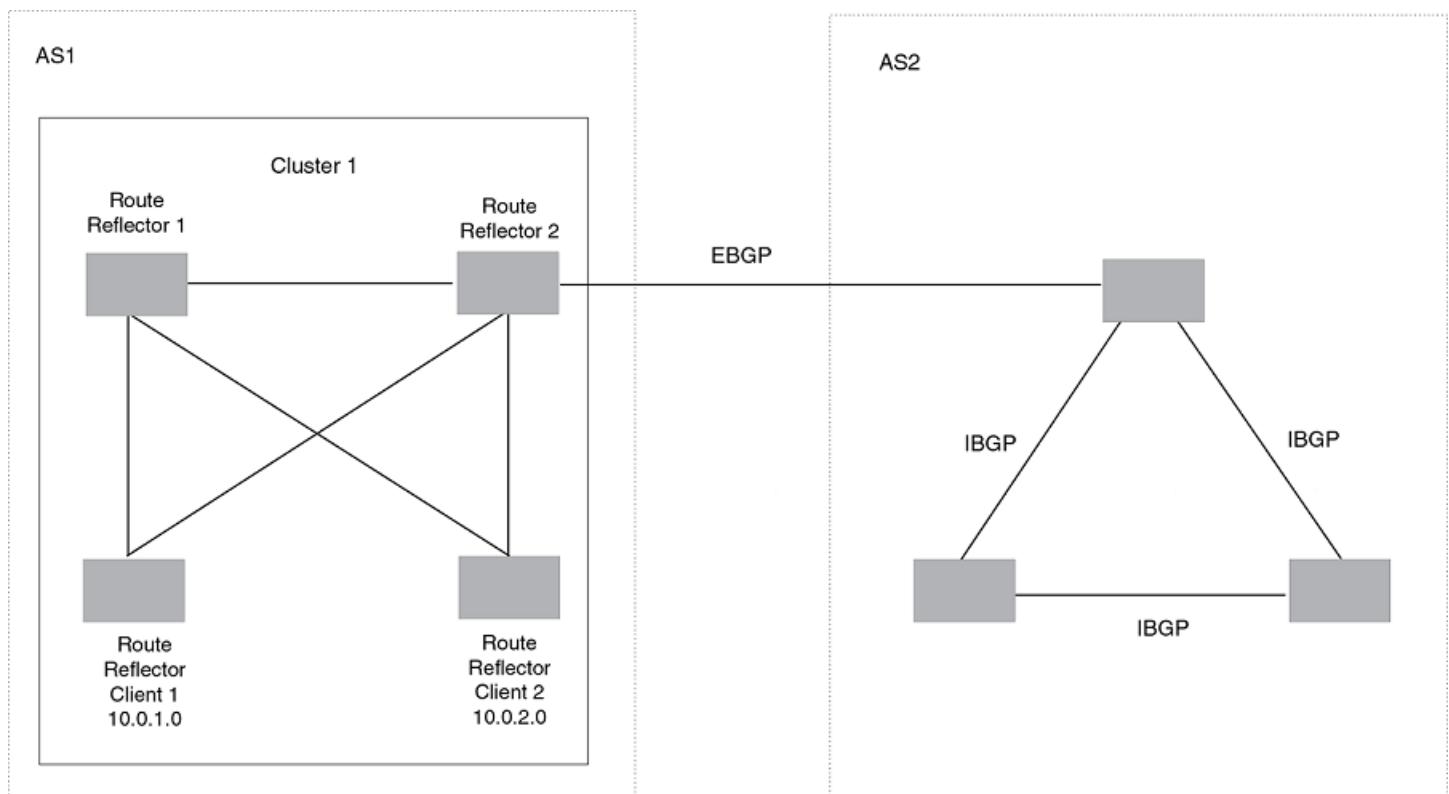
NOTE

Route reflection applies only among IBGP devices within the same AS. You cannot configure a cluster that spans multiple autonomous systems.

This is an example of a route reflector configuration. In this example, two devices are configured as route reflectors for the same cluster, which provides redundancy in case one of the reflectors becomes unavailable. Without redundancy, if a route reflector becomes unavailable, the clients for that device are cut off from BGP4 updates.

AS1 contains a cluster with two route reflectors and two clients. The route reflectors are fully meshed with other BGP4 devices, but the clients are not fully meshed and rely on the route reflectors to propagate BGP4 route updates.

FIGURE 31 A route reflector configuration



Support for RFC 4456

Route reflection on Ruckus devices is based on RFC 4456. This updated RFC helps eliminate routing loops that are possible in some implementations of the older specification, RFC 1966. These instances include:

- The device adds the route reflection attributes only if it is a route reflector, and only when advertising IBGP route information to other IBGP neighbors. The attributes are not used when communicating with EBGP neighbors.
- A device configured as a route reflector sets the ORIGINATOR_ID attribute to the device ID of the device that originated the route. The route reflector sets this attribute only if this is the first time the route is being reflected (sent by a route reflector).
- If a device receives a route with an ORIGINATOR_ID attribute value that is the same as the ID of the device, the device discards the route and does not advertise it. By discarding the route, the device prevents a routing loop.
- The first time a route is reflected by a device configured as a route reflector, the route reflector adds the CLUSTER_LIST attribute to the route. Other route reflectors that receive the route from an IBGP neighbor add their cluster IDs to the front of the routes CLUSTER_LIST. If the route reflector does not have a cluster ID configured, the device adds its device ID to the front of the CLUSTER_LIST.
- If a device configured as a route reflector receives a route with a CLUSTER_LIST that contains the cluster ID of the route reflector, the route reflector discards the route.

Configuration procedures for BGP4 route reflector

To configure a Ruckus device to be a BGP4 route reflector, use either of the following methods.

NOTE

All configuration for route reflection takes place on the route reflectors, not on the clients.

Enter the following commands to configure a Ruckus device as route reflector 1. To configure route reflector 2, enter the same commands on the device that will be route reflector 2. The clients require no configuration for route reflection.

```
device(config-bgp) # cluster-id 1
```

Syntax: [no] cluster-id num | ip-addr

The *num* and *ip-addr* parameters specify the cluster ID and can be a number from 1 - 4294967295, or an IP address. The default is the device ID. You can configure one cluster ID on the device. All route-reflector clients for the device are members of the cluster.

NOTE

If the cluster contains more than one route reflector, you need to configure the same cluster ID on all the route reflectors in the cluster. The cluster ID helps route reflectors avoid loops within the cluster.

To add an IBGP neighbor to the cluster, enter the following command:

```
device(config-bgp) # neighbor 10.0.1.0 route-reflector-client
```

Syntax: [no] neighbor ip-addr route-reflector-client

Disabling or re-enabling client-to-client route reflection

By default, the clients of a route reflector are not required to be fully meshed. Routes from a client are reflected to other clients. However, if the clients are fully meshed, route reflection is not required between clients.

If you need to disable route reflection between clients, enter the **no client-to-client-reflection** command. When this feature is disabled, route reflection does not occur between clients does still occur between clients and non-clients.

```
device(config-bgp-router) # no client-to-client-reflection
```

Enter the following command to re-enable the feature.

```
device(config-bgp) # client-to-client-reflection
```

Syntax: [no] **client-to-client-reflection**

Configuring confederations

A **confederation** is a BGP4 Autonomous System (AS) that has been subdivided into multiple, smaller autonomous systems. Subdividing an AS into smaller autonomous systems simplifies administration and reduces BGP4-related traffic, which in turn reduces the complexity of the Interior Border Gateway Protocol (IBGP) mesh among the BGP4 devices in the AS.

The Ruckus implementation of this feature is based on RFC 3065.

Normally, all BGP4 devices within an AS must be fully meshed, so that each BGP4 device has BGP4 sessions to all the other BGP4 devices within the AS. This is feasible in smaller autonomous systems, but becomes unmanageable in autonomous systems containing many BGP4 devices.

When you configure BGP4 devices into a confederation, all the devices within a sub-AS (a subdivision of the AS) use IBGP and must be fully meshed. However, devices use EBGP to communicate between different sub-autonomous systems.

NOTE

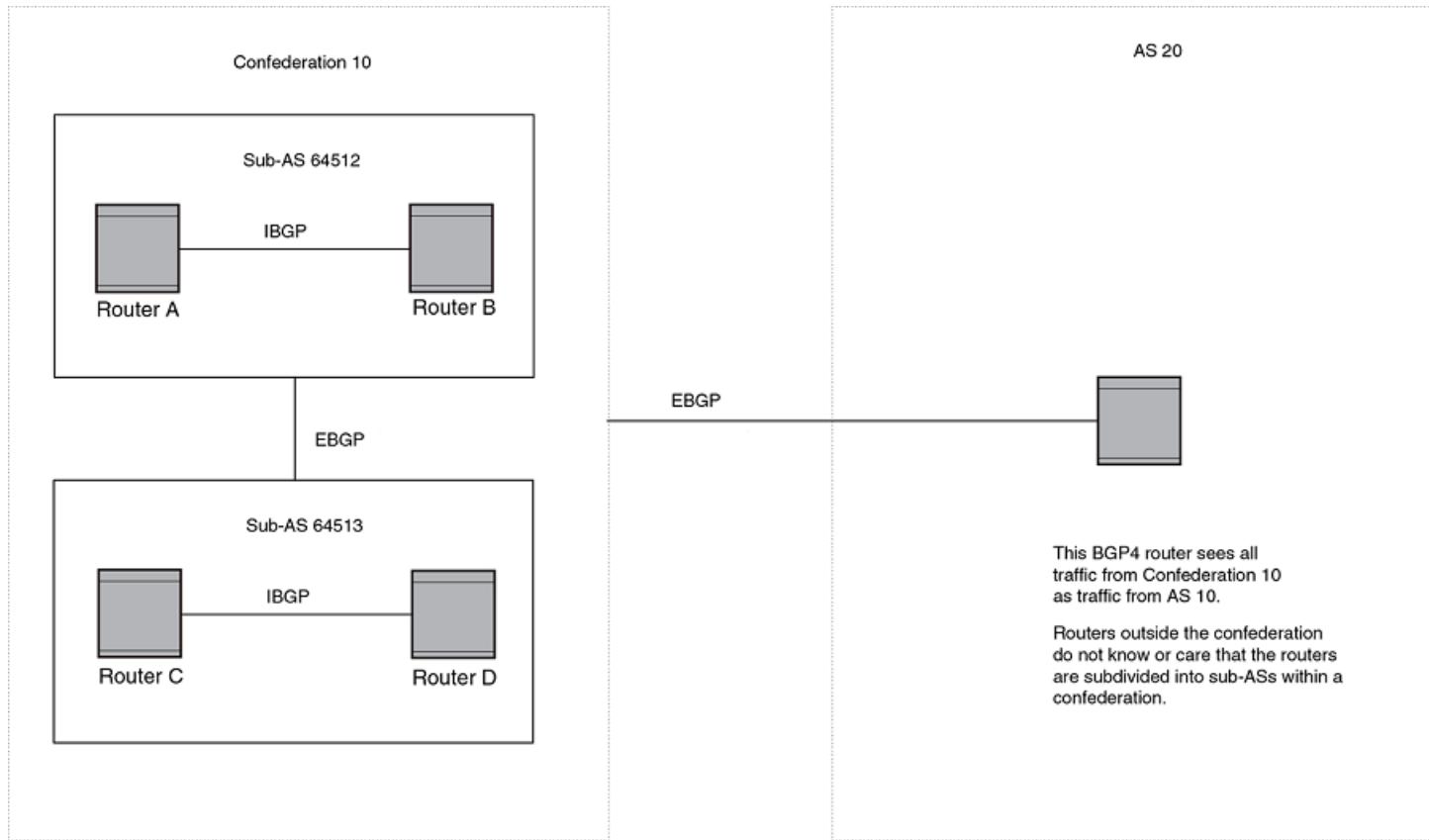
Another way to reduce the complexity of an IBGP mesh is to use route reflection. However, if you want to run different Interior Gateway Protocols (IGPs) within an AS, you must configure a confederation. You can run a separate IGP within each sub-AS.

To configure a confederation, configure groups of BGP4 devices into sub-autonomous systems. A sub-AS is simply an AS. The term "sub-AS" distinguishes autonomous systems within a confederation from autonomous systems that are not in a confederation. For the viewpoint of remote autonomous systems, the confederation ID is the AS ID. Remote autonomous systems do not know that the AS represents multiple sub-autonomous systems with unique AS IDs.

NOTE

You can use any valid AS numbers for the sub-autonomous systems. If your AS is connected to the Internet, Ruckus recommends that you use numbers from within the private AS range (64512 through 65535). These are private autonomous system numbers and BGP4 devices do not propagate these AS numbers to the Internet.

FIGURE 32 Example BGP4 confederation



In this example, four devices are configured into two sub-autonomous systems, each containing two of the devices. The sub-autonomous systems are members of confederation 10. Devices within a sub-AS must be fully meshed and communicate using IBGP. In this example, devices A and B use IBGP to communicate. Devices C and D also use IBGP. However, the sub-autonomous systems communicate with one another using EBGP. For example, device A communicates with device C using EBGP. The devices in the confederation communicate with other autonomous systems using EBGP.

Devices in other autonomous systems are unaware that devices A through D are configured in a confederation. In fact, when devices in confederation 10 send traffic to devices in other autonomous systems, the confederation ID is the same as the AS number for the devices in the confederation. Thus, devices in other autonomous systems see traffic as coming from AS 10 and are unaware that the devices in AS 10 are subdivided into sub-autonomous systems within a confederation.

Configuring a BGP4 confederation

To configure a BGP4 configuration, perform these configuration tasks on each BGP4 device within the confederation:

- Configure the local AS number. The local AS number indicates membership in a sub-AS. All BGP4 devices with the same local AS number are members of the same sub-AS. BGP4 devices use the local AS number when communicating with other BGP4 devices in the confederation.
- Configure the confederation ID. The confederation ID is the AS number by which BGP4 devices outside the confederation recognize the confederation. A BGP4 device outside the confederation is not aware of, and does not care that BGP4 devices are in multiple sub-autonomous systems. A BGP4 device uses the confederation ID to communicate with devices outside the confederation. The confederation ID must differ from the sub-AS numbers.

- Configure the list of the sub-AS numbers that are members of the confederation. All devices within the same sub-AS use IBGP to exchange device information. Devices in different sub-autonomous systems within the confederation use EBGP to exchange device information.

To configure four devices to be members of confederation 10 (consisting of sub-autonomous systems 64512 and 64513), enter commands such as the following.

Commands for device A

```
deviceA(config)# router bgp
deviceA(config-bgp-router)# local-as 64512
deviceA(config-bgp-router)# confederation identifier 10
deviceA(config-bgp-router)# confederation peers 64512 64513
deviceA(config-bgp-router)# write memory
```

Syntax: [no] local-as num

The *num* parameter with the **local-as** command indicates the AS number for the BGP4 devices within the sub-AS. You can specify a number in the range 1 - 4294967295. Ruckus recommends that you use a number within the range of well-known private autonomous systems, 64512 through 65535.

Syntax: [no] confederation identifier num

The *num* parameter with the **confederation identifier** command indicates the confederation number. The confederation ID is the AS number by which BGP4 devices outside the confederation recognize the confederation. A BGP4 device outside the confederation is not aware of, and does not care that your BGP4 devices are in multiple sub-autonomous systems. BGP4 devices use the confederation ID when communicating with devices outside the confederation. The confederation ID must be different from the sub-AS numbers. For the *num* parameter, you can specify a number in the range 1 - 4294967295.

Syntax: [no] confederation peers num [num ...]

The *num* parameter with the **confederation peers** command indicates the sub-AS numbers for the sub-autonomous systems in the confederation. You can list all sub-autonomous systems in the confederation. You must specify all the sub-autonomous systems with which this device has peer sessions in the confederation. All the devices within the same sub-AS use IBGP to exchange device information. Devices in different sub-autonomous systems within the confederation use EBGP to exchange device information. The *num* is a number in the range 1 - 4294967295.

Commands for device B

```
deviceB(config)# router bgp
deviceB(config-bgp-router)# local-as 64512
deviceB(config-bgp-router)# confederation identifier 10
deviceB(config-bgp-router)# confederation peers 64512 64513
deviceB(config-bgp-router)# write memory
```

Commands for device C

```
deviceC(config)# router bgp
deviceC(config-bgp-router)# local-as 64513
deviceC(config-bgp-router)# confederation identifier 10
deviceC(config-bgp-router)# confederation peers 64512 64513
deviceC(config-bgp-router)# write memory
```

Commands for device D

```
deviceD(config)# router bgp
deviceD(config-bgp-router)# local-as 64513
deviceD(config-bgp-router)# confederation identifier 10
```

```
deviceD(config-bgp-router)# confederation peers 64512 64513  
deviceD(config-bgp-router)# write memory
```

Aggregating routes advertised to BGP4 neighbors

By default, the device advertises individual routes for all networks. The aggregation feature allows you to configure the device to aggregate routes from a range of networks into a single network prefix. For example, without aggregation, the device will individually advertise routes for networks 10.95.1.0/24, 10.95.2.0/24, and 10.95.3.0/24. You can configure the device to end a single, aggregate route for the networks instead. The aggregate route can be advertised as 10.95.0.0/16.

To aggregate routes for 10.157.22.0/24, 10.157.23.0/24, and 10.157.24.0/24, enter the following command.

```
device(config-bgp)# aggregate-address 10.157.0.0 255.255.0.0
```

Syntax: [no] **aggregate-address** *ip-addr ip-mask* [**as-set**] [**summary-only**] [**suppress-map** *map-name*] [**advertise-map** *map-name*] [**attribute-map** *map-name*]

The *ip-addr* and *ip-mask* parameters specify the aggregate value for the networks. Specify 0 for the host portion and for the network portion that differs among the networks in the aggregate. For example, to aggregate 10.0.1.0/24, 10.0.2.0/24, and 10.0.3.0/24, enter the IP address 10.0.0.0 and the network mask 255.255.0.0.

The **as-set** parameter causes the device to aggregate AS-path information for all the routes in the aggregate address into a single AS-path.

The **summary-only** parameter prevents the device from advertising more specific routes contained within the aggregate route.

The **suppress-map** *map-name* parameter prevents the more specific routes contained in the specified route map from being advertised.

The **advertise-map** *map-name* parameter configures the device to advertise the more specific routes in the specified route map.

The **attribute-map** *map-name* parameter configures the device to set attributes for the aggregate routes based on the specified route map.

NOTE

For the **suppress-map**, **advertise-map**, and **attribute-map** parameters, the route map must already be defined.

Configuring BGP4 restart

BGP4 restart can be configured for a global routing instance or for a specified Virtual Routing and Forwarding (VRF) instance. The following sections describe how to enable the BGP4 restart feature.

BGP4 restart is enabled by default.

Configuring BGP4 Restart for the global routing instance

Use the following command to enable the BGP4 Restart feature globally on a device.

```
device(config)# router bgp  
device(config-bgp-router)# graceful-restart
```

Syntax: [no] **graceful-restart**

Configuring BGP4 Restart for a VRF

Use the following command to enable the BGP4 Restart feature for a specified VRF.

```
device(config)# router bgp  
device(config-bgp-router)# address-family ipv4 unicast vrf blue  
device(config-bgp-ipv4u-vrf)# graceful-restart
```

Syntax: [no] graceful-restart

Configuring timers for BGP4 Restart (optional)

You can optionally configure the following timers to change their values from the default values:

- Restart Timer
- Stale Routes Timer
- Purge Timer

The *seconds* variable sets the maximum restart wait time advertised to neighbors. Possible values are 1 - 3600 seconds. The default value is 120 seconds.

Configuring the restart timer for BGP4 Restart

Use the following command to specify the maximum amount of time a device will maintain routes from and forward traffic to a restarting device.

```
device(config-bgp)# graceful-restart restart-time 150
```

Syntax: [no] graceful-restart restart-time *seconds*

The *seconds* variable sets the maximum restart wait time advertised to neighbors. Possible values are 1 through 3600 seconds. The default value is 120 seconds.

Configuring BGP4 Restart stale routes timer

Use the following command to specify the maximum amount of time a helper device will wait for an end-of-RIB message from a peer before deleting routes from that peer.

```
device(config-bgp)# graceful-restart stale-routes-time 120
```

Syntax: [no] graceful-restart stale-routes-time *seconds*

The *seconds* variable sets the maximum time before a helper device cleans up stale routes. Possible values are 1 through 3600 seconds. The default value is 360 seconds.

Configuring BGP4 Restart purge timer

Use the following command to specify the maximum amount of time a device will maintain stale routes in its routing table before purging them.

```
device(config-bgp)# graceful-restart purge-time 900
```

Syntax: [no] graceful-restart purge-time *seconds*

The *seconds* variable sets the maximum time before a restarting device cleans up stale routes. Possible values are 1 - 3600 seconds. The default value is 600 seconds.

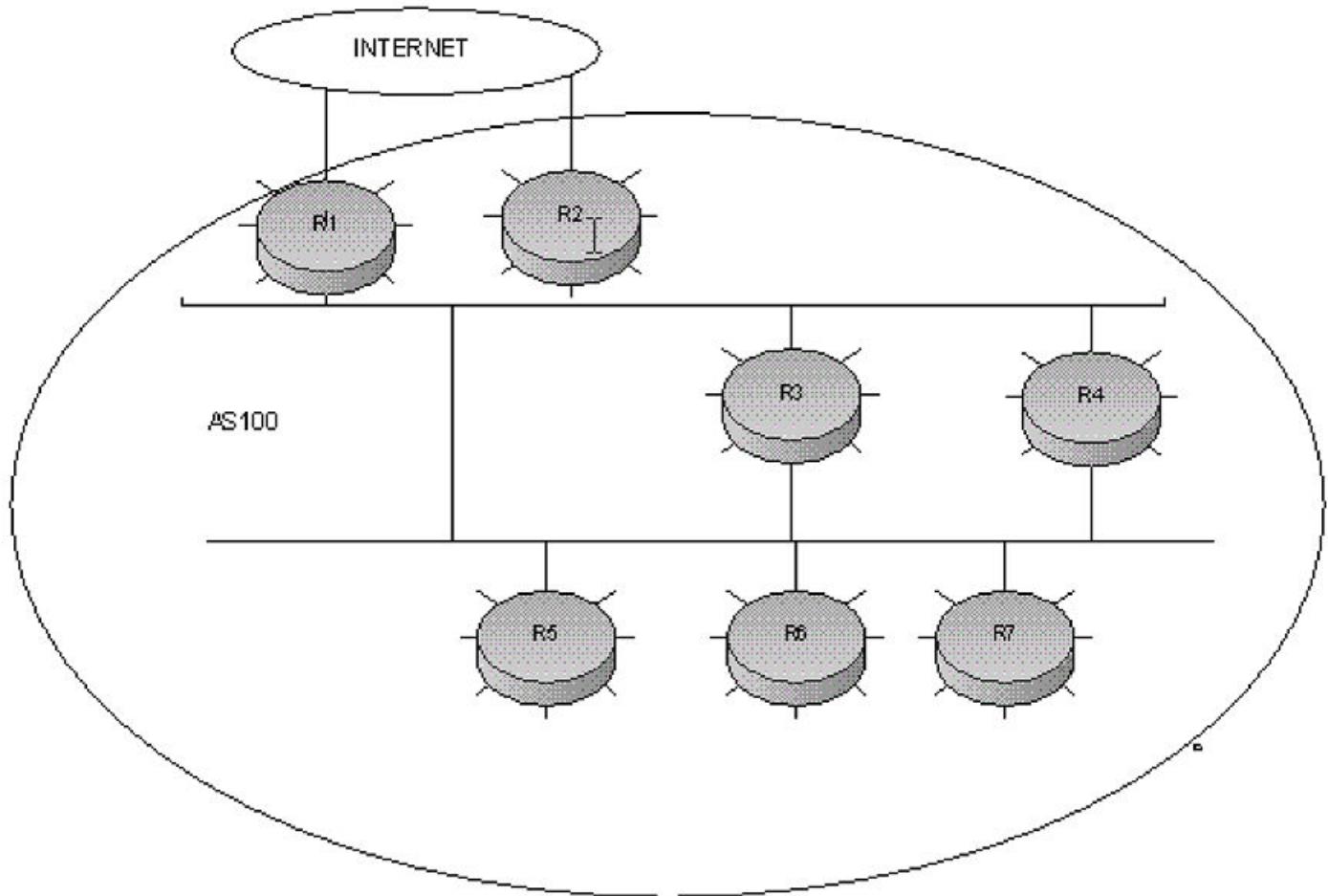
BGP4 null0 routing

BGP4 considers the null0 route in the routing table (for example, static route) as a valid route, and can use the null0 route to resolve the next hop. If the next hop for BGP4 resolves into a null0 route, the BGP4 route is also installed as a null0 route in the routing table.

The null0 routing feature allows network administrators to block certain network prefixes using null0 routes and route-maps, directing a remote device to drop all traffic for a network prefix by redistributing a null0 route into BGP4.

This example shows a topology for a null0 routing application example.

FIGURE 33 SAMPLE null0 routing application



Configuring BGP4 null0 routing

The following example configures a null0 routing application to stop denial of service attacks from remote hosts on the Internet.

1. Select a device, for example, device 6, to distribute null0 routes throughout the BGP4 network.
2. To configure a route-map perform the following step.
 - Configure a route-map to match a particular tag (50) and set the next-hop address to an unused network address (10.199.1.1).

3. Set the local-preference to a value higher than any possible internal or external local-preference (50).
4. Complete the route map by setting origin to IGP.
5. On device 6, redistribute the static routes into BGP4, using route-map *route-map-name* (redistribute static route-map block user).
6. To configure a route-map perform the following step.
 - On device 1, (the device facing the Internet), configure a null0 route matching the next-hop address in the route-map (ip route 10.199.1.1/32 null0).
7. Repeat step 3 for all devices interfacing with the Internet (edge corporate devices). In this case, device 2 has the same null0 route as device 1.
8. On device 6, configure the network prefixes associated with the traffic you want to drop. The static route IP address references a destination address. You must point the static route to the egress port, (for example, Ethernet 1/3/7), and specify the tag 50, matching the route-map configuration.

Configuration examples

Device 6

The following configuration defines specific prefixes to filter:

```
device(config)# ip route 10.0.0.40/29 ethernet 1/3/7 tag 50
device(config)# ip route 10.0.0.192/27 ethernet 1/3/7 tag 50
device(config)# ip route 10.014.0/23 ethernet 1/3/7 tag 50
```

The following configuration redistributes routes into BGP4.

```
device(config)# router bgp
device(config-bgp-router)# local-as 100
device(config-bgp-router)# neighbor router1_int_ip address remote-as 100
device(config-bgp-router)# neighbor router2_int_ip address remote-as 100
device(config-bgp-router)# neighbor router3_int_ip address remote-as 100
device(config-bgp-router)# neighbor router4_int_ip address remote-as 100
device(config-bgp-router)# neighbor router5_int_ip address remote-as 100
device(config-bgp-router)# neighbor router7_int_ip address remote-as 100
device(config-bgp-router)# redistribute static route-map blockuser
device(config-bgp-router)# exit
```

The following configuration defines the specific next hop address and sets the local preference to preferred.

```
device(config)# route-map blockuser permit 10
device(config-routemap blockuser)# match tag 50
device(config-routemap blockuser)# set ip next-hop 10.199.1.1
device(config-routemap blockuser)# set local-preference 1000000
device(config-routemap blockuser)# set origin igp
device(config-routemap blockuser)# exit
```

NOTE

A match tag can take up to 16 tags. During the execution of a route-map, a match on any tag value in the list is considered a successful match.

Device 1

The following configuration defines the null0 route to the specific next hop address. The next hop address 10.199.1.1 points to the null0 route.

```
device(config)# ip route 10.199.1.1/32 null0
device(config)# router bgp
device(config-bgp-router)# local-as 100
device(config-bgp-router)# neighbor router2_int_ip address remote-as 100
device(config-bgp-router)# neighbor router3_int_ip address remote-as 100
```

Configuring BGP4 (IPv4)

Configuring BGP4 restart

```
device(config-bgp-router)# neighbor router4_int_ip address remote-as 100
device(config-bgp-router)# neighbor router5_int_ip address remote-as 100
device(config-bgp-router)# neighbor router6_int_ip address remote-as 100
device(config-bgp-router)# neighbor router7_int_ip address remote-as 100
```

Device 2

The following configuration defines a null0 route to the specific next hop address. The next hop address 10.199.1.1 points to the null0 route, which gets blocked.

```
device(config)# ip route 10.199.1.1/32 null0
device(config)# router bgp
device(config-bgp-router)# local-as 100
device(config-bgp-router)# neighbor router1_int_ip address remote-as 100
device(config-bgp-router)# neighbor router3_int_ip address remote-as 100
device(config-bgp-router)# neighbor router4_int_ip address remote-as 100
device(config-bgp-router)# neighbor router5_int_ip address remote-as 100
device(config-bgp-router)# neighbor router6_int_ip address remote-as 100
device(config-bgp-router)# neighbor router7_int_ip address remote-as 100
```

Show commands for BGP4 null0 routing

After configuring the null0 application, you can display the output using **show** commands.

Device 6

Show ip route static output for device 6.

```
device# show ip route static
Type Codes - B:BGP D:Connected S:Static R:RIP O:OSPF; Cost - Dist/Metric
          Destination      Gateway      Port      Cost      Type
 1        10.0.0.40/29   DIRECT      eth 1/3/7  1/1      S
 2        10.0.0.192/27  DIRECT      eth 1/3/7  1/1      S
 3        10.0.14.0/23   DIRECT      eth 1/3/7  1/1      S
device#
```

Device 1 and 2

Show ip route static output for device 1 and device 2.

```
device# show ip route static
Type Codes - B:BGP D:Connected S:Static R:RIP O:OSPF; Cost - Dist/Metric
          Destination      Gateway      Port      Cost      Type
 1        10.199.1.1/32  DIRECT      drop     1/1      S
device#
```

Device 6

The following is the **show ip bgp route** output for Device-6

```
device# show ip bgp route
Total number of BGP Routes: 126
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED s:STALE
Prefix           Next Hop       MED      LocPrf      Weight Status
 1    10.0.1.0/24    10.0.1.3    0        100        0        BI
    AS_PATH:
    .
 9    10.0.0.16/30   10.0.1.3    .        100        0        I
    AS_PATH: 85
10    10.0.0.40/29   10.199.1.1/32 1    1000000  32768    BL
    AS_PATH:
11    10.0.0.80/28   10.0.1.3    .        100        0        I
    .
 36    10.0.0.96/28   10.0.1.3    .        100        0        I
    AS_PATH: 50
```

```

37    10.0.0.192/27      10.199.1.1/32 1        10000000 32768 BL
      AS_PATH:
.
64    10.0.7.0/24        ..          10.0.1.3           100      0     I
      AS_PATH: 10
65    10.0.14.0/23       10.199.1.1/32 1        1000000 32768 BL
      AS_PATH: ..
.
```

Device 1 and 2

The **show ip route** output for device 1 and device 2 shows "drop" under the Port column for the network prefixes you configured with null0 routing

```

device# show ip route
Total number of IP routes: 133
  Type Codes - B:BGP  D:Connected  S:Static  R:RIP O:OSPF;  Cost - Dist/Metric
  Destination      Gateway      Port      Cost      Type
  1      10.0.1.24/32      DIRECT      loopback 1  0/0      D
  2      10.0.1.0/24        ..          DIRECT      eth 1/2/7  0/0      D
  3      10.0.1.1/24        ..          DIRECT      eth 1/2/1  0/0      D
.
13    10.0.0.6/31          ..          10.0.1.3      eth 1/2/2  20/1      B
14    10.0.0.16/30         ..          10.0.1.3      eth 1/2/2  20/1      B
15    10.0.0.40/29         ..          DIRECT      drop
200/0   B
.
42    10.0.0.192/27        ..          DIRECT      drop
200/0   B
43    10.0.1.128/26        ..          10.0.1.3      eth 1/2/7  20/1      B
.
69    10.0.7.0/24          ..          10.0.1.3      eth 1/2/10 20/1      B
70    10.0.14.0/23         ..          DIRECT      drop
200/0   B
.
131   10.144.0.0/12        ..          10.0.1.3      eth 1/3/4   20/1      B
132   10.199.1.1/32        ..          DIRECT      drop
1/1
.
```

Modifying redistribution parameters

By default, the route information between BGP4 and the IP IGPs (RIP and OSPF) is not redistributed. You can configure the device to redistribute OSPF routes, RIP routes, directly connected routes, or static routes into BGP4.

To enable redistribution of all OSPF routes and directly attached routes into BGP4, enter the following commands.

```

device(config)# router bgp
device(config-bgp-router)# redistribute ospf
device(config-bgp-router)# redistribute connected
device(config-bgp-router)# write memory
.
```

Syntax: [no] **redistribute connected | ospf | rip | static**

The **connected** parameter indicates that you are redistributing routes to directly attached devices into BGP4.

The **ospf** parameter indicates that you are redistributing OSPF routes into BGP4.

NOTE

Entering **redistribute ospf** simply redistributes internal OSPF routes. To redistribute external OSPF routes also, use the **redistribute ospf match external** command.

The **rip** parameter indicates that you are redistributing RIP routes into BGP4.

The **isis** parameter indicates that you are redistributing IS-IS routes into BGP4.

The **static** parameter indicates that you are redistributing static routes into BGP4.

Redistributing connected routes

To configure BGP4 to redistribute directly connected routes, enter the following command.

```
device(config-bgp-router) # redistribute connected
```

Syntax: [no] **redistribute connected** [**metric num**] [**route-map map-name**]

The **connected** parameter indicates that you are redistributing routes to directly attached devices into BGP4.

The **metric num** parameter changes the metric. You can specify a value from 0 through 4294967295. The default is not assigned.

The **route-map map-name** parameter specifies a route map to be consulted before adding the RIP route to the BGP4 route table.

NOTE

The route map you specify must already be configured on the device.

Redistributing RIP routes

To configure BGP4 to redistribute RIP routes and add a metric of 10 to the redistributed routes, enter the following command.

```
device(config-bgp-router) # redistribute rip metric 10
```

Syntax: [no] **redistribute rip** [**metric num**] [**route-map map-name**]

The **rip** parameter indicates that you are redistributing RIP routes into BGP4.

The **metric num** parameter changes the metric. You can specify a value from 0 - 4294967295. The default is not assigned.

The **route-map map-name** parameter specifies a route map to be consulted before adding the RIP route to the BGP4 route table.

NOTE

The route map you specify must already be configured on the device.

Redistributing OSPF external routes

To configure the device to redistribute OSPF external type 1 routes, enter the following command.

```
device(config-bgp-router) # redistribute ospf match external1
```

Syntax: [no] **redistribute ospf** [**match internal | external1 | external2**] [**metric num**] [**route-map map-name**]

The **ospf** parameter indicates that you are redistributing OSPF routes into BGP4.

The match **internal**, **external1**, and **external2** parameters apply only to OSPF. These parameters specify the types of OSPF routes to be redistributed into BGP4. The default is internal.

NOTE

If you do not enter a value for the **match** parameter, (for example, you enter **redistribute ospf** only) then only internal OSPF routes will be redistributed.

The **metric num** parameter changes the metric. You can specify a value from 0 through 4294967295. The default is not assigned.

The **route-map map-name** parameter specifies a route map to be consulted before adding the OSPF route to the BGP4 route table.

NOTE

The route map you specify must already be configured on the device.

NOTE

If you use both the **redistribute ospf route-map** command and the **redistribute ospf match internal** command, the software uses only the route map for filtering.

Redistributing static routes

To configure the device to redistribute static routes, enter the following command.

```
device(config-bgp)# redistribute static
```

Syntax: [no] **redistribute static** [**metric num**] [**route-map map-name**]

The **static** parameter indicates that you are redistributing static routes into BGP4.

The **metricnum** parameter changes the metric. You can specify a value from 0 - 4294967295. The default is 0.

The **route-map map-name** parameter specifies a route map to be consulted before adding the static route to the BGP4 route table.

NOTE

The route map you specify must already be configured on the device.

Redistributing IBGP routes

By default, the device does not allow redistribute IBGP routes from BGP4 into RIP, or OSPF. This behavior helps eliminate routing loops. In non-default VRF instances, by default, the device does allow redistribution IBGP routes from BGP4 into RIP, OSPF.

To enable the device to redistribute BGP4 routes into OSPF and RIP, enter the following command.

```
device(config-bgp-router)# bgp-redistribute-internal
```

Syntax: [no] **bgp-redistribute-internal**

To disable redistribution of IBGP routes into RIP, IS-IS, and OSPF, enter the **bgp-redistribute-internal** command.

Filtering

This section describes the following:

- AS-path filtering
- Defining and applying IP prefix lists
- Defining neighbor distribute lists
- Defining route maps
- Configuring cooperative BGP4 route filtering

AS-path filtering

You can filter updates received from BGP4 neighbors based on the contents of the AS-path list accompanying the updates. For example, to deny routes that have the AS 10.3.2.1 in the AS-path from entering the BGP4 route table, you can define a filter.

The device provides the following methods for filtering on AS-path information:

- AS-path filters
- AS-path ACLs

NOTE

The device cannot support AS-path filters and AS-path ACLs at the same time. Use one method or the other, but do not mix methods.

NOTE

Once you define a filter or ACL, the default action for updates that do not match a filter is **deny**. To change the default action to **permit**, configure the last filter or ACL as **permit any any**.

AS-path filters or AS-path ACLs can be referred to by the filter list number of a BGP4 neighbor as well as by match clauses in a route map.

Defining an AS-path ACL

To configure an AS-path list that uses "acl 1", enter a command such as the following.

```
device(config)# ip as-path access-list acl1 permit 100
device(config)# router bgp
device(config-bgp-router)# neighbor 10.10.10.1 filter-list acl1 in
```

Syntax: [no] ip as-path access-list *string* [seq *s eq-value*] deny | permit *regular-expression*

The **ip as-path** command configures an AS-path ACL that permits routes containing AS number 100 in their AS paths. The **neighbor** command then applies the AS-path ACL to advertisements and updates received from neighbor 10.10.10.1. In this example, the only routes the device permits from neighbor 10.10.10.1 are those whose AS-paths contain AS-path number 100.

The *string* parameter specifies the ACL name. (If you enter a number, the CLI interprets the number as a text string.)

The **seq***seq-value* parameter is optional and specifies the sequence number for the AS-path list. If you do not specify a sequence number, the software numbers in increments of 5, beginning with number 5. The software interprets the entries in an AS-path list in numerical order, beginning with the lowest sequence number.

The **deny** and **permit** parameters specify the action the software takes if the AS-path list for a route matches a match clause in this ACL. To configure the AS-path match clauses in a route map, use the match as-path command.

The *regular-expression* parameter specifies the AS path information you want to permit or deny to routes that match any of the match clauses within the ACL. You can enter a specific AS number or use a regular expression.

The **neighbor** command uses the **filter-list** parameter to apply the AS-path ACL to the neighbor.

Using regular expressions

Use a regular expression for the *as-path* parameter to specify a single character or multiple characters as a filter pattern. If the AS-path matches the pattern specified in the regular expression, the filter evaluation is true; otherwise, the evaluation is false.

You can also include special characters that influence the way the software matches the AS-path against the filter value.

To filter on a specific single-character value, enter the character for the *as-path* parameter. For example, to filter on AS-paths that contain the letter "z", enter the following command:

```
device(config-bgp-router)# ip as-path access-list acl1 permit z
```

To filter on a string of multiple characters, enter the characters in brackets. For example, to filter on AS-paths that contain "x", "y", or "z", enter the following command.

```
device(config-bgp-router) # ip as-path access-list acl1 permit [xyz]
```

BGP4 Special characters

When you enter a single-character expression or a list of characters, you also can use the special characters listed in "Using regular expressions." The description for each character includes an example. Some special characters must be placed in front of the characters they control and others must be placed after the characters they control. The examples show where to place the special character.

TABLE 91 BGP4 special characters for regular expressions

Character	Operation
.	The period matches on any single character, including a blank space. For example, the following regular expression matches for "aa", "ab", "ac", and so on, but not just "a". a.
*	The asterisk matches on zero or more sequences of a pattern. For example, the following regular expression matches on an AS-path that contains the string "1111" followed by any value: 1111*
+	The plus sign matches on one or more sequences of a pattern. For example, the following regular expression matches on an AS-path that contains a sequence of "g"s, such as "deg", "degg", "deggg", and so on: deg+
?	The question mark matches on zero occurrences or one occurrence of a pattern. For example, the following regular expression matches on an AS-path that contains "dg" or "deg": de?g
^	A caret (when not used within brackets) matches on the beginning of an input string. For example, the following regular expression matches on an AS-path that begins with "3": ^3
\$	A dollar sign matches on the end of an input string. For example, the following regular expression matches on an AS-path that ends with "deg": deg\$
-	An underscore matches on one or more of the following: <ul style="list-style-type: none"> • , (comma) • { (left curly brace) • } (right curly brace) • ((left parenthesis) •) (right parenthesis) • The beginning of the input string • The end of the input string • A blank space For example, the following regular expression matches on "100" but not on "1002", "2100", and so on.

TABLE 91 BGP4 special characters for regular expressions (continued)

Character	Operation
[]	<p><u>_100_</u></p> <p>Square brackets enclose a range of single-character patterns. For example, the following regular expression matches on an AS-path that contains "1", "2", "3", "4", or "5":</p> <p>[1-5]</p> <p>You can use the following expression symbols within the brackets. These symbols are allowed only inside the brackets:</p> <ul style="list-style-type: none"> • ^ - The caret matches on any characters except the ones in the brackets. For example, the following regular expression matches on an AS-path that does not contain "1", "2", "3", "4", or "5":[^1-5] • - The hyphen separates the beginning and ending of a range of characters. A match occurs if any of the characters within the range is present. Refer to the example above.
	<p>A vertical bar (sometimes called a pipe or a "logical or") separates two alternative values or sets of values. The AS-path can match one or the other value. For example, the following regular expression matches on an AS-path that contains either "abc" or "defg":</p> <p>(abc) (defg)</p> <p>NOTE The parentheses group multiple characters to be treated as one value. Refer to the following row for more information about parentheses.</p>
()	<p>Parentheses allow you to create complex expressions. For example, the following complex expression matches on "abc", "abca", or "abcaabcabcdefg", but not on "abcdefgdefg":</p> <p>((abc)+) (defg)?</p>

To filter for a special character instead of using the special character as described in "Using regular expressions," enter "\\" (backslash) in front of the character. For example, to filter on AS-path strings containing an asterisk, enter the asterisk portion of the regular expression as "*".

```
device(config-bgp-router)# ip as-path access-list acl12 deny \*
```

To use the backslash as a string character, enter two slashes. For example, to filter on AS-path strings containing a backslash, enter the backslash portion of the regular expression as "\\".

```
device(config-bgp-router)# ip as-path access-list acl12 deny \\
```

BGP4 filtering communities

You can filter routes received from BGP4 neighbors based on community names.

A community is an optional attribute that identifies the route as a member of a user-defined class of routes. Community names are arbitrary values made of two five-digit integers joined by a colon. You determine what the name means when you create the community name as a route attribute. Each string in the community name can be a number from 0 through 65535.

This format allows you to easily classify community names. For example, a common convention used in community naming is to configure the first string as the local AS and the second string as the unique community within that AS. Using this convention, communities 1:10, 1:20, and 1:30 can be easily identified as member communities of AS 1.

The device provides the following methods for filtering on community information.

- Community filters
- Community list ACLs

NOTE

The device cannot actively support community filters and community list ACLs at the same time. Use one method or the other but do not mix methods.

NOTE

Once you define a filter or ACL, the default action for communities that do not match a filter or ACL is **deny**. To change the default action to **permit**, configure the last filter or ACL entry as **permit any any**.

Community filters or ACLs can be referred to by match clauses in a route map.

Defining a community ACL

To configure community ACL 1, enter a command such as the following. This command configures a community ACL that permits routes that contain community 123:2.

```
device(config)# ip community-list 1 permit 123:2
```

Syntax: **no ip community-list standard string [seq seq-value] deny | permit community-num**

The *string* parameter specifies the ACL name. (If you enter a number, the CLI interprets the number as a text string.)

The **standard** parameter specifies whether you are configuring a standard community ACL.

The **seq seq-value** parameter is optional and specifies the sequence number for the community list. You can configure up to 199 entries in a community list. If you do not specify a sequence number, the software numbers the entries in increments of 5, beginning with number 5. The software interprets the entries in a community list in numerical order, beginning with the lowest sequence number.

The **deny** and **permit** parameters specify the action the software takes if a route community list matches a match clause in this ACL. To configure the community-list match clauses in a route map, use the **match community** command.

The *community-num* parameter specifies the community type or community number. This parameter can have the following values:

- **num:num** - A specific community number
- **internet** - The Internet community
- **no-export** - The community of sub-autonomous systems within a confederation. Routes with this community can be exported to other sub-autonomous systems within the same confederation but cannot be exported outside the confederation to other autonomous systems or otherwise sent to EBGP neighbors.
- **local-as** - The local sub-AS within the confederation. Routes with this community can be advertised only within the local subAS.
- **no-advertise** - Routes with this community cannot be advertised to any other BGP4 devices at all.

The *regular-expression* parameter specifies a regular expression for matching on community names.

To use a community-list filter, use route maps with the **match community** parameter.

Defining and applying IP prefix lists

An IP prefix list specifies a list of networks. When you apply an IP prefix list to a neighbor, the device sends or receives only a route whose destination is in the IP prefix list. The software interprets the prefix lists in order, beginning with the lowest sequence number.

To configure an IP prefix list and apply it to a neighbor, enter commands such as the following.

```
device(config)# ip prefix-list Routesfor20 permit 10.20.0.0/24
device(config)# router bgp
device(config-bgp-router)# neighbor 10.10.10.1 prefix-list Routesfor20 out
```

These commands configure an IP prefix list named Routesfor20, which permits routes to network 10.20.0.0/24. The **neighbor** command configures the device to use IP prefix list Routesfor20 to determine which routes to send to neighbor 10.10.10.1. The device sends routes that go to 10.20.x.x to neighbor 10.10.10.1 because the IP prefix list explicitly permits these routes to be sent to the neighbor.

Syntax: [no] ip prefix-list *name* [seq *seq-value*] [description *string*] deny | permit *network-addr* / *mask-bits* [ge *ge-value*] [le *le-value*]

The *name* parameter specifies the prefix list name. Use this name when applying the prefix list to a neighbor.

The **description** *string* parameter is a text string describing the prefix list.

The **seq** *seq-value* parameter is optional and specifies the sequence number of the IP prefix list. If you do not specify a sequence number, the software numbers the entries in increments of 5, beginning with prefix list entry 5. The software interprets the prefix list entries in numerical order, beginning with the lowest sequence number.

The **deny** and **permit** parameters specify the action the software takes if a neighbor route is in this prefix list.

The *network-addr* and *mask-bits* parameters specify the network number and the number of bits in the network mask.

You can specify a range of prefix length for prefixes that are more specific than *network-addr* and *mask-bits*.

The prefix-list matches only on this network unless you use the **ge** *ge-value* or **le** *le-value* parameters.

- If you specify only **ge** *ge-value*, the mask-length range is from *ge-value* to 81.
- If you specify only **le** *le-value*, the mask-length range is from length to *le-value*.

The *ge-value* or *le-value* you specify must meet the following condition:

length < *ge-value* <= *le-value* <= 81

If you do not specify **ge** *ge-value* or **le** *le-value*, the prefix list matches only on the exact network prefix you specified with the *network-addr* and *mask-bits* parameters.

In the following example, only default routes are allowed:

```
device(config)# ip prefix-list match-default-routes permit 0.0.0.0/0
```

In the following example, only default routes are denied:

```
device(config)# ip prefix-list match-default-routes deny 0.0.0.0/0
```

In the following example, all routes are allowed, including all subnet masks and all prefixes:

```
device(config)# ip prefix-list match-all-routes permit 0.0.0.0/0 le 32
```

NOTE

Be careful to determine exactly which routes you want to allow using a prefix list.

Defining neighbor distribute lists

A neighbor distribute list is a list of BGP4 address filters or ACLs that filter the traffic to or from a neighbor.

To configure a distribute list that uses ACL 1, enter a command such as the following.

```
device(config-bgp)# neighbor 10.10.10.1 distribute-list 1 in
```

This command configures the device to use ACL 1 to select the routes that the device will accept from neighbor 10.10.10.1.

Syntax: [no] **neighbor ip-addr distribute-list name-or-num in | out**

The *ip-addr* parameter specifies the neighbor.

The *name-or-num* parameter specifies the name or number of a standard or named ACL.

The **in** and **out** parameters specify whether the distribute list applies to inbound or outbound routes:

- **in** - controls the routes the device will accept from the neighbor.
- **out** - controls the routes sent to the neighbor.

Defining route maps

A route map is a named set of match conditions and parameter settings that the device can use to modify route attributes and to control redistribution of the routes into other protocols. A route map consists of a sequence of instances . If you think of a route map as a table, an instance is a row in that table. The device evaluates a route according to route map instances in ascending numerical order. The route is first compared against instance 1, then against instance 2, and so on. When a match is found, the device stops evaluating the route.

Route maps can contain match clauses and **set** statements. Each route map contains a **permit** or **deny** action for routes that match the match clauses:

- If the route map contains a **permit** action, a route that matches a match statement is permitted; otherwise, the route is denied.
- If the route map contains a **deny** action, a route that matches a match statement is denied.
- If a route does not match any match statements in the route map, the route is denied. This is the default action. To change the default action, configure the last match statement in the last instance of the route map to **permit any any** .
- If there is no match statement, the software considers the route to be a match.
- For route maps that contain address filters, AS-path filters, or community filters, if the action specified by a filter conflicts with the action specified by the route map, the route map action takes precedence over the filter action.

If the route map contains set clauses, routes that are permitted by the route map match statements are modified according to the set clauses.

Match statements compare the route against one or more of the following:

- The route BGP4 MED (metric)
- A sequence of AS-path filters
- A sequence of community filters
- A sequence of address filters
- The IP address of the next hop device
- The route tag
- For OSPF routes only, the route type (internal, external type-1, or external type-2)
- An AS-path ACL

- A community ACL
- An IP prefix list
- An IP ACL

For routes that match all of the match statements, the route map set clauses can perform one or more of the following modifications to the route attributes:

- Prepend AS numbers to the front of the route AS-path. By adding AS numbers to the AS-path, you can cause the route to be less preferred when compared to other routes based on the length of the AS-path.
- Add a user-defined tag an automatically calculated tag to the route.
- Set the community attributes.
- Set the local preference.
- Set the MED (metric).
- Set the IP address of the next-hop device.
- Set the origin to IGP or INCOMPLETE.
- Set the weight.
- Set a BGP4 static network route.

When you configure parameters for redistributing routes into BGP4, one of the optional parameters is a route map. If you specify a route map as one of the redistribution parameters, the device matches the route against the match statements in the route map. If a match is found and if the route map contains set clauses, the device sets the attributes in the route according to the set clauses.

To create a route map, you define instances of the map by a sequence number.

To define a route map, use the procedures in the following sections.

Entering the route map into the software

To add instance 1 of a route map named "GET_ONE" with a permit action, enter the following command.

```
device(config)# route-map GET_ONE permit 1  
device(config-routemap GET_ONE) #
```

Syntax: [no] route-map *map-name* **permit | deny *num***

As shown in this example, the command prompt changes to the route map level. You can enter the match and set clauses at this level.

The *map-name* is a string of characters that names the map. Map names can be up to 80 characters in length.

The **permit** and **deny** parameters specify the action the device will take if a route matches a match statement:

- If you specify **deny**, the device does not advertise or learn the route.
- If you specify **permit**, the device applies the match and set clauses associated with this route map instance.

The *num* parameter specifies the instance of the route map you are defining.

To delete a route map, enter a command such as the following. When you delete a route map, all the permit and deny entries in the route map are deleted.

```
device(config)# no route-map Map1
```

This command deletes a route map named Map1. All entries in the route map are deleted.

To delete a specific instance of a route map without deleting the rest of the route map, enter a command such as the following.

```
device(config)# no route-map Map1 permit 10
```

This command deletes the specified instance from the route map but leaves the other instances of the route map intact.

Specifying the match conditions

Use the following command to define the match conditions for instance 1 of the route map GET_ONE. This instance compares the route updates against BGP4 address filter 11.

```
device(config-routemap GET_ONE) # match address-filters 11
```

Syntax: [no] **match** [**as-path name**] [**community acl exact-match**] | [**ip address acl** | **prefix-list string**] | [**ip route-source acl** | **prefix name**] [**metric num**] | [**next-hop address-filter-list**] | [**route-type internal** | **external-type1** | **external-type2**] [**tag tag-value**] | [**interface interface** **protocol bgp static-network**] [**protocol bgp external**] [**protocol bgp internal**]

The **as-pathnum** parameter specifies an AS-path ACL. You can specify up to five AS-path ACLs. To configure an AS-path ACL, use the **ip as-path access-list** command.

The **community num** parameter specifies a community ACL.

NOTE

The ACL must already be configured.

The **communityacl/exact-match** parameter matches a route if (and only if) the route community attributes field contains the same community numbers specified in the match statement.

The **ip address**, **next-hop acl-num**, **prefix-list**, and **string** parameters specify an ACL or IP prefix list. Use this parameter to match based on the destination network or next-hop gateway. To configure an IP ACL for use with this command, use the **ip access-list** command. To configure an IP prefix list, use the **ip prefix-list** command.

The **ip route-sourceacl** and **prefixname** parameters match based on the source of a route (the IP address of the neighbor from which the device learned the route).

The **metricnum** parameter compares the route MED (metric) to the specified value.

The **next-hop address-filter-list** parameter compares the IP address of the route next-hop to the specified IP address filters. The filters must already be configured.

The **route-type internal**, **external-type1**, and **external-type2** parameters apply only to OSPF routes. These parameters compare the route type to the specified value.

The **tagtag-value** parameter compares the route tag to the specified tag value.

The **protocol bgp static-network** parameter matches on BGP4 static network routes.

The **protocol bgp external** parameter matches on eBGP (external) routes.

The **protocol bgp internal** parameter matches on iBGP (internal) routes.

Match examples using ACLs

The following sections contain examples of how to configure route maps that include match statements that match on ACLs.

Matching based on AS-path ACL

To construct a route map that matches based on AS-path ACL 1, enter the following commands.

```
device(config)# route-map PathMap permit 1  
device(config-routemap PathMap)# match as-path 1
```

Syntax: [no] match as-path *string*

The *string* parameter specifies an AS-path ACL and can be a number from 1 through 199. You can specify up to five AS-path ACLs.

Matching based on community ACL

To construct a route map that matches based on community ACL 1, enter the following commands.

```
device(config)# ip community-list 1 permit 123:2  
device(config)# route-map CommMap permit 1  
device(config-routemap CommMap)# match community 1
```

Syntax: [no] match community *string*

The *string* parameter specifies a community list ACL. To configure a community list ACL, use the **ip community-list** command.

Matching based on destination network

You can use the results of an IP ACL or an IP prefix list as the match condition.

To construct a route map that matches based on destination network, enter commands such as the following.

```
device(config)# route-map NetMap permit 1  
device(config-routemap NetMap)# match ip address 1
```

Syntax: [no] match ip address *ACL-name-or-num*

Syntax: [no] match ip address *prefix-list name*

The *ACL-name-or-num* parameter with the first command specifies an IP ACL and can be a number from 1 through 199 or the ACL name if it is a named ACL. Multiple ACLs may be added when separated by spaces. To configure an IP ACL, use the **ip access-list** or **access-list** command.

The *name* parameter with the second command specifies an IP prefix list name.

Matching based on next-hop device

You can use the results of an IP ACL or an IP prefix list as the match condition.

To construct a route map that matches based on the next-hop device, enter commands such as the following.

```
device(config)# route-map HopMap permit 1  
device(config-routemap HopMap)# match ip next-hop 2
```

Syntax: [no] match ip next-hop *string*

Syntax: [no] match ip next-hop *prefix-list name*

The *string* parameter with the first command specifies an IP ACL and can be a number from 1 through 199 or the ACL name if it is a named ACL. To configure an IP ACL, use the **ip access-list** or **access-list** command.

The *name* parameter with the second command specifies an IP prefix list name.

Matching based on the route source

To match a BGP4 route based on its source, use the **match ip route-source** command.

```
device(config)# access-list 10 permit 192.168.6.0 0.0.0.255
device(config)# route-map bgp1 permit 1
device(config-routemap bgp1)# match ip route-source 10
```

The first command configures an IP ACL that matches on routes received from 192.168.6.0/24. The remaining commands configure a route map that matches on all BGP4 routes advertised by the BGP4 neighbors whose addresses match addresses in the IP prefix list. You can add a set clause to change a route attribute in the routes that match. You also can use the route map as input for other commands, such as the **neighbor** and **network** commands and some show commands.

Syntax: [no] **match ip route-source** *ACL | prefix-list name*

The *acl* and **prefix-list name** parameters specify the name or ID of an IP ACL, or an IP prefix list.

Matching on routes containing a specific set of communities

The device can match routes based on the presence of a community name or number in a route. To match based on a set of communities, configure a community ACL that lists the communities, then compare routes against the ACL.

```
device(config)# ip community-list standard std_1 permit 12:34 no-export
device(config)# route-map bgp2 permit 1
device(config-routemap bgp2)# match community std_1 exact-match
```

The first command configures a community ACL that contains community number 12:34 and community name no-export. The remaining commands configure a route map that matches the community attributes field in BGP4 routes against the set of communities in the ACL. A route matches the route map only if the route contains all the communities in the ACL and no other communities.

Syntax: [no] **match community** *ACL exact-match*

The *ACL* parameter specifies the name of a community list ACL. You can specify up to five ACLs. Separate the ACL names or IDs with spaces.

Here is another example.

```
device(config)# ip community-list standard std_2 permit 23:45 56:78
device(config)# route-map bgp3 permit 1
device(config-routemap bgp3)# match community std_1 std_2 exact-match
```

These commands configure an additional community ACL, std_2, that contains community numbers 23:45 and 57:68. Route map bgp3 compares each BGP4 route against the sets of communities in ACLs std_1 and std_2. A BGP4 route that contains either but not both sets of communities matches the route map. For example, a route containing communities 23:45 and 57:68 matches. However, a route containing communities 23:45, 57:68 and 12:34, or communities 23:45, 57:68, 12:34, and no-export does not match. To match, the route communities must be the same as those in exactly one of the community ACLs used by the match community statement.

Matching based on BGP4 static network

The **match** option has been added to the **route-map** command that allows you to match on a BGP4 static network. In the following example, the route-map is configured to match on the BGP4 static network. The device is then configured to advertise to the core BGP4 peer (IP address 192.168.6.0) only the BGP4 static routes and nothing else.

```
device(config)# route-map policygroup3 permit 10
device(config-routemap policygroup3)# match protocol bgp static-network
device(config-routemap policygroup3)# set local-preference 150
device(config-routemap policygroup3)# set community no-export
```

```
device(config-routemap policygroup3) # exit  
device(config) # router bgp  
device(config-bgp) # neighbor 192.168.6.0 route-map out policymap3
```

Syntax: [no] match protocol bgp [external | internal | static-network]

The **match protocol bgp external** option will match the eBGP routes.

The **match protocol bgp internal** option will match the iBGP routes.

The **match protocol bgp static-network** option will match the static-network BGP4 route, applicable at BGP4 outbound policy only.

Matching based on interface

The *match* option has been added to the **route-map** command that distributes any routes that have their next hop out one of the interfaces specified. This feature operates with the following conditions:

- The **match interface** option can only use the interface name (for example ethernet 1/1/2) and not the IP address as an argument.
- The **match interface** option is only effective during redistribution and does not apply for other route map usage such as: bgp outbound route update policy.
- The **match interface** option can be applied to other types of redistribution such as redistributing OSPF routes to BGP4, or filtering out all OSPF routes that point to a specific interface.

To configure the match-interface option, use the following command.

```
device(config) # route-map test-route permit 99  
device(config-routemap test-route) # match interface ethernet 1/1/1 ethernet 1/3/2  
device(config-routemap test-route) # exit
```

Syntax: [no] match interface *interface* *interface* ...

The *interface* variable specifies the interface that you want to use with the **match interface** command. Up to 5 interfaces of the following types can be specified:

- **ethernet *unit/slot/port***
- **loopback *loopback-number***
- **null0**
- **tunnel *tunnel-ID***
- **ve *ve-ID***

Setting parameters in the routes

Use the following command to define a set clause that prepends an AS number to the AS path on each route that matches the corresponding match statement.

```
device(config-routemap GET_ONE) # set as-path prepend 65535
```

Syntax: [no] set [as-path [prepend *as-num,as-num,...*]] | [automatic-tag] | [comm-list *acl* delete] | [community *num : num | num*] | [additive] | [local-as] | [no-advertise] | [no-export] | [dampening [half-life *reuse suppress max-suppress-time*]] | [ip next hop *ip-addr*] | [ip next-hop *peer-address*] | [local-preference *num*] | [metric [+ | -] *num* | none] | [metric-type type-1 | type-2] | [external [metric-type internal]] | [next-hop *ip-addr*] | [origin igp | incomplete] | [tag] | [weight *num*]

The **as-path prependnum,num,...** parameter adds the specified AS numbers to the front of the AS-path list for the route. The range of num values is 1 - 65535 for two-byte ASNs and 1 - 4294967295 if AS4s have been enabled.

The **automatic-tag** parameter calculates and sets an automatic tag value for the route.

NOTE

This parameter applies only to routes redistributed into OSPF.

The **comm-list** parameter deletes a community from the community attributes field for a BGP4 route.

The **community** parameter sets the community attribute for the route to the number or well-known type you specify.

The **dampening** [*half-life reuse suppress max-suppress-time*] parameter sets route dampening parameters for the route. The *half-life* parameter specifies the number of minutes after which the route penalty becomes half its value. The *reuse* parameter specifies how low a route penalty must become before the route becomes eligible for use again after being suppressed. The *suppress* parameter specifies how high a route penalty can become before the device suppresses the route. The *max-suppress-time* parameter specifies the maximum number of minutes that a route can be suppressed regardless of how unstable it is.

The **ip next hop ip-addr** parameter sets the next-hop IP address for route that matches a match statement in the route map.

The **ip next-hop peer-address** parameter sets the BGP4 next hop for a route to the neighbor address.

The **local-preference num** parameter sets the local preference for the route. You can set the preference to a value from 0 through 4294967295.

The **metric [+ | -] num | none** parameter sets the MED (metric) value for the route. The default MED value is 0. You can set the preference to a value from 0 through 4294967295.

- **set metric num** - Sets the metric for the route to the number you specify.
- **set metric + num** - Increases route metric by the number you specify.
- **set metric - num** - Decreases route metric by the number you specify.
- **set metric none** - Removes the metric from the route (removes the MED attribute from the BGP4 route).

The **metric-type type-1** and **type-2** parameters change the metric type of a route redistributed into OSPF.

The **metric-type internal** parameter sets the route MED to the same value as the IGP metric of the BGP4 next-hop route. The parameter does this when advertising a BGP4 route to an EBGP neighbor.

The **next-hop ip-addr** parameter sets the IP address of the route next-hop device.

The **origin igr incomplete** parameter sets the route origin to IGP or INCOMPLETE.

The **tagtag-value** parameter sets the route tag. You can specify a tag value from 0 through 4294967295.

NOTE

This parameter applies only to routes redistributed into OSPF.

NOTE

You also can set the tag value using a table map. The table map changes the value only when the device places the route in the IP route table instead of changing the value in the BGP4 route table.

The **weight num** parameter sets the weight for the route. The range for the weight value is 0 through 4294967295.

Setting a BGP4 route MED to equal the next-hop route IGP metric

To set a route's MED to the same value as the IGP metric of the BGP4 next-hop route, when advertising the route to a neighbor, enter commands such as the following.

```
device(config)# access-list 1 permit 192.168.9.0 0.0.0.255
device(config)# route-map bgp4 permit 1
device(config-routemap bgp4)# match ip address 1
device(config-routemap bgp4)# set metric-type internal
```

The first command configures an ACL that matches on routes with destination network 192.168.9.0. The remaining commands configure a route map that matches on the destination network in ACL 1, then sets the metric type for those routes to the same value as the IGP metric of the BGP4 next-hop route.

Syntax: no set metric-type internal

Setting the next-hop of a BGP4 route

To set the next-hop address of a BGP4 route to a neighbor address, enter commands such as the following.

```
device(config)# route-map bgp5 permit 1
device(config-routemap bgp5)# match ip address 1
device(config-routemap bgp5)# set ip next-hop peer-address
```

These commands configure a route map that matches on routes whose destination network is specified in ACL 1, and sets the next hop in the routes to the neighbor address (inbound filtering) or the local IP address of the BGP4 session (outbound filtering).

Syntax: [no] set ip next-hop peer-address

The value that the software substitutes for **peer-address** depends on whether the route map is used for inbound filtering or outbound filtering:

- When you use the **set ip next-hop peer-address** command in an inbound route map filter, **peer-address** substitutes for the neighbor IP address.
- When you use the **set ip next-hop peer-address** command in an outbound route map filter, **peer-address** substitutes for the local IP address of the BGP4 session.

NOTE

You can use this command for a peer group configuration.

Deleting a community from a BGP4 route

To delete a community from a BGP4 route's community attributes field, enter commands such as the following.

```
device(config)# ip community-list standard std_3 permit 12:99 12:86
device(config)# route-map bgp6 permit 1
device(config-routemap bgp6)# match ip address 1
device(config-routemap bgp6)# set comm-list std_3 delete
```

The first command configures a community ACL containing community numbers 12:99 and 12:86. The remaining commands configure a route map that matches on routes whose destination network is specified in ACL 1, and deletes communities 12:99 and 12:86 from those routes. The route does not need to contain all the specified communities in order for them to be deleted. For example, if a route contains communities 12:86, 33:44, and 66:77, community 12:86 is deleted.

Syntax: [no] set comm-list ACL delete

The **ACL** parameter specifies the name of a community list ACL.

Using a table map to set the tag value

Route maps that contain set statements change values in routes when the routes are accepted by the route map. For inbound route maps (route maps that filter routes received from neighbors), the routes are changed before they enter the BGP4 route table.

For tag values, if you do not want the value to change until a route enters the IP route table, you can use a table map to change the value. A table map is a route map that you have associated with the IP routing table. The device applies the set statements for tag values in the table map to routes before adding them to the route table.

To configure a table map, you first configure the route map, then identify it as a table map. The table map does not require separate configuration. You can have one table map.

NOTE

Use table maps only for setting the tag value. Do not use table maps to set other attributes. To set other route attributes, use route maps or filters.

To create a route map and identify it as a table map, enter commands such as following. These commands create a route map that uses an address filter. For routes that match the IP prefix list filter, the route map changes the tag value to 100 and is then considered as a table map. This route map is applied only to routes the device places in the IP route table. The route map is not applied to all routes. This example assumes that IP prefix list p11 has already been configured.

```
device(config)# route-map TAG_IP permit 1
device(config-routemap TAG_IP)# match ip address prefix-list p11
device(config-routemap TAG_IP)# set tag 100
device(config-routemap TAG_IP)# router bgp

device(config-bgp)# table-map TAG_IP
```

Configuring cooperative BGP4 route filtering

By default, the device performs all filtering of incoming routes locally, on the device itself. You can use cooperative BGP4 route filtering to cause the filtering to be performed by a neighbor before it sends the routes to the device. Cooperative filtering conserves resources by eliminating unnecessary route updates and filter processing. For example, the device can send a deny filter to a neighbor, which the neighbor uses to filter out updates before sending them to the device. The neighbor saves the resources it would otherwise use to generate the route updates, and the device saves the resources it would use to filter out the routes.

When you enable cooperative filtering, the device advertises this capability in its Open message to the neighbor when initiating the neighbor session. The Open message also indicates whether the device is configured to send filters, receive filters, or both, and the types of filters it can send or receive. The device sends the filters as Outbound Route Filters (ORFs) in route refresh messages.

To configure cooperative filtering, perform the following tasks on the device and on the BGP4 neighbor:

- Configure the filter.

NOTE

Cooperative filtering is currently supported only for filters configured using IP prefix lists.

- Apply the filter as an inbound filter to the neighbor.
- Enable the cooperative route filtering feature on the device. You can enable the device to send ORFs to the neighbor, to receive ORFs from the neighbor, or both. The neighbor uses the ORFs you send as outbound filters when it sends routes

to the device. Likewise, the device uses the ORFs it receives from the neighbor as outbound filters when sending routes to the neighbor.

- Reset the BGP4 neighbor session to send and receive ORFs.
- Perform these steps on the other device.

NOTE

If the device has inbound filters, the filters are still processed even if equivalent filters have been sent as ORFs to the neighbor.

Enabling cooperative filtering

To configure cooperative filtering, enter commands such as the following.

```
device(config)# ip prefix-list Routesfrom10234 deny 10.20.0.0/24
device(config)# ip prefix-list Routesfrom10234 permit 0.0.0.0/0 le 32
device(config)# router bgp
device(config-bgp-router)# neighbor 10.2.3.4 prefix-list Routesfrom1234 in
device(config-bgp-router)# neighbor 10.2.3.4 capability orf prefixlist send
```

The first two commands configure statements for the IP prefix list Routesfrom1234. The first command configures a statement that denies routes to 10.20.20./24. The second command configures a statement that permits all other routes. Once you configure an IP prefix list statement, all routes not explicitly permitted by statements in the prefix list are denied.

The next two commands change the CLI to the BGP4 configuration level, then apply the IP prefix list to neighbor 10.2.3.4. The last command enables the device to send the IP prefix list as an ORF to neighbor 10.2.3.4. When the device sends the IP prefix list to the neighbor, the neighbor filters out the 10.20.0.x routes from its updates to the device. This assumes that the neighbor is also configured for cooperative filtering.

Syntax: [no] **neighbor** *ip-addr | peer-group-name* **capability orf prefixlist** [**send | receive**]

The *ip-addr | peer-group-name* parameters specify the IP address of a neighbor or the name of a peer group of neighbors.

The **send and receive** parameters specify the support you are enabling:

- **send** - The device sends the IP prefix lists to the neighbor.
- **receive** - The device accepts filters from the neighbor.

If you do not specify the capability, both capabilities are enabled.

The **prefixlist** parameter specifies the type of filter you want to send to the neighbor.

NOTE

The current release supports cooperative filtering only for filters configured using IP prefix lists.

Sending and receiving ORFs

Cooperative filtering affects neighbor sessions that start after the filtering is enabled, but do not affect sessions that are already established.

To activate cooperative filtering, reset the session with the neighbor. This is required because the cooperative filtering information is exchanged in Open messages during the start of a session.

To place a prefix-list change into effect after activating cooperative filtering, perform a soft reset of the neighbor session. A soft reset does not end the current session, but sends the prefix list to the neighbor in the next route refresh message.

NOTE

Make sure cooperative filtering is enabled on the device and on the neighbor before you send the filters.

To reset a neighbor session and send ORFs to the neighbor, enter a command such as the following.

```
device# clear ip bgp neighbor 10.2.3.4
```

This command resets the BGP4 session with neighbor 10.2.3.4 and sends the ORFs to the neighbor. If the neighbor sends ORFs to the device, the device accepts them if the send capability is enabled.

To perform a soft reset of a neighbor session and send ORFs to the neighbor, enter a command such as the following.

```
device# clear ip bgp neighbor 10.2.3.4 soft in prefix-list
```

Syntax: clear ip bgp neighbor *ip-addr* [soft in prefix-filter | soft in prefix-list]

If you use the **soft in prefix-filter** parameter, the device sends the updated IP prefix list to the neighbor as part of its route refresh message to the neighbor.

NOTE

If the device or the neighbor is not configured for cooperative filtering, the command sends a normal route refresh message.

Displaying cooperative filtering information

You can display the following cooperative filtering information:

- The cooperative filtering configuration on the device.
- The ORFs received from neighbors.

To display the cooperative filtering configuration on the device, enter a command such as the following.

```
device# show ip bgp neighbor 10.10.10.1
1  IP Address: 10.10.10.1, AS: 65200 (IBGP), RouterID: 10.10.10.1
    State: ESTABLISHED, Time: 0h0m7s, KeepAliveTime: 60, HoldTime: 180
    RefreshCapability: Received
    CooperativeFilteringCapability: Received
    Messages:      Open      Update      KeepAlive      Notification      Refresh-Req
                  Sent       1          0           1             0               1
                  Received:  1          0           1             0               1
    Last Update Time: NLRI          Withdraw          NLRI          Withdraw
                      Tx: ---        ---          Rx: ---        ---
    Last Connection Reset Reason: Unknown
    Notification Sent:      Unspecified
    Notification Received: Unspecified
    TCP Connection state: ESTABLISHED
    Byte Sent:     110, Received: 110
    Local host:   10.10.10.2, Local Port: 8138
    Remote host:  10.10.10.1, Remote Port: 179
    ISentSeq:     460  SendNext:      571  TotUnAck:      0
    TotSent:      111  ReTrans:       0  UnAckSeq:      571
    IRcvSeq:     7349  RcvNext:      7460  SendWnd:      16384
    TotalRcv:     111  DuplRcv:       0  RcvWnd:      16384
    SendQue:      0  RcvQue:        0  CngstWnd:      5325
```

Syntax: show ip bgp neighbor *ip-addr*

To display the ORFs received from a neighbor, enter a command such as the following:

```
device# show ip bgp neighbor 10.10.10.1 received prefix-filter
ip prefix-list 10.10.10.1: 4 entries
  seq 5 permit 10.10.0.0/16 ge 18 le 28
  seq 10 permit 10.20.10.0/24
  seq 15 permit 10.0.0.0/8 le 32
  seq 20 permit 10.10.0.0/16 ge 18
```

Syntax: show ip bgp neighbor *ip-addr* received prefix-filter

Four-byte Autonomous System Numbers (AS4)

This section describes the reasons for enabling four-byte autonomous system numbers (AS4s). AS4s are supported by default. You can specify and view AS4s by default and using the enable facility described in this section. However, not all devices in a network are always capable of utilizing AS4s. The act of enabling them on the local device initiates a facility for announcing the capability and negotiating its use with neighbors. If you do not enable AS4s on a device, other devices do not know that this device is sending them.

The system uses a hierarchy to prioritize the utilization of the AS4 capability. The prioritization depends on the CLI configuration commands. AS4s can be enabled and configured at the level of a neighbor, a peer group, or globally for the entire device, according to the following bottom-up hierarchy:

- If a neighbor has no configuration for AS4s but it belongs to a peer group, the neighbor uses the configuration from the peer group. For example, if you configure a neighbor but do not include a specification for AS4s, one of the following applies:
 - The neighbor uses the AS4 configuration for a peer group if it belongs to a peer group.
 - The neighbor uses the device configuration if it does not belong to a peer group or the peer group has no AS4 configuration.
- If a peer group has no configuration for AS4s, it can use the global configuration of the device. If the device has no configuration for AS4s, then a neighbor or peer group without a configuration for AS4s use the device default--no announcement or negotiation of AS4s.
- If a neighbor belongs to peer group with an AS4 configuration but you want that neighbor to be disabled or have a different AS4 configuration, the neighbor AS4 configuration overrides the peer group configuration. For example, you can ensure that neighbor has no AS4 announcement and negotiation activity even though the peer group is enabled for AS4 capability.

NOTE

The configuration for AS4 can be enabled, disabled, or can have no explicit configuration.

CLI commands allow you to disable AS4s on an entity whose larger context has AS4s enabled. For example, you can use a CLI command to disable AS4s on a neighbor that is a member of a peer group that is enabled for AS4s.

Normally, AS4s are sent only to a device, peer group, or neighbor that is similarly configured for AS4s. If a AS4 is configured for a local-autonomous systemS, the system signals this configuration by sending AS_TRANS in the My Autonomous System field of the OPEN message. However, if the AS4 capability for a neighbor is disabled, the local device does not send the four-byte Autonomous System number capability to the neighbor.

Enabling AS4 numbers

This section describes how to enable the announcement and negotiation of AS4s and describes the different types of notation that you can use to represent a AS4.

You can enable AS4s on a device, a peer group, and a neighbor. For global configuration, the **capability** command in the BGP4 configuration context enables or disables AS4 support. For a peer group or a neighbor, **capability** is a keyword for the **neighbor** command. In addition to enabling AS4s for a neighbor or a peer group, you can also use the combination of the **capability** keyword and the optional **enable** or **disable** keyword to disable this feature in a specific case where the AS4s are enabled for a larger context. The Neighbor configuration of AS4s section illustrates this capability.

Global AS4 configuration

To enable AS4s globally, use the **capability** command in the BGP4 configuration context as shown.

```
device(config-bgp)# capability as4 enable
```

Syntax: [no] capability as4 enable | disable

The **no** form of the **capability** command deletes the announcement and negotiation configuration of AS4s (if it has been enabled) at the global level. Using the regular form of the command with the **disable** keyword has the same effect on the global configuration. Disabling or using the **no** form of the command does not affect the configuration at the level of a peer or neighbor.

The consequences of choosing between the **enable** or **disable** keyword are reflected in the output of the **show running configuration** command.

Peer group configuration of AS4s

To enable AS4s for a peer group, use the **capability** keyword with the **neighbor** command in the BGP4 configuration context, as the following example for the Peergroup_1 peer group illustrates.

```
device(config-bgp)# neighbor Peergroup_1 capability as4 enable
```

Syntax: [no] neighbor peer-group-name capability as4 enable | disable

The **no** form of the **neighbor** command along with the **capability** and **as4** keywords disables the announcement and negotiation of AS4s in the named peer group. Using the regular form of the command with the **disable** keyword has the same effect on the neighbor configuration.

The consequences using the **enable** or **disable** keywords are reflected in the output of the **show running configuration** command. However, if the peer group configuration omits an explicit AS4 argument, the **show running configuration** output will not contain AS4 information.

Neighbor configuration of AS4s

To enable AS4s for a neighbor, use the **capability** and **as4** keywords with the **neighbor** command in the BGP4 configuration context, as the following example for IP address 1.1.1.1 illustrates.

```
device(config-bgp)# neighbor 1.1.1.1 capability as4 enable
```

Syntax: [no] neighbor IPaddress capability as4 enable | disable

The **no** form of the **neighbor** command with the **capability** and **as4** keywords deletes the neighbor-enable for AS4s.

The consequences of using the **enable** or **disable** keywords are reflected in the output of the **show running configuration** command. However, if the neighbor configuration omits an explicit AS4 argument, the **show running configuration** output will not contain AS4 information.

To disable AS4s on a particular neighbor within a peer group that is enabled for AS4s, enter a command similar to the following.

```
device(config-bgp)# neighbor 1.1.1.1 capability as4 disable
```

Specifying the local AS number

The local autonomous system number (ASN) identifies the autonomous system where the BGP4 device resides.

Configuring BGP4 (IPv4)

Four-byte Autonomous System Numbers (AS4)

Normally, AS4s are sent only to a device, peer group, or neighbor that is similarly configured for AS4s. Typically, if you try to set up a connection from an AS4-enabled device to a device that processes only two-byte ASNs, the connection fails to come up unless you specify the reserved ASN 23456 as the local ASN to send to the far-end device.

To set the local autonomous system number, enter commands such as the following.

```
device(config)# router bgp  
BGP4: Please configure 'local-as' parameter in order to enable BGP4.  
device(config-bgp)# local-as 100000  
device(config-bgp)# write memory
```

Syntax: [no] local-as num

The *num* parameter specifies a local ASN in the range 1 - 4294967295. No default exists for *num*. ASNs 64512 - 65535 are the well-known private BGP4 autonomous system numbers and are not advertised to the Internet community.

Route-map set commands and AS4s

You can prepend an AS4 number to an autonomous system path or make the autonomous system number a tag attribute for a route map as shown here.

```
device(config-routemap test)# set as-path prepend 7701000
```

Syntax: [no] set as-path prepend num,num , ... | tag

Use the **no** form of this command to remove the configuration.

NOTE

If the autonomous system path for a route map has prepended ASNs and you want to use the **no** form of the command to delete the configuration, you must include the prepended ASNs in the **no set as-path** entry. For example, if 70000 and 70001 have been prepended to a route map, enter **no set as-path prepend 70000 70001**. As a shortcut, in the configuration context of a particular route map, you can also copy and paste ASNs from the output of **show** commands, such as **show route-map** or **show ip bgp route**.

Use the **prepend** keyword to prepend one or more ASNs. The maximum number of ASNs that you can prepend is 16. The range for each ASN is 1 - 4294967295.

Entering the **tag** keyword sets the tag as an AS-path attribute.

Clearing BGP4 routes to neighbors

You can clear BGP4 connections using the AS4 as an argument with the **clear ip bgp neighbor** command in the configuration context level of the CLI. as shown.

```
device(config)# clear ip bgp neighbor 80000
```

Syntax: clear ip bgp neighbor all | ip-addr | peer-group-name | as-num [last-packet-with-error | notification-errors | [soft [in | out] | soft-outbound]]

The neighbor specification is either **all**, **ip-addr**, **peer-group-name**, or **as-num**. The **all** parameter specifies all neighbors. The **ip-addr** parameter specifies a neighbor by its IP interface with the device. The **peer-group-name** specifies all neighbors in a specific peer group. The **as-num** parameter specifies all neighbors within the specified AS. After choosing one mandatory parameter, you can choose an optional parameter.

The **soft in** and **soft out** parameters determine whether to refresh the routes received from the neighbor or the routes sent to the neighbor. If you do not specify **in** or **out**, the device performs a soft refresh in both options:

- **soft in** performs one of the following actions on inbound routes, according to other configuration settings:
 - If you enabled soft reconfiguration for the neighbor or peer group, **soft in** updates the routes by comparing the route policies against the route updates that the device has stored. Soft reconfiguration does not request additional updates from the neighbor or otherwise affect the session with the neighbor.
 - If you did not enable soft reconfiguration, **soft in** requests the entire BGP4 route table on the neighbor (Adj-RIB-Out), then applies the filters to add, change, or exclude routes.
 - If a neighbor does not support dynamic refresh, **soft in** resets the neighbor session.
- **soft out** updates all outbound routes and then sends the entire BGP4 route table for the device (Adj-RIB-Out) to the neighbor after the device changes or excludes the routes affected by the filters.
- The **soft-outbound** parameter updates all outbound routes by applying the new or changed filters, but sends only the existing routes affected by the new or changed filters to the neighbor.

NOTE

Use **soft-outbound** only if the outbound policy is changed. The **soft-outbound** parameter updates all outbound routes by applying the new or changed filters. However, the device sends to the neighbor only the existing routes that are affected by the new or changed filters. The **soft out** parameter updates all outbound routes and then sends the entire BGP4 route table on the device to the neighbor after the device changes or excludes the routes affected by the filters.

AS4 notation

A AS4 can appear in either a plain or a dot notation format in the output of **show** commands. To select one of these formats, specify the format before entering the **show** command. This section defines these formats and describes how to select a format. The following notations are currently supported:

- With the default **asplain**, the ASN is a decimal integer in the range 1 - 4294967295.
- With **asdot +**, all ASNs are two integer values joined by a period character in the following format:

<high order 16-bit value in decimal>.<low order 16-bit value in decimal>

Using the asdot+ notation, an autonomous system number of value 65526 is represented as the string "0.65526," and an autonomous system number of value 65546 is represented as the string "1.10."

- With **asdot**, an ASN less than 65536 uses the asplain notation (and represents autonomous system number values equal to or greater than 65536 using the asdot+ notation). Using the asdot notation, ASN 65526 is represented as the string "65526," and ASN 65546 is represented as the string "1.10".

NOTE

You can enter autonomous system numbers in any format. However, if you want the **asdot** or the **asdot+** format to appear in the output of a **show** command, you must specify these in the CLI.

NOTE

Remember that autonomous system path matching that uses regular expression is based on the configured autonomous system format.

The following command sequences show how to enable the different notations for AS4s and how these notations appear in the output display.

To see ASNs in asplain, use the **show ip bgp** command.

```
device(config)# show ip bgp
Total number of BGP Routes: 1
```

Configuring BGP4 (IPv4)

BGP4 AS4 attribute errors

```
Status codes: s suppressed, d damped, h history, * valid, > best, i internal, S stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Next Hop      Metric LocPrf Weight Path
*> 47.1.1.0/24   192.168.1.5  1       100     0      90000 100 200 65535 65536 65537 65538 65539 75000 ?
```

To specify **asdot** notation before displaying IP BGP4 information, use the **as-format** command.

```
device(config)# as-format asdot
device(config)# show ip bgp
Total number of BGP Routes: 1
Status codes: s suppressed, d damped, h history, * valid, > best, i internal, S stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Next Hop      Metric LocPrf Weight Path
*> 10.1.1.0/24   192.168.1.5  1       100     0      1.24464 100 200 65535
1.0 1.1 1.2 1.3 1.9464 ?
```

Syntax: [no] **as-format asplain | asdot | asdot+**

The default is **asplain** and can be restored using the **no** version of the command, if the CLI is currently using **asdot** or **asdot+**.

To activate **asdot+** notation, enter **as-format asdot+** in the CLI.

```
device(config)# as-format asdot+
device(config)# show ip bgp
Total number of BGP Routes: 1
Status codes: s suppressed, d damped, h history, * valid, > best, i internal, S stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Next Hop      Metric LocPrf Weight Path
*> 10.1.1.0/24   192.168.1.5  1       100     0      1.24464 0.100 0.200
0.65535 1.0 1.1 1.2 1.3 1.9464 ?
```

BGP4 AS4 attribute errors

This section describes the handling of the confederation path segments in the AS4_PATH attribute, and also specifies the error handling for the new attributes.

To support AS4, the following attributes: AS4_PATH and AS4_Aggregator were specified in RFC 4893. Confederation path segments in an AS4_PATH are discarded and if there are any other errors such as: *attribute length*, *flag*, confederation segments after AS_SEQ/AS_SET, Invalid segment types and More than one AS4_PATH in these new attributes, the attribute is discarded and the error is logged.

Error logs

The device generates a log when it encounters attribute errors in AS4_PATH and AS4_AGGREGATOR.

NOTE

Logging of errors is rate-limited to not more than one message for every two minutes. Some errors may be lost due to this rate-limiting.

Sample log messages for various attribute errors are shown here.

Attribute length error (ignore the AS4_PATH)

```
SYSLOG: Sep 9 19:02:03:<11>mu2, BGP: From Peer 192.168.1.1 received invalid AS4_PATH attribute length (3)
- entire AS4_PATH ignored
```

Attribute flag error (ignore the AS4_PATH)

```
SYSLOG: Sep 9 19:02:03:<11>mu2, BGP: From Peer 192.168.1.1 received invalid AS4_PATH attribute flag (0x40)
- entire AS4_PATH ignored
```

Confederation segments after AS_SEQ/AS_SET (ignore the AS4_PATH)

```
SYSLOG: Sep 9 19:02:03:<11>mu2, BGP: From Peer 192.168.1.1 received invalid Confed info in AS4_PATH (@byte
43) - entire AS4_PATH not ignored
```

Invalid segment types (ignore the AS4_PATH)

```
SYSLOG: Sep 9 19:02:03:<11>mu2, BGP: From Peer 192.168.1.1 received incorrect Seq type/len in AS4_PATH
(@byte 41) - entire AS4_PATH ignored
```

More than one AS4_PATH (Use the first one and ignore the others)

```
SYSLOG: Sep 9 19:02:03:<11>mu2, BGP: From Peer 192.168.1.1 received multiple AS4_PATH attributes - used
first AS4_PATH attribute only
```

Configuring route flap dampening

A route flap is a change in the state of a route, from up to down or down to up. A route state change causes changes in the route tables of the devices that support the route. Frequent route state changes can cause Internet instability and add processing overhead to the devices that support the route.

Route flap dampening helps reduce the impact of route flap by changing the way a BGP4 device responds to route state changes. When route flap dampening is configured, the device suppresses unstable routes until the number of route state changes drops enough to meet an acceptable degree of stability. The Ruckus implementation of route flap dampening is based on RFC 2439.

Route flap dampening is disabled by default. You can enable the feature globally or on an individual route basis using route maps.

NOTE

The device applies route flap dampening only to routes learned from EBGP neighbors.

The route flap dampening mechanism is based on penalties. When a route exceeds a configured penalty value, the device stops using that route and stops advertising it to other devices. The mechanism also allows route penalties to reduce over time if route stability improves.

The route flap dampening mechanism uses the following parameters:

- Suppression threshold - Specifies the penalty value at which the device stops using the route. Each time a route becomes unreachable or is withdrawn by a BGP4 UPDATE from a neighbor, the route receives a penalty of 1000. By default, when a route penalty is greater than 2000, the device stops using the route. By default, if a route goes down more than twice, the device stops using the route. You can set the suppression threshold to a value from 1 through 20000. The default is 2000.
- Half-life - Once a route has been assigned a penalty, the penalty decreases exponentially and decreases by half after the half-life period. The default half-life period is 15 minutes. The software reduces route penalties every five seconds. For example, if a route has a penalty of 2000 and does not receive any more penalties during the half-life, the penalty is reduced to 1000 after the half-life expires. You can configure the half-life to be from 1 - 45 minutes. The default is 15 minutes.

- Reuse threshold - Specifies the minimum penalty a route can have and still be suppressed by the device. If the route penalty falls below this value, the device un-suppresses the route and can use it again. The software evaluates the dampened routes every ten seconds and un-suppresses the routes that have penalties below the reuse threshold. You can set the reuse threshold to a value from 1 through 20000. The default is 750.
- Maximum suppression time - Specifies the maximum number of minutes a route can be suppressed regardless of how unstable the route has been before this time. You can set the parameter to a value from 1 through 20000 minutes. The default is four times the half-life. When the half-life value is set to its default (15 minutes), the maximum suppression time defaults to 60 minutes.

You can configure route flap dampening globally or for individual routes using route maps. If you configure route flap dampening parameters globally and also use route maps, the settings in the route maps override the global values.

Globally configuring route flap dampening

Route flap dampening reduces the amount of route state changes propagated by BGP4 due to unstable routes. This in turn reduces processing requirements.

To enable route flap dampening using the default values, enter the following command.

```
device(config-bgp-router) # dampening
```

Syntax: [no] **dampening** [*half-life reuse suppress max-suppress-time*]

The *half-life* parameter specifies the number of minutes after which the penalty for a route becomes half its value. The route penalty allows routes that have remained stable for a period despite earlier instability to eventually become eligible for use again. The decay rate of the penalty is proportional to the value of the penalty. After the half-life expires, the penalty decays to half its value. A damped route that is no longer unstable can eventually again become eligible for use. You can configure the half-life to be from 1 through 45 minutes. The default is 15 minutes.

The *reuse* parameter specifies how low a penalty for a route must be before the route becomes eligible for use again, after being suppressed. You can set the reuse threshold to a value from 1 through 20000. The default is 750 (0.75, or three-fourths, of the penalty assessed for a one flap).

The *suppress* parameter specifies how high the penalty for a route can be before the device suppresses the route. You can set the suppression threshold to a value from 1 through 20000. The default is 2000 (more than two flaps).

The *max-suppress-time* parameter specifies the maximum number of minutes that a route can be suppressed regardless of how unstable it is. You can set the maximum suppression time to a value from 1 through 255 minutes. The default is 40 minutes.

This example shows how to change the dampening parameters.

```
device(config-bgp-router) # dampening 20 200 2500 40
```

This command changes the half-life to 20 minutes, the reuse threshold to 200, the suppression threshold to 2500, and the maximum number of minutes a route can be damped to 40.

NOTE

To change any of the parameters, you must specify all the parameters with the command. To want to leave any parameters unchanged, enter their default values.

Using a route map to configure route flap dampening for a specific neighbor

You can use a route map to configure route flap dampening for a specific neighbor by performing the following tasks:

- Configure an empty route map with no match or set clauses. This route map does not specify particular routes for dampening but does allow you to enable dampening globally when you refer to this route map from within the BGP4 configuration level.
- Configure another route map that explicitly enables dampening. Use a set clause within the route map to enable dampening. When you associate this route map with a specific neighbor, the route map enables dampening for all routes associated with the neighbor. You also can use match clauses within the route map to selectively perform dampening on some routes from the neighbor.

NOTE

You still need to configure the first route map to enable dampening globally. The second route map does not enable dampening by itself; it just applies dampening to a neighbor.

- Apply the route map to the neighbor.

To enable route flap dampening for a specific BGP4 neighbor, enter commands such as the following.

```
device(config)# route-map DAMPENING_MAP_ENABLE permit 1
device(config-routemap DAMPENING_MAP_ENABLE)# exit
device(config)# route-map DAMPENING_MAP_NEIGHBOR_A permit 1
device(config-routemap DAMPENING_MAP_NEIGHBOR_A)# set dampening
device(config-routemap DAMPENING_MAP_NEIGHBOR_A)# exit
device(config)# router bgp
device(config-bgp)# dampening route-map DAMPENING_MAP_ENABLE
device(config-bgp)# neighbor 10.10.10.1 route-map in DAMPENING_MAP_NEIGHBOR_A
```

In this example, the first command globally enables route flap dampening. This route map does not contain any match or set clauses. At the BGP4 configuration level, the **dampening route-map** command refers to the DAMPENING_MAP_ENABLE route map created by the first command, thus enabling dampening globally.

The third and fourth commands configure a second route map that explicitly enables dampening. Notice that the route map does not contain a match clause. The route map implicitly applies to all routes. Since the route map will be applied to a neighbor at the BGP4 configuration level, the route map will apply to all routes associated with the neighbor.

Although the second route map enables dampening, the first route map is still required. The second route map enables dampening for the neighbors to which the route map is applied. However, unless dampening is already enabled globally by the first route map, the second route map has no effect.

The last two commands apply the route maps. The **dampening route-map** command applies the first route map, which enables dampening globally. The **neighbor** command applies the second route map to neighbor 10.10.10.1. Since the second route map does not contain match clauses for specific routes, the route map enables dampening for all routes received from the neighbor.

Removing route dampening from a route

You can un-suppress routes by removing route flap dampening from the routes. The device allows you to un-suppress all routes at once or un-suppress individual routes.

To un-suppress all the suppressed routes, enter the following command at the Privileged EXEC level of the CLI.

```
device# clear ip bgp dampening
```

Syntax: **clear ip bgp dampening [ip-addr ip-mask]**

The **ip-addr** parameter specifies a particular network.

The **ip-mask** parameter specifies the network mask.

To un-suppress a specific route, enter a command such as the following.

```
device# clear ip bgp dampening 10.157.22.0 255.255.255.0
```

This command un-suppresses only the routes for network 10.157.22.0/24.

Displaying and clearing route flap dampening statistics

The software provides many options for displaying and clearing route flap statistics.

Displaying route flap dampening statistics

To display route dampening statistics or all the damped routes, enter the following command at any CLI level.

```
device# show ip bgp flap-statistics
Total number of flapping routes: 414
  Status Code  >:best d:damped h:history *:valid
  Network        From          Flaps Since    Reuse     Path
h> 10.50.206.0/23  10.90.213.77  1      0 :0 :13 0 :0 :0  65001 4355 1 701
h> 10.255.192.0/20 10.90.213.77  1      0 :0 :13 0 :0 :0  65001 4355 1 7018
h> 10.252.165.0/24 10.90.213.77  1      0 :0 :13 0 :0 :0  65001 4355 1 7018
h> 10.50.208.0/23  10.90.213.77  1      0 :0 :13 0 :0 :0  65001 4355 1 701
h> 10.33.0.0/16    10.90.213.77  1      0 :0 :13 0 :0 :0  65001 4355 1 701
*> 10.17.220.0/24  10.90.213.77  1      0 :1 :4 0 :0 :0   65001 4355 701 62
```

Syntax: **show ip bgp flap-statistics [regular-expression regular-expression | address mask [longer-prefixes] | neighbor ip-addr] as-path-filter num**

The **regular-expression regular-expression** parameter is a regular expression. Regular expressions are the same ones supported for BGP4 AS-path filters.

The **address mask** parameters specify a particular route. If you also use the optional **longer-prefixes** parameter, all statistics for routes that match the specified route or have a longer prefix than the specified route are displayed. For example, if you specify **10.157.0.0 longer**, all routes with the prefix 10.157. or longer (such as 10.157.22.) are displayed.

The **neighbor ip-addr** parameter displays route flap dampening statistics only for routes learned from the specified neighbor. You also can display route flap statistics for routes learned from a neighbor by entering the following command: **show ip bgp neighbor flap-statistics**.

The **as-path-filter num** parameter specifies one or more filters. Only the routes that have been damped and that match the specified filter or filters are displayed.

TABLE 92 show ip bgp flap-statistics output descriptions

This field	Displays
Total number of flapping routes	The total number of routes in the BGP4 route table that have changed state and have been marked as flapping routes.
Status code	Indicates the dampening status of the route, which can be one of the following: <ul style="list-style-type: none">• > - This is the best route among those in the BGP4 route table to the route destination.• d - This route is currently damped, and unusable.• h - The route has a history of flapping and is unreachable now.

TABLE 92 show ip bgp flap-statistics output descriptions (continued)

This field	Displays
	<ul style="list-style-type: none"> * - The route has a history of flapping but is currently usable.
Network	The destination network of the route.
From	The neighbor that sent the route to the device.
Flaps	The number of flaps the route has experienced.
Since	The amount of time since the first flap of this route.
Reuse	The amount of time remaining until this route will be un-suppressed and can be used again.
Path	Shows the AS-path information for the route.

You also can display all dampened routes by entering the **show ip bgp dampened-paths** command.

Clearing route flap dampening statistics

Clearing the dampening statistics for a route does not change the dampening status of the route. To clear all the route dampening statistics, enter the following command at any level of the CLI.

```
device# clear ip bgp flap-statistics
```

Syntax: **clear ip bgp flap-statistics [regular-expression regular-expression | address mask | neighbor ip-addr]**

The parameters are the same as those for the **show ip bgp flap-statistics** command (except the **longer-prefixes** option is not supported).

NOTE

The **clear ip bgp dampening** command not only clears statistics but also un-suppresses the routes.

Generating traps for BGP4

You can enable and disable SNMP traps for BGP4. BGP4 traps are enabled by default.

To enable BGP4 traps after they have been disabled, enter the following command.

```
device(config)# snmp-server enable traps bgp
```

Syntax: **[no] snmp-server enable traps bgp**

Use the **no** form of the command to disable BGP4 traps.

Configuring BGP4

Once you activate BGP4, you can configure the BGP4 options. There are two configuration levels: global and address family.

At the **global level**, all BGP4 configurations apply to IPv4 and IPv6. Enter this layer using the **device BGP4** command

Under the global level, you specify an address family . Address families separate IPv4 and IPv6 BGP4 configurations. Go to this level by entering the **address-family** command at the device BGP4 level. The command requires you to specify the IPv4 or IPv6 network protocol.

Configuring BGP4 (IPv4)

Configuring BGP4

The **address-family** command also requires you to select a sub-address family, which is the type of routes for the configuration. Specify unicast routes.

TABLE 93 IPv4 BGP4 commands for different configuration levels

Command	Global (IPv4 and IPv6)	IPv4 address family unicast
address-family	x	x
aggregate-address		x
always-compare-med	x	
always-propagate		x
as-path-ignore	x	
bgp-redistribute-internal	x	
client-to-client-reflection	x	x
cluster-id		x
compare-med-empty-aspath	x	
compare-routerid	x	
confederation	x	
dampening		x
default-information-originate		x
default-local-preference	x	
default-metric		x
distance	x	
enforce-first-as	x	
exit-address-family	x	x
fast-external-failover	x	
graceful-restart		x
install-igp-cost		x
local-as	x	
log-dampening-debug		x
maxas-limit		x
maximum-paths		x
med-missing-as-worst	x	
multipath		x
neighbor	x	x
network		x
next-hop-enable-default		x
next-hop-recursion		x
redistribute		x
rib-route-limit		x
show	x	x
static-network		
table-map		x
timers	x	
update-time		x

Entering and exiting the address family configuration level

The BGP4 address family contains a unicast sub-level.

To go to the IPv4 BGP4 unicast address family configuration level, enter the following command.

```
device(config-bgp) # address-family ipv4 unicast  
device(config-bgp) #
```

NOTE

The CLI prompt for the global BGP4 level and the BGP4 address-family IPv4 unicast level is the same.

Syntax: [no] **address-family ipv4 unicast** [**vrf vrf-name**]

The default is the IPv4 unicast address family level.

The **vrf** option allows you to configure a unicast instance for the VRF specified by the *vrf-name* variable.

To exit an address family configuration level, enter the following command.

```
device(config-bgp) # exit-address-family  
device(config-bgp) #
```

Syntax: [no] **exit-address-family**

BGP route reflector

A BGP device selects a preferred BGP4 route for a specific prefix learned from multiple peers by using the BGP best path selection algorithm, and installs the BGP4 route in the Routing Table Manager (RTM). The BGP device marks the preferred BGP4 route as the best route, and advertises the route to other BGP4 neighbors. Generally, the RTM route table size is larger than the number of unique BGP4 routes in the BGP4 route table. All preferred BGP4 routes are installed in RTM and are marked as the best BGP4 routes.

However, in certain configurations it is possible that the total number of preferred BGP4 routes may exceed the RTM route table size limit. Therefore, some preferred BGP4 routes may not be installed in the RTM, and the BGP device is not able to forward traffic correctly for those BGP4 routes. Those BGP4 routes are not considered as the best BGP4 routes, and are not advertised to other BGP4 neighbors because traffic miss-forwarding or packet drop can occur.

When a BGP device is configured as only a route reflector server, and is not placed directly in the forwarding path, it is possible to mark all preferred BGP4 routes as the best routes to be advertised to other BGP4 neighbors even if the routes are not installed in the RTM. To support the behavior of a BGP device as a route reflector server in such a scenario, use the **always-propagate** command and the **rib-route-limit** command.

NOTE

The **always-propagate** command and the **rib-route-limit** command are supported.

Configuring BGP route reflector

The **always-propagate** command enables a device to mark a preferred BGP4 route not installed in the RTM as the best route, and advertise the route to other BGP4 neighbors. The same process for outbound route policy continues to apply to all best BGP4 routes. The **rib-route-limit** command limits the number of BGP4 Routing Information Base (RIB) routes that can be installed in the RTM. The RTM must be able to reserve enough entries for Interior Gateway Protocol (IGP) routes because the IGP routes are required by BGP4 to resolve BGP4 next-hop entries. If the RTM is not able to reserve enough entries for IGP routes, BGP4 RIB routes can fill the entire RTM with only BGP4 route entries. The **rib-route-limit** command enables IGP and BGP4 route entries to be installed in the RTM.

NOTE

The **always-propagate** command and the **rib-route-limit** command are configurable in any order under the BGP4 address family configuration level.

Perform the following steps to advertise a preferred BGP4 route not installed in the RTM.

1. Configure a BGP4 unicast route. Enter a command such as the following.

```
device(config-bgp) # address-family ipv4 unicast
```

Syntax: **address-family ipv4 unicast [vrf *vrf-name*] | ipv6 unicast**

NOTE

To configure a BGP4 unicast route for a specified VRF instance, use the **vrf *vrf-name*** parameter. The **vrf*vrf-name*** parameter allows you to create a VPN routing or forwarding instance specified by the *vrf-name* variable. The *vrf-name* variable specifies the name of the VRF instance you want to create.

2. Enter the **always-propagate** command to enable a preferred BGP4 route (not installed in the RTM) to be advertised to other BGP4 neighbors.

```
device(config-bgp) # always-propagate
```

Syntax: **always-propagate**

3. Enter the **rib-route-limit** command to set the maximum number of BGP4 rib routes that can be installed in the RTM.

```
device(config-bgp) # rib-route-limit 500
```

Syntax: **rib-route-limit** *decimal*

The *decimal* variable specifies the maximum number of BGP4 rib routes that can be installed in the RTM. The user may enter any number for the *decimal* variable for the **rib-route-limit** command. By default, there is no limit. If the **rib-route-limit** command is set to 0, no BGP4 routes are installed in the RTM. If a BGP4 route is not installed in the RTM because of the configuration set by the **rib-route-limit** command, the **always-propagate** command must be enabled for preferred BGP4 routes to be advertised to the BGP4 neighbors.

If the **rib-route-limit** command is configured to a value that is below the number of BGP4 routes already installed in the RTM, the following warning message is displayed on the console.

```
device(config-bgp) # rib-route-limit 250
The new limit is below the current bgp rib route count. Please use Clear ip bgp routes command to
remove bgp rib routes.
```

You can only use one of the following commands to clear all BGP4 routes in the RTM, and reset the routes for preferred BGP4 routes to be reinstalled in the RTM. Depending on the type of route the **rib-route-limit** command is used for, select from one of the following commands:

- **clear ip bgp routes** command. This command is used to clear IPv4 BGP unicast routes.
- **clear ipv6 bgp routes** command. This command is used to clear IPv6 BGP unicast routes.

NOTE

It is not guaranteed that the same number of preferred BGP4 routes will be reinstalled in the RTM.

4. Perform the following step to:

- exit the BGP4 unicast family configuration.

```
device(config-bgp-ipv4u) # exit-address-family
```

Syntax: **exit-address-family**

When you enter the **exit-address-family** command at the address family configuration level, you return to the BGP4 unicast address family configuration level (the default BGP4 level).

Displaying configuration for BGP route reflector

To display the configuration for preferred BGP4 routes not installed in the RTM, use the **show ip bgp route** command as shown in the following example.

```
device(config-bgp) # show ip bgp route
Total number of BGP Routes: 333422
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED s:STALE
Prefix          Next Hop      MED    LocPrf   Weight Status
...5  10.12.0.0/24  10.100.100.4  100     0        E
AS_PATH:48 1994 65148 21948 6461 1239 4837 4808 17431 18245...
```

Syntax: **show ip bgp route**

In the previous output, BGP4 receives 333,422 routes and the **rib-route-limit** command is configured to 300,000 routes. The **always-propagate** command has not been enabled. However, because the **rib-route-limit** command is configured to allow for 300,000 routes in the RTM, BGP4 installs only 300,000 routes of the 333,422 routes received in the RTM. When the **always-propagate** command is enabled, a preferred BGP4 route not installed in the RTM is now considered as the best BGP4 route to be

Configuring BGP4 (IPv4)

Specifying a maximum AS path length

advertised to other peers. The route is identified by the letter "b" (for NOT-INSTALLED-BEST) in the Status field. However, when the **always-propagate** command is not enabled, the status field displays only the default letter "E", as displayed for BGP4 route 10.12.0.0/24. The letter "B" or "b" is missing from the Status field.

NOTE

The description of the status "b: NOT-INSTALLED-BEST" has changed. The status description for "b: NOT-INSTALLED-BEST" is now: The routes received from the neighbor are the best BGP4 routes to their destinations, but were nonetheless not installed in the IP route table due to the **rib-route-limit** option (or RTM route table size limit), and the **always-propagate** option to allow the propagating of those best BGP routes.

NOTE

Traffic loss on a BGP4 route occurs when a device is advertising preferred BGP4 routes not installed in the RTM as part of the forwarding path.

Because the BGP4 route 10.12.0.0/24 is not considered as the best BGP4 route, the route is not advertised to other BGP4 neighbors.

```
device(config-bgp)# show ip bgp route 10.12.0.0/24
Number of BGP Routes matching display condition : 1
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
      E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
      S:SUPPRESSED F:FILTERED s:STALE
      Prefix          Next Hop        MED     LocPrf    Weight Status
1      10.12.0.0/24    10.100.100.4    100      0         E
      AS_PATH: 48 1994 65148 21948 6461 1239 4837 4808 17431 18245
      Last update to IP routing table: 0h16m2s
      No path is selected as BEST route
```

Syntax: **show ip bgp route ip-address/prefix**

After enabling the **always-propagate** command, the BGP4 route is now considered the best BGP4 route, even though the route is not installed in the RTM. Because the **rib-route-limit** command was configured to allow for only 300,000 routes in the RTM some preferred BGP4 routes are not installed in the RTM, and are not advertised to other BGP4 neighbors. By enabling the **always-propagate** command, the device is now able to advertise those preferred BGP4 routes to other BGP4 neighbors. In the following example, the Status field displays "bE" indicating that the route is now considered the best BGP4 route for forwarding and will be advertised to other BGP4 neighbors.

```
device(config-bgp)# show ip bgp route 10.12.0.0/24
Number of BGP Routes matching display condition : 1
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
      E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
      S:SUPPRESSED F:FILTERED s:STALE
      Prefix          Next Hop        MED     LocPrf    Weight Status
1      10.12.0.0/24    10.100.100.4    100      0         bE
      AS_PATH: 48 1994 65148 21948 6461 1239 4837 4808 17431 18245
      Last update to IP routing table: 0h12m53s
      Route is to be sent to 1 peers:
      10.0.0.14(6)
```

For an explanation of the fields displayed in the output of the **show ip bgp route** command, refer to [Displaying information for a specific route](#) on page 459.

Specifying a maximum AS path length

You can use the **maxas-limit in** command to configure a device running BGP4 to discard routes that exceed a specified AS path limit. This limit can be configured globally, for peer groups, and for BGP neighbors.

When you configure **maxas-limit in**, the behavior of the device changes to first check the length of the AS paths in the UPDATE messages and then to apply the inbound policy. If the AS path exceeds the configured length, then the device performs the following actions:

- Does not store the route in the RIB and does not forward the NLRIIs and attributes contained in the UPDATE message for that route
- Logs an error
- Processes the withdrawn NLRIIs in the same update message

If a route from a peer exceeds the configured Maximum AS path limit, the device also removes the same route from that peer, if it exists, from its own RIB.

After a maximum AS path length is configured, the maximum AS path limit applies to all new inbound routes. To update previously stored routes, you must perform an inbound soft reset for all of the address families activated for that particular BGP neighbor session.

NOTE

If the neighbor soft-reconfiguration feature is enabled, you must perform a hard reset on the device to impose the maximum length limit.

NOTE

maxas-limit in is checked against the received AS_PATH and AS4_PATH attributes.

BGP devices check for and, if configured, apply **maxas-limit in** in the following order:

1. Neighbor value
2. Peer group value
3. Global value

In a case where a neighbor has no maximum AS limit, a peer group has a value of 3 configured, and the system has a value of 9 configured, all of the devices in the peer group will only use the peer group value; the global value will never be used.

Setting a global maximum AS path limit

The syntax for the global maximum AS path limit command is:

Syntax: [no] maxas-limit in num

The **maxas-limit** keyword specifies the limit on the AS numbers in the as-path attribute. The **in** keyword allows the as-path attribute from any neighbor imposing a limit on AS numbers received. The default maximum length for the global system is 300. The range is 0 - 300. The **no** keyword removes the configuration at the global level.

NOTE

The device applies the BGP4 maximum AS path limit on a per virtual device basis.

To configure the global Maximum AS path limit to 15, enter the following command:

```
device(config-bgp) # maxas-limit in 15
```

Setting a maximum AS path limit for a peer group or neighbor

To set maximum AS path limit for a peer group or a neighbor, the syntax is:

Syntax: neighbor { ip-addr | peer-group-name } maxas-limit in [num | disable]

By default, neighbors or peer groups have no configured maximum values. The range is 0 - 300. The **disable** keyword is used to stop a neighbor from inheriting the configuration from the peer-group or global and to the use system default value.

To configure a peer group named "PeerGroup1" and set a maximum AS path value of 7, enter the following commands:

```
device(config-bgp)# neighbor PeerGroup1 peer-group  
device(config-bgp)# neighbor PeerGroup1 maxas-limit in 7
```

BGP4 max-as error messages

This section lists error log messages that you might see when the device receives routes that exceed the configured AS segment limit or the internal memory limit. The log messages can contain a maximum of 30 ASNs. If a message contains more than 30 ASNs, the message is truncated and an ellipsis appears.

Maximum AS path limit error

```
SYSLOG: <11>Jan 1 00:00:00 mul1, BGP: From Peer 192.168.1.2 received Long AS_PAT H= AS_CONFED_SET(4) 1 2 3  
AS_CONFED_SEQUENCE(3) 4 AS_SET(1) 5 6 7 AS_SEQ(2) 8 9 attribute length (9) More than configured MAXAS-LIMIT  
7
```

Memory limit error

```
SYSLOG: <11>Jan 1 00:00:00 mul1, BGP: From Peer 192.168.1.2 received Long AS_PAT H= AS_CONFED_SET(4) 1 2 3  
AS_CONFED_SEQUENCE(3) 4 AS_SET(1) 5 6 7 AS_SEQ(2) 8 9 attribute length (9) Exceeded internal memory limit
```

NOTE

The device generates a log message one time every two minutes. Because of this rate limit, it is possible that some errors might not appear in the log. In this case, you can use the **debug ip bgp events** command to view errors pertaining to the **maxas-limit** value and the actual AS path attributes received.

Originating the default route

By default, the device does not originate and advertise a default route using BGP4. A BGP4 default route is the IP address 0.0.0.0 and the route prefix 0 or network mask 0.0.0.0. For example, 0.0.0.0/0 is a default route.

NOTE

The device checks for the existence of an IGP route for 0.0.0.0/0 in the IP route table before creating a local BGP4 route for 0.0.0.0/0.

To configure the device to originate and advertise a default BGP4 route, enter this command.

```
device(config-bgp)# default-information-originate
```

Syntax: [no] default-information-originate

Changing the default metric used for route cost

By default, BGP4 uses the BGP MED value as the route cost when adding the route to the RTM. However, you can configure BGP4 to use the IGP cost instead.

NOTE

It is recommended that you change the default to IGP cost only in mixed-vendor environments, and that you change it on all Ruckus devices in the environment.

To change the route cost default from BGP MED to IGP cost, enter a command such as the following:

```
device(config-bgp) # install-igp-cost
```

Syntax: [no] install-igp-cost

Use the **no** form of the command to revert to the default of BGP MED.

Configuring a static BGP4 network

This feature allows you to configure a static network in BGP4, creating a stable BGP4 network in the core. While a route configured with this feature will never flap unless it is manually deleted, a "static" BGP4 network will not interrupt the normal BGP4 decision process on other learned routes being installed into the RTM (Routing Table Manager). Consequently, when there is a route that can be resolved, it will be installed into the RTM.

To configure a static BGP4 network, enter commands such as the following.

```
device(config) # router bgp  
device(config-bgp) # static-network 10.157.22.26/16
```

Syntax: [no] static-network *ipAddressPrefix/mask*

The *ipAddress* and *mask* variables are the IPv4 address prefix and mask of the static BGP4 network you are creating.

Using the **no** option uninstalls a route (that was previously installed) from BGP4 RIB-IN and removes the corresponding drop route from the RTM. If there is a new best route, it is advertised to peers if necessary. Otherwise, a withdraw message is sent.

NOTE

The BGP4 network route and the BGP4 static network route are mutually exclusive. They cannot be configured with the same prefix and mask.

When you configure a route using the **static-network** command, BGP4 automatically generates a local route in BGP4 RIB-IN, and installs a NULL0 route in the RTM if there is no other valid route with the same prefix/mask learned from any peer. Otherwise, the learned BGP4 route will be installed in the RTM. In either situation, the new locally generated route will be the best route in RIB-IN and will be advertised to peers if it passes the per-peer outbound policies.

Setting an administrative distance for a static BGP4 network

When a static BGP4 network route is configured, its type is **local BGP4 route** and has a default administrative distance value of 200. To change the administrative distance value, change the value of all local BGP4 routes using the **distance** command at the router bgp level of the CLI, and set a new value for local routes. You can also assign a specific administrative distance value for each static network using the **distance** option as shown.

```
device(config) # router bgp  
device(config-bgp) # static-network 10.157.22.26/16 distance 100
```

Syntax: [no] static-network *ipAddressPrefix/mask* **distance *distance-value***

The *ipAddress* and *mask* variables are the IPv4 address prefix and mask of the static BGP4 network for which you are setting an administrative distance.

The *distance-value* sets the administrative distance of the static BGP4 network route. The range for this value is 1 - 255.

LIMITING ADVERTISEMENT OF A STATIC BGP4 NETWORK TO SELECTED NEIGHBORS

You can control the advertisement of a static BGP4 network to BGP4 neighbors that are configured as Service Edge Devices. When this feature is configured for a BGP4 neighbor, static BGP4 network routes that are installed in the routing table as DROP routes are not advertised to that neighbor. When this feature is configured, the route is only advertised to identified Service Edge devices if it is installed as a forward route, such as the routes described in these steps.

1. There is a learned route from a customer BGP4 peering.
2. There is a valid learned route from another Services Edge device as a result of a customer route present on that device.

To configure a BGP4 neighbor to limit the advertisement of Static BGP4 Network routes, enter the **static-network-edge** command as shown.

```
device(config)# router bgp  
device(config-bgp)# neighbor 10.2.3.4 static-network-edge
```

Syntax: [no] neighbor *ip-address* | *peer-group-name* **static-network-edge**

The *ip-addr* and *peer-group-name* variables indicate whether you are configuring an individual neighbor or a peer group. If you specify a neighbor IP address, you are configuring that individual neighbor. If you specify a peer group name, you are configuring a peer group.

DYNAMIC ROUTE FILTER UPDATE

Routing protocols use various route filters to control the distribution of routes. Route filters are used to filter routes received from and advertised to other devices. Protocols also use route-map policies to control route redistribution from other routing protocols. In addition, route filter policies are used to select routes to be installed in the routing tables, and used by forwarding engine to forward traffic.

There are currently 5 different types of route filters defined for use in a device:

- Access List (ACL)
- Prefix-List
- BGP4 as-path Access-list
- BGP4 community-list
- Route-map

Not every protocol uses all of these route filters. A protocol will usually use two or three filter types.

TABLE 94 Route filters used by each protocol

Protocol	Route map	Prefix list	Community- list	As-path access- list	ACL
BGP4	X	X	BGP4 does not use Community- List filters directly. It does use them indirectly	X	X

TABLE 94 Route filters used by each protocol (continued)

Protocol	Route map	Prefix list	Community- list	As-path access- list	ACL
			through route-map filters that contain Community-List filters.		
OSPF	X	X	X	X	X
RIP	X	X	X	X	
RIPng		X			
OSPFv3	X	X	X	X	
MSDP	X				
MCast					X

When a route filter is changed (created, modified or deleted) by a user, the filter change notification will be sent to all relevant protocols, so that protocols can take appropriate actions. For example if BGP4 is using a route-map (say MapX) to control the routes advertised to a particular peer, the change of route-map (MapX) will cause BGP4 to re-evaluate the advertised routes, and make the appropriate advertisements or withdrawals according to the new route-map policy.

A route filter change action can happen in three ways.

1. A new filter is defined (created).

This filter name may be already referenced by an application. The application needs to be notified of the addition of the new filter, and will bind to and use the new filter. In general, if a filter name is referenced by an application, but is not actually defined, the application assumes the default **deny** action for the filter.

2. An existing filter is undefined (removed).

If the deleted filter is already used and referenced by an application, the application will unbind itself from the deleted filter.

3. An existing filter is modified (updated).

If the filter is already used and referenced by an application, the application will be notified.

Protocols are automatically notified when a route filter is created, deleted or modified. In addition, when a protocol is notified of a filter change, appropriate steps are taken to apply the new or updated filter to existing routes.

Filter update delay and BGP

The **filter-changes-update-delay** command applies (remove only) to changes of filters that are already used or referenced by applications. If the content of a filter is changed, the new filter action takes effect after **filter-changes-update-delay** for existing routes. The notification delay also applies to situations where the usage or reference of a filter is changed in BGP.

For example, the following BGP neighbor command sets or changes the route-map filter on a neighbor:

```
device(config-bgp)# neighbor x.x.x.x route-map map_abc out
```

In this case, the device applies the route-map "map_abc" to the peer, and updates the neighbor out-bound routes after a delay.

If the *delay-time* is 0, BGP does not start peer out-bound policy updates immediately.

Use the **clear filter-change-update** or **clear ip bgp neighbor soft-out** commands to trigger BGP policy updates.

Similarly, the **filter-changes-update-delay** command also applies to the neighbor in-bound policy change.

Configuring BGP4 (IPv4)

Generalized TTL Security Mechanism support

NOTE

The auto-update action for a BGP peer filter is newly introduced in release 08.0.01. In previous releases, a user needs to manually issue the **clear ip bgp neighbor soft out** command to cause the device to apply the new route-map retroactively to existing routes.

The general guideline is to define a policy *first*, then apply it to a BGP peer.

BGP4 policy processing order

The order of application of policies when processing inbound and outbound route advertisements on the device is:

1. Ip prefix-list
2. Outbound Ip prefix-list ORF, if negotiated
3. Filter-list (using As-path access-list)
4. Distribute list (using IP ACL - IPv4 unicast only)
5. Route-map

Generalized TTL Security Mechanism support

The device supports the Generalized TTL Security Mechanism (GTSM) as defined in RFC 3682. GTSM protects the device from attacks of invalid BGP4 control traffic that is sent to overload the CPU or hijack the BGP4 session. GTSM protection applies to EBGP neighbors only.

When GTSM protection is enabled, BGP4 control packets sent by the device to a neighbor have a Time To Live (TTL) value of 255. In addition, the device expects the BGP4 control packets received from the neighbor to have a TTL value of either 254 or 255. For multihop peers (where the **ebgp-multihop** option is configured for the neighbor), the device expects the TTL for BGP4 control packets received from the neighbor to be greater than or equal to 255, minus the configured number of hops to the neighbor. If the BGP4 control packets received from the neighbor do not have the anticipated value, the device drops them.

For more information on GTSM protection, refer to RFC 3682.

To enable GTSM protection for neighbor 192.168.9.210 (for example), enter the following command.

```
device(config-bgp-router) # neighbor 192.168.9.210 ebgp-btsh
```

Syntax: [no] **neighbor** *ip-addr | peer-group-name* **ebgp-btsh**

NOTE

For GTSM protection to work properly, it must be enabled on both the device and the neighbor.

Displaying BGP4 information

You can display the following configuration information and statistics for BGP4 protocol:

- Summary BGP4 configuration information for the device
- Active BGP4 configuration information (the BGP4 information in the running configuration)
- Neighbor information
- Peer-group information
- Information about the paths from which BGP4 selects routes

- Summary BGP4 route information
- Virtual Routing and Forwarding (VRF) instance information
- The device's BGP4 route table
- Route flap dampening statistics
- Active route maps (the route map configuration information in the running configuration)
- BGP4 graceful restart neighbor Information
- AS4 support and asdot notation

Displaying summary BGP4 information

You can display the local AS number, the maximum number of routes and neighbors supported, and some BGP4 statistics. You can also display BGP4 memory usage for:

- BGP4 routes installed
- Routes advertising to all neighbors (aggregated into peer groups)
- Attribute entries installed

The **show ip bgp summary** command output has the following limitations:

- If a BGP4 peer is not configured for an address-family, the peer information is not displayed.
- If a BGP4 peer is configured for an address-family but not negotiated for an address-family after the BGP4 peer is in the established state, the **show ip bgp summary** command output shows (**NoNeg**) at the end of the line for this peer.
- If a BGP4 peer is configured and negotiated for that address-family, its display is the same as in previous releases.

To view summary BGP4 information for the device, enter the following command at any CLI prompt

```
device# show ip bgp summary
BGP4 Summary
Router ID: 10.10.1.14 Local AS Number: 100
Confederation Identifier: not configured
Confederation Peers:
Maximum Number of IP ECMP Paths Supported for Load Sharing: 1
Number of Neighbors Configured: 67, UP: 67
Number of Routes Installed: 258088, Uses 22195568 bytes
Number of Routes Advertising to All Neighbors: 17,035844(3,099146 entries),
Uses 192,147052 bytes
Number of Attribute Entries Installed: 612223, Uses 55100070 bytes
Neighbor Address AS# State Time Rt:Accepted Filtered Sent ToSend
10.0.100.2      100  ESTABp 0h28m24s 0      0      258087 0
10.0.101.2      100  ESTAB  0h28m24s 0      0      258087 0
10.2.3.4        200  ADMDN   0h44m56s 0      0      0      2
```

Syntax: show ip bgp summary

TABLE 95 show ip bgp summary output descriptions

This field	Displays
Router ID	The device ID.
Local AS Number	The BGP4 AS number for the device.
Confederation Identifier	The AS number of the confederation in which the device resides.
Confederation Peers	The numbers of the local autonomous systems contained in the confederation. This list matches the confederation peer list you configure on the device.
Maximum Number of Paths Supported for Load Sharing	The maximum number of route paths across which the device can balance traffic to the same destination. The feature is enabled by

TABLE 95 show ip bgp summary output descriptions (continued)

This field	Displays
	default but the default number of paths is 1. You can increase the number from 2 through 8 paths.
Number of Neighbors Configured	The number of BGP4 neighbors configured on this device, and currently in established state.
Number of Routes Installed	The number of BGP4 routes in the device BGP4 route table and the route or path memory usage.
Number of Routes Advertising to All Neighbors	The total of the RtSent and RtToSend columns for all neighbors, the total number of unique ribout group entries, and the amount of memory used by these groups.
Number of Attribute Entries Installed	The number of BGP4 route-attribute entries in the device route-attributes table and the amount of memory used by these entries.
Neighbor Address	The IP addresses of the BGP4 neighbors for this device.
AS#	The AS number.
State	<p>The state of device sessions with each neighbor. The states are from this perspective of the device, not the neighbor. State values are based on the BGP4 state machine values described in RFC 1771 and can be one of the following for each device:</p> <ul style="list-style-type: none"> • IDLE - The BGP4 process is waiting to be started. Usually, enabling BGP4 or establishing a neighbor session starts the BGP4 process. A minus sign (-) indicates that the session has gone down and the software is clearing or removing routes. • ADMND - The neighbor has been administratively shut down. • CONNECT - BGP4 is waiting for the connection process for the TCP neighbor session to be completed. • ACTIVE - BGP4 is waiting for a TCP connection from the neighbor. Note : If the state frequently changes between CONNECT and ACTIVE, there may be a problem with the TCP connection. • OPEN SENT - BGP4 is waiting for an Open message from the neighbor. • OPEN CONFIRM - BGP4 has received an Open message from the neighbor and is now waiting for either a KEEPALIVE or NOTIFICATION message. If the device receives a KEEPALIVE message from the neighbor, the state changes to Established. If the message is a NOTIFICATION, the state changes to Idle. • ESTABLISHED - BGP4 is ready to exchange UPDATE packets with the neighbor. <p>Operational States:</p> <p>Additional information regarding the operational states of the BGP4 states described above may be added as described in the following:</p> <ul style="list-style-type: none"> • (+) - is displayed if there is more BGP4 data in the TCP receiver queue. Note : If you display information for the neighbor using the show ip bgp neighborip-addr command, the TCP receiver queue value will be greater than 0. • (-) - indicates that the session has gone down and the software is clearing or removing routes. • (*) - indicates that the inbound or outbound policy is being updated for the peer. • (s) - indicates that the peer has negotiated restart, and the session is in a stale state.

TABLE 95 show ip bgp summary output descriptions (continued)

This field	Displays
	<ul style="list-style-type: none"> • (r) - indicates that the peer is restarting the BGP4 connection, through restart. • (^) - on the standby MP indicates that the peer is in the ESTABLISHED state and has received restart capability (in the primary MP). • (<) - indicates that the device is waiting to receive the "End of RIB" message the peer. • (p) - indicates that the neighbor ribout group membership change is pending or in progress • () - indicates that the device is waiting to receive the "End of RIB" message the peer
Time	The time that has passed since the state last changed.
Accepted	The number of routes received from the neighbor that this device installed in the BGP4 route table. Usually, this number is lower than the RoutesRcvd number. The difference indicates that this device filtered out some of the routes received in the UPDATE messages.
Filtered	<p>The routes or prefixes that have been filtered out:</p> <ul style="list-style-type: none"> • If soft reconfiguration is enabled, this field shows how many routes were filtered out (not placed in the BGP4 route table) but retained in memory. • If soft reconfiguration is not enabled, this field shows the number of BGP4 routes that have been filtered out.
Sent	The number of BGP4 routes the device has sent to the neighbor.
ToSend	The number of routes the device has queued to advertise and withdraw to a neighbor.

Displaying the active BGP4 configuration

To view the active BGP4 configuration information contained in the running configuration without displaying the entire running configuration, enter the following command at any level of the CLI.

```
device# show ip bgp config
router bgp
  local-as 200
neighbor 10.102.1.1 remote-as 200
neighbor 10.102.1.1 ebgp-multipath
neighbor 10.102.1.1 update-source loopback 1
neighbor 192.168.2.1 remote-as 100
neighbor 10.200.2.2 remote-as 400
neighbor 2001:db8::1:1 remote-as 200
neighbor 2001:db8::1:2 remote-as 400
neighbor 2001:db8::1 remote-as 300

address-family ipv4 unicast
no neighbor 2001:db8::1:1 activate
no neighbor 2001:db8::1:2 activate
no neighbor 2001:db8::1 activate
exit-address-family

address-family ipv6 unicast
redistribute static
neighbor 2001:db8::1:1 activate
neighbor 2001:db8::1:2 activate
neighbor 2001:db8::1 activate
exit-address-family
end of BGP configuration
```

Syntax: show ip bgp config

Displaying summary neighbor information

The **show ip bgp neighbor** command output has the following limitations.

1. If BGP4 peer is not configured for an address-family, the peer information will NOT be displayed.
2. If BGP4 peer is configured for an address-family, it will display the same as in previous releases.

To display summary neighbor information, enter a command such as the following at any level of the CLI.

```
device# show ip bgp neighbor 192.168.4.211 routes-summary
1   IP Address: 192.168.4.211
    Routes Accepted/Installed:1,  Filtered/Kept:11,  Filtered:11
      Routes Selected as BEST Routes:1
        BEST Routes not Installed in IP Forwarding Table:0
        Unreachable Routes (no IGP Route for NEXTHOP):0
        History Routes:0

    NLRIs Received in Update Message:24,  Withdraws:0 (0),  Replacements:1
      NLRIs Discarded due to
        Maximum Prefix Limit:0, AS Loop:0
        Invalid Nexthop:0, Invalid Nexthop Address:0.0.0.0
        Duplicated Originator_ID:0, Cluster_ID:0

    Routes Advertised:0,  To be Sent:0,  To be Withdrawn:0
    NLRIs Sent in Update Message:0,  Withdraws:0,  Replacements:0

  Peer Out of Memory Count for:
    Receiving Update Messages:0, Accepting Routes (NLRI):0
    Attributes:0, Outbound Routes (RIB-out):0
```

Syntax: show ip bgp neighbors [ip-addr] | [route-summary]

TABLE 96 show ip bgp neighbors route-summary output descriptions

This field	Displays
IP Address	The IP address of the neighbor.
Routes Received	<p>How many routes the device has received from the neighbor during the current BGP4 session:</p> <ul style="list-style-type: none"> Accepted or Installed - Number of received routes the device accepted and installed in the BGP4 route table. Filtered or Kept - Number of routes that were filtered out, but were retained in memory for use by the soft reconfiguration feature. Filtered - Number of received routes filtered out.
Routes Selected as BEST Routes	The number of routes that the device selected as the best routes to their destinations.
BEST Routes not Installed in IP Forwarding Table	The number of routes received from the neighbor that are the best BGP4 routes to their destinations, but were not installed in the IP route table because the device received better routes from other sources (such as OSPF, RIP, or static IP routes).
Unreachable Routes	The number of routes received from the neighbor that are unreachable because the device does not have a valid RIP, OSPF, or static route to the next-hop.
History Routes	The number of routes that are down but are being retained for route flap dampening purposes.

TABLE 96 show ip bgp neighbors route-summary output descriptions (continued)

This field	Displays
NLRIs Received in Update Message	The number of routes received in Network Layer Reachability (NLRI) format in UPDATE messages: <ul style="list-style-type: none"> Withdraws - Number of withdrawn routes the device has received. Replacements - Number of replacement routes the device has received.
NLRIs Discarded due to	Indicates the number of times the device discarded an NLRI for the neighbor due to the following reasons: <ul style="list-style-type: none"> Maximum Prefix Limit - The configured maximum prefix amount had been reached. AS Loop - An AS loop occurred. An AS loop occurs when the BGP4 AS-path attribute contains the local AS number. maxas-limit aspath - The number of route entries discarded because the AS path exceeded the configured maximum length or exceeded the internal memory limits. Invalid Nexthop - The next-hop value was not acceptable. Duplicated Originator_ID - The originator ID was the same as the local device ID. Cluster_ID - The cluster list contained the local cluster ID, or the local device ID if the cluster ID is not configured.
Routes Advertised	The number of routes the device has advertised to this neighbor: <ul style="list-style-type: none"> To be Sent - The number of routes queued to send to this neighbor. To be Withdrawn - The number of NLRI for withdrawing routes the device has queued to send to this neighbor in UPDATE messages.
NLRIs Sent in Update Message	The number of NLRI for new routes the device has sent to this neighbor in UPDATE messages: <ul style="list-style-type: none"> Withdraws - Number of routes the device has sent to the neighbor to withdraw. Replacements - Number of routes the device has sent to the neighbor to replace routes the neighbor already has.
Peer Out of Memory Count for	Statistics for the times the device has run out of BGP4 memory for the neighbor during the current BGP4 session: <ul style="list-style-type: none"> Receiving Update Messages - The number of times UPDATE messages were discarded because there was no memory for attribute entries. Accepting Routes (NLRI) - The number of NLRI discarded because there was no memory for NLRI entries. This count is not included in the Receiving Update Messages count. Attributes - The number of times there was no memory for BGP4 attribute entries. Outbound Routes (RIB-out) - The number of times there was no memory to place a "best" route into the neighbor route information base (Adj-RIB-Out) for routes to be advertised.

Displaying BGP4 neighbor information

You can display configuration information and statistics for BGP4 neighbors of the device.

To view BGP4 neighbor information, including the values for all the configured parameters, enter the following command.

Configuring BGP4 (IPv4)

Displaying BGP4 information

NOTE

The display shows all the configured parameters for the neighbor. Only the parameters that have values different from their defaults are shown.

```
device(config-bgp)# show ip bgp neighbors 10.4.0.2
  Total number of BGP neighbors:
  1  IP Address: 10.4.0.2, AS: 5 (EBGP), RouterID: 10.0.0.1
    Description: neighbor 10.4.0.2
  Local AS: 101
  State: ESTABLISHED, Time: 0h1m0s, KeepAliveTime: 0, HoldTime: 0
    PeerGroup: pg1
    Multihop-EBGP: yes, ttl: 1
    RouteReflectorClient: yes
    SendCommunity: yes
    NextHopSelf: yes
    DefaultOriginate: yes (default sent)
    MaximumPrefixLimit: 90000
    RemovePrivateAs: : yes
    RefreshCapability: Received
  Route Filter Policies:
    Distribute-list: (out) 20
    Filter-list: (in) 30
    Prefix-list: (in) pf1
    Route-map: (in) setnp1 (out) setnp2
  Messages:      Open      Update      KeepAlive      Notification      Refresh-Req
  Sent : 1        1          1          0          0
  Received: 1     8          1          0          0
  Last Update Time: NLRI           Withdraw           NLRI           Withdraw
  Tx: 0h0m59s   ---           Rx: 0h0m59s   ---
  Last Connection Reset Reason: Unknown
    Notification Sent: Unspecified
    Notification Received: Unspecified
  TCP Connection state: ESTABLISHED
    Local host: 10.4.0.1, Local Port: 179
    Remote host: 10.4.0.2, Remote Port: 8053
    ISentSeq: 52837276  SendNext: 52837392  TotUnAck: 0
    TotSent: 116  ReTrans: 0  UnAckSeq: 52837392
    IRcvSeq: 2155052043  RcvNext: 2155052536  SendWnd: 16384
    TotalRcv: 493  DupliRcv: 0  RcvWnd: 16384
    SendQue: 0  RcvQue: 0  CngstWnd: 1460
```

This example shows how to display information for a specific neighbor, by specifying the neighbor's IP address with the `neighbors` command. Since none of the other display options are used, all of the information is displayed for the neighbor. The number in the far left column indicates the neighbor for which information is displayed. When you list information for multiple neighbors, this number makes the display easier to read.

The TCP statistics at the end of the display show status for the TCP session with the neighbor. Most of the fields show information stored in the Transmission Control Block (TCB) for the TCP session between the device and the neighbor. These fields are described in detail in section 3.2 of RFC 793, "Transmission Control Protocol Functional Specification".

Syntax: `show ip bgp neighbors [ip-addr [advertised-routes [detail [ip-add [/ mask-bits]]]] | [attribute-entries [detail]] | [flap-statistics] | [last-packet-with-error] | [received prefix-filter] | [received-routes] | [routes [best] | [detail [best] | [not-installed-best] | [unreachable]] | [rib-out-routes [ip-addr/mask-bits | ip-addr net-mask | detail]] | [routes-summary]]]`

The `ip-addr` option lets you narrow the scope of the command to a specific neighbor.

The **advertised-routes** option displays only the routes that the device has advertised to the neighbor during the current BGP4 session.

The **attribute-entries** option shows the attribute-entries associated with routes received from the neighbor.

The **flap-statistics** option shows the route flap statistics for routes received from or sent to the neighbor.

The **last-packet-with-error** option displays the last packet from the neighbor that contained an error. The packet contents are displayed in decoded (human-readable) format.

The **received prefix-filter** option shows the Outbound Route Filters (ORFs) received from the neighbor. This option applies to cooperative route filtering.

The **received-routes** option lists all the route information received in route updates from the neighbor since the soft reconfiguration feature was enabled.

The **routes** option lists the routes received in UPDATE messages from the neighbor. You can specify the following additional options:

- **best** - Displays the routes received from the neighbor that the device selected as the best routes to their destinations.
- **not-installed-best** - Displays the routes received from the neighbor that are the best BGP4 routes to their destinations, but were not installed in the IP route table because the device received better routes from other sources (such as OSPF, RIP, or static IP routes).
- **unreachable** - Displays the routes that are unreachable because the device does not have a valid RIP, OSPF, or static route to the next hop.
- **detail** - Displays detailed information for the specified routes. You can refine your information request by also specifying one of the options (**best**, **not-installed-best**, or **unreachable**).

The **rib-out-routes** option lists the route information base (RIB) for outbound routes. You can display all routes or specify a network address.

The **routes-summary** option displays a summary of the following information:

- Number of routes received from the neighbor
- Number of routes accepted by this device from the neighbor
- Number of routes this device filtered out of the UPDATES received from the neighbor and did not accept
- Number of routes advertised to the neighbor
- Number of attribute entries associated with routes received from or advertised to the neighbor.

TABLE 97 show ip bgp neighbor output descriptions

Field	Information displayed
Total Number of BGP4 Neighbors	The number of BGP4 neighbors configured.
IP Address	The IP address of the neighbor.
AS	The AS the neighbor is in.
EBGP or IBGP	Whether the neighbor session is an IBGP session, an EBGP session, or a confederation EBGP session: <ul style="list-style-type: none"> • EBGP - The neighbor is in another AS. • EBGP_Confederation - The neighbor is a member of another sub-AS in the same confederation. • IBGP - The neighbor is in the same AS.
RouterID	The neighbor device ID.
Description	The description you gave the neighbor when you configured it on the device.
Local AS	The value (if any) of the Local AS configured.
State	The state of the session with the neighbor. The states are from the device perspective, not the neighbor perspective. The state values are

TABLE 97 show ip bgp neighbor output descriptions (continued)

Field	Information displayed
	<p>based on the BGP4 state machine values described in RFC 1771 and can be one of the following for each device:</p> <ul style="list-style-type: none"> • IDLE - The BGP4 process is waiting to be started. Usually, enabling BGP4 or establishing a neighbor session starts the BGP4 process. A minus sign (-) indicates that the session has gone down and the software is clearing or removing routes. • ADMND - The neighbor has been administratively shut down. Refer to Administratively shutting down a session with a BGP4 neighbor on page 380. A minus sign (-) indicates that the session has gone down and the software is clearing or removing routes. • CONNECT - BGP4 is waiting for the connection process for the TCP neighbor session to be completed. • ACTIVE - BGP4 is waiting for a TCP connection from the neighbor. <p>NOTE If the state frequently changes between CONNECT and ACTIVE, there may be a problem with the TCP connection.</p> <ul style="list-style-type: none"> • OPEN SENT - BGP4 is waiting for an Open message from the neighbor. • OPEN CONFIRM - BGP4 has received an OPEN message from the neighbor and is now waiting for either a KEEPALIVE or NOTIFICATION message. If the device receives a KEEPALIVE message from the neighbor, the state changes to Established. If the message is a NOTIFICATION, the state changes to Idle. • ESTABLISHED - BGP4 is ready to exchange UPDATE messages with the neighbor. <p>If there is more BGP4 data in the TCP receiver queue, a plus sign (+) is also displayed.</p> <p>NOTE If you display information for the neighbor using the show ip bgp neighbor ip-addr command, the TCP receiver queue value will be greater than 0.</p>
Time	The amount of time this session has been in the current state.
KeepAliveTime	The keep alive time, which specifies how often this device sends keepalive messages to the neighbor.
HoldTime	The hold time, which specifies how many seconds the device will wait for a keepalive or update message from a BGP4 neighbor before deciding that the neighbor is not operational.
PeerGroup	The name of the peer group the neighbor is in, if applicable.
Multihop-EBGP	Whether this option is enabled for the neighbor.
RouteReflectorClient	Whether this option is enabled for the neighbor.
SendCommunity	Whether this option is enabled for the neighbor.
NextHopSelf	Whether this option is enabled for the neighbor.
DefaultOriginate	Whether this option is enabled for the neighbor.
MaximumPrefixLimit	Maximum number of prefixes the device will accept from this neighbor.
RemovePrivateAs	Whether this option is enabled for the neighbor.

TABLE 97 show ip bgp neighbor output descriptions (continued)

Field	Information displayed
RefreshCapability	Whether this device has received confirmation from the neighbor that the neighbor supports the dynamic refresh capability.
CooperativeFilteringCapability	Whether the neighbor is enabled for cooperative route filtering.
Distribute-list	Lists the distribute list parameters, if configured.
Filter-list	Lists the filter list parameters, if configured.
Prefix-list	Lists the prefix list parameters, if configured.
Route-map	Lists the route map parameters, if configured.
Messages Sent	The number of messages this device has sent to the neighbor. The display shows statistics for the following message types: <ul style="list-style-type: none"> • Open • Update • KeepAlive • Notification • Refresh-Req
Messages Received	The number of messages this device has received from the neighbor. The message types are the same as for the Message Sent field.
Last Update Time	Lists the last time updates were sent and received for the following: <ul style="list-style-type: none"> • NLRI • Withdraws
Last Connection Reset Reason	The reason the previous session with this neighbor ended. The reason can be one of the following: Reasons described in the BGP4 specifications: <ul style="list-style-type: none"> • Message Header Error • Connection Not Synchronized • Bad Message Length • Bad Message Type • OPEN Message Error • Unsupported Version Number • Bad Peer AS Number • Bad BGP4 Identifier • Unsupported Optional Parameter • Authentication Failure • Unacceptable Hold Time • Unsupported Capability • UPDATE Message Error • Malformed Attribute List • Unrecognized Well-known Attribute • Missing Well-known Attribute • Attribute Flags Error • Attribute Length Error • Invalid ORIGIN Attribute • Invalid NEXT_HOP Attribute • Optional Attribute Error • Invalid Network Field • Malformed AS_PATH • Hold Timer Expired

TABLE 97 show ip bgp neighbor output descriptions (continued)

Field	Information displayed
	<ul style="list-style-type: none"> • Finite State Machine Error • Rcv Notification
Last Connection Reset Reason (cont.)	Reasons specific to the Ruckus implementation: <ul style="list-style-type: none"> • Reset All Peer Sessions • User Reset Peer Session • Port State Down • Peer Removed • Peer Shutdown • Peer AS Number Change • Peer AS Confederation Change • TCP Connection KeepAlive Timeout • TCP Connection Closed by Remote • TCP Data Stream Error Detected
Notification Sent	If the device receives a NOTIFICATION message from the neighbor, the message contains an error code corresponding to one of the following errors. Some errors have subcodes that clarify the reason for the error. Where applicable, the subcode messages are listed underneath the error code messages. <ul style="list-style-type: none"> • Message Header Error: <ul style="list-style-type: none"> - Connection Not Synchronized - Bad Message Length - Bad Message Type - Unspecified • Open Message Error: <ul style="list-style-type: none"> - Unsupported Version - Bad Peer As - Bad BGP4 Identifier - Unsupported Optional Parameter - Authentication Failure - Unacceptable Hold Time - Unspecified • Update Message Error: <ul style="list-style-type: none"> - Malformed Attribute List - Unrecognized Attribute - Missing Attribute - Attribute Flag Error - Attribute Length Error - Invalid Origin Attribute - Invalid NextHop Attribute - Optional Attribute Error - Invalid Network Field - Malformed AS Path - Unspecified • Hold Timer Expired • Finite State Machine Error • Cease • Unspecified
Notification Received	Refer to details for the field Notification Sent.
TCP Connection state	The state of the connection with the neighbor. The connection can have one of the following states: <ul style="list-style-type: none"> • LISTEN - Waiting for a connection request.

TABLE 97 show ip bgp neighbor output descriptions (continued)

Field	Information displayed
	<ul style="list-style-type: none"> • SYN-SENT - Waiting for a matching connection request after having sent a connection request. • SYN-RECEIVED - Waiting for a confirming connection request acknowledgment after having both received and sent a connection request. • ESTABLISHED - Data can be sent and received over the connection. This is the normal operational state of the connection. • FIN-WAIT-1 - Waiting for a connection termination request from the remote TCP, or an acknowledgment of the connection termination request previously sent. • FIN-WAIT-2 - Waiting for a connection termination request from the remote TCP. • CLOSE-WAIT - Waiting for a connection termination request from the local user. • CLOSING - Waiting for a connection termination request acknowledgment from the remote TCP. • LAST-ACK - Waiting for an acknowledgment of the connection termination request previously sent to the remote TCP (which includes an acknowledgment of its connection termination request). • TIME-WAIT - Waiting for enough time to pass to be sure the remote TCP received the acknowledgment of its connection termination request. • CLOSED - There is no connection state.
Byte Sent	The number of bytes sent.
Byte Received	The number of bytes received.
Local host	The IP address of the device.
Local port	The TCP port the device is using for the BGP4 TCP session with the neighbor.
Remote host	The IP address of the neighbor.
Remote port	The TCP port the neighbor is using for the BGP4 TCP session with the device.
ISentSeq	The initial send sequence number for the session.
SendNext	The next sequence number to be sent.
TotUnAck	The number of sequence numbers sent by the device that have not been acknowledged by the neighbor.
TotSent	The number of sequence numbers sent to the neighbor.
ReTrans	The number of sequence numbers that the device retransmitted because they were not acknowledged.
UnAckSeq	The current acknowledged sequence number.
IRcvSeq	The initial receive sequence number for the session.
RcvNext	The next sequence number expected from the neighbor.
SendWnd	The size of the send window.
TotalRcv	The number of sequence numbers received from the neighbor.
DupliRcv	The number of duplicate sequence numbers received from the neighbor.
RcvWnd	The size of the receive window.

TABLE 97 show ip bgp neighbor output descriptions (continued)

Field	Information displayed
SendQue	The number of sequence numbers in the send queue.
RcvQue	The number of sequence numbers in the receive queue.
CngstWnd	The number of times the window has changed.

Displaying route information for a neighbor

You can display routes based on the following criteria:

- A summary of the routes for a specific neighbor.
- Routes received from the neighbor that the device selected as the best routes to their destinations.
- Routes received from the neighbor that are the best BGP4 routes to their destinations, but were not installed in the IP route table because the device received better routes from other sources (such as OSPF, RIP, or static IP routes).
- Routes that are unreachable because the device does not have a valid RIP, OSPF, or static route to the next hop.
- Routes for a specific network advertised by the device to the neighbor.
- The Routing Information Base (RIB) for a specific network advertised to the neighbor. You can display the RIB regardless of whether the device has already sent it to the neighbor.

Displaying advertised routes

To display the routes the device has advertised to a specific neighbor for a specific network, enter a command such as the following at any level of the CLI.

```
device# show ip bgp neighbors 192.168.4.211 advertised-routes
      There are 2 routes advertised to neighbor 192.168.4.211
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
      E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
      S:SUPPRESSED F:FILTERED s:STALE
      Network      Next Hop      Metric     LocPrf     Weight     Status
1       10.102.0.0/24  192.168.2.102  12          32768     BL
2       10.200.1.0/24  192.168.2.102  0           32768     BL
```

You also can enter a specific route.

```
device# show ip bgp neighbors 192.168.4.211 advertised 10.1.1.0/24
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST I:IBGP L:LOCAL
      Network      Next Hop      Metric     LocPrf     Weight     Status
1       10.200.1.0/24  192.168.2.102  0           32768     BL
```

Syntax: **show ip bgp neighbor ip-addr advertised-routes [ip-addr/prefix]**

For information about the fields in this display, refer to [Displaying summary route information](#) on page 456. The fields in this display also appear in the **show ip bgp** display.

Displaying the best routes

To display the routes received from a specific neighbor that are the "best" routes to their destinations, enter a command such as the following at any level of the CLI.

```
device#show ip bgp neighbors 192.168.4.211 routes best
```

Syntax: **show ip bgp neighbors ip-addr routes best**

For information about the fields in this display, refer to [Displaying information for a specific route](#) on page 459. The fields in this display also appear in the **show ip bgp** display.

Displaying the routes with destinations that are unreachable

To display BGP4 routes with destinations that are unreachable using any of the BGP4 paths in the BGP4 route table, enter a command such as the following at any level of the CLI:

```
device(config-bgp) # show ip bgp neighbor 192.168.4.211 routes unreachable
```

Syntax: **show ip bgp neighbor ip-addr routes unreachable**

For information about the fields in this display, refer to [Displaying summary route information](#) on page 456. The fields in this display also appear in the **show ip bgp** display.

Displaying the Adj-RIB-Out for a neighbor

To display the current BGP4 Routing Information Base (Adj-RIB-Out) for a specific neighbor and a specific destination network, enter a command such as the following at any level of the CLI.

```
device# show ip bgp neighbor 192.168.4.211 rib-out-routes 192.168.1.0/24
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED s:STALE
Prefix          Next Hop          Metric     LocPrf      Weight Status
1   10.200.1.0/24       0.0.0.0        0         101      32768   BL
```

The Adj-RIB-Out contains the routes that the device either has most recently sent to the neighbor or is about to send to the neighbor.

Syntax: **show ip bgp neighbor ip-addr rib-out-routes [ip-addr/prefix]**

For information about the fields in this display, refer to [Displaying summary route information](#) on page 456. The fields in this display also appear in the **show ip bgp** display.

Displaying peer group information

To display peer-group information, enter a command such as the following at the Privileged EXEC level of the CLI.

```
device# show ip bgp peer-group STR
1   BGP peer-group is STR
      Address family : IPV4 Unicast
          activate
      Address family : IPV4 Multicast
          no activate
      Address family : IPV6 Unicast
          no activate
      Address family : IPV6 Multicast
          no activate
      Address family : VPNV4 Unicast
          no activate
      Address family : L2VPN VPLS
          no activate
Members:
      IP Address: 10.1.1.1, AS: 5
```

Syntax: **show ip bgp peer-group [peer-group-name]**

Only the parameters that have values different from their defaults are listed.

Displaying summary route information

To display summary statistics for all the routes in the device's BGP4 route table, enter a command such as the following at any level of the CLI.

```
device# show ip bgp routes summary
Total number of BGP routes (NLIRIs) Installed : 20
Distinct BGP destination networks : 20
Filtered BGP routes for soft reconfig : 100178
Routes originated by this router : 2
Routes selected as BEST routes : 19
BEST routes not installed in IP forwarding table : 1
Unreachable routes (no IGP route for NEXTHOP) : 1
IBGP routes selected as best routes : 0
EBGP routes selected as best routes : 17
```

Syntax: **show ip bgp routes summary**

TABLE 98 show ip bgp routes output descriptions

This field	Displays
Total number of BGP4 routes (NLIRIs) Installed	Number of BGP4 routes the device has installed in the BGP4 route table.
Distinct BGP4 destination networks	Number of destination networks the installed routes represent. The BGP4 route table can have multiple routes to the same network.
Filtered BGP4 routes for soft reconfig	Number of route updates received from soft-reconfigured neighbors or peer groups that have been filtered out but retained.
Routes originated by this device	Number of routes in the BGP4 route table that this device originated.
Routes selected as BEST routes	Number of routes in the BGP4 route table that this device has selected as the best routes to the destinations.
BEST routes not installed in IP forwarding table	Number of BGP4 routes that are the best BGP4 routes to their destinations but were not installed in the IP route table because the device received better routes from other sources (such as OSPF, RIP, or static IP routes).
Unreachable routes (no IGP route for NEXTHOP)	Number of routes in the BGP4 route table whose destinations are unreachable because the next-hop is unreachable.
IBGP routes selected as best routes	Number of "best" routes in the BGP4 route table that are IBGP routes.
EBGP routes selected as best routes	Number of "best" routes in the BGP4 route table that are EBGP routes.

Displaying VRF instance information

To display VRF instance information, enter a command such as the following at the Privileged EXEC level of the CLI.

```
device# show ip bgp vrf red
Total number of BGP Routes: 2
Status codes: s suppressed, d damped, h history, * valid, > best, i internal, S stale
Origin codes: i - IGP, e - EGP, ? - incomplete
      Network          Next Hop          RD      MED      LocPrf  Weight Path
*> 10.14.14.0/24    0.0.0.0           0       100      32768   ?
*> 10.11.11.11/32   0.0.0.0           0       100      32768   ?
```

Displaying the BGP4 route table

BGP4 uses filters that you define as well as the algorithm described in [How BGP4 selects a path for a route \(BGP best path selection algorithm\)](#) on page 357 to determine the preferred route to a destination. BGP4 sends only the preferred route to the IP table. To view all the learned BGP4 routes, you can display the BGP4 table.

To view the BGP4 route table, enter the following command.

```
device# show ip bgp routes
Total number of BGP Routes: 97371
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED s:STALE
Prefix          Next Hop      MED     LocPrf   Weight Status
1   10.3.0.0/8    192.168.4.106 100      0        BE
      AS PATH: 65001 4355 701 80
2   10.4.0.0/8    192.168.4.106 100      0        BE
      AS PATH: 65001 4355 1
3   10.60.212.0/22 192.168.4.106 100      0        BE
      AS PATH: 65001 4355 701 1 189
4   10.6.0.0/8    192.168.4.106 100      0        BE
      AS PATH: 65001 4355 3356 7170 1455
5   10.8.1.0/24   192.168.4.106 0       100      0        BE
      AS PATH: 65001
```

Syntax: **show ip bgp routes** [[**network**] *ip-addr*] | *num* | [**age** *secs*] | [**as-path-access-list** *num*] | [**best**] | [**cdr-only**] | [**community** *num*] | [**no-export**] | [**no-advertise**] | [**internet**] | [**local-as**] | [**community-access-list** *num*] | [**community-list** *num*] | [**detail** *option*] | [**filter-list** *num,num,..*] | [**next-hop** *ip-addr*] | [**no-best**] | [**not-installed-best**] | [**prefix-list** *string*] | [**regular-expression** *regular-expression*] | [**route-map** *map-name*] | [**summary**] | [**unreachable**]

The *ip-addr* option displays routes for a specific network. The **network** keyword is optional. You can enter the network address without entering **network** in front of it.

The *num* option specifies the table entry with which you want the display to start. For example, if you want to list entries beginning with table entry 100, specify 100.

The **age** *secs* parameter displays only the routes that have been received or updated more recently than the number of seconds you specify.

The **as-path-access-list** *num* parameter filters the display using the specified AS-path ACL.

The **best** parameter displays the routes received from the neighbor that the device selected as the best routes to their destinations.

The **cdr-only** option lists only the routes whose network masks do not match their class network length.

The **community** option lets you display routes for a specific community. You can specify **local-as**, **no-export**, **no-advertise**, **internet**, or a private community number. You can specify the community number as either two five-digit integer values of up to 1 through 65535, separated by a colon (for example, 12345:6789) or a single long integer value.

The **community-access-list** *num* parameter filters the display using the specified community ACL.

The **community-list** option lets you display routes that match a specific community filter.

The **detail** option lets you display more details about the routes. You can refine your request by also specifying one of the other display options after the detail keyword.

The **filter-list** option displays routes that match a specific address filter list.

The **next-hop** *ip-addr* option displays the routes for a given next-hop IP address.

The **no-best** option displays the routes for which none of the routes to a given prefix were selected as the best route. The IP route table does not contain a BGP4 route for any of the routes listed by the command.

The **not-installed-best** option displays the routes received from the neighbor that are the best BGP4 routes to their destinations, but were not installed in the IP route table because the device received better routes from other sources (such as OSPF, RIP, or static IP routes).

The **prefix-list** *string* parameter filters the display using the specified IP prefix list.

The **regular-expression** *regular-expression* option filters the display based on a regular expression. Refer to [Using regular expressions](#) on page 406.

The **route-map** *map-name* parameter filters the display by using the specified route map. The software displays only the routes that match the match clauses in the route map. Software disregards the route map's set clauses.

The **summary** option displays summary information for the routes.

The **unreachable** option displays the routes that are unreachable because the device does not have a valid RIP, OSPF, or static route to the next-hop.

Displaying the best BGP4 routes

To display all the BGP4 routes in the device's BGP4 route table that are the best routes to their destinations, enter a command such as the following at any level of the CLI

```
device# show ip bgp routes best
Searching for matching routes, use ^C to quit...
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED EBGP D:DAMPED
      E:EBGP H:History I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
      S:SUPPRESSED F:FILTERED s:STALE
      Prefix      Next Hop      MED      LocPrf      Weight Status
1    10.3.0.0/8        192.168.4.106      100      0      BE
          AS PATH: 65001 4355 701 80
2    10.4.0.0/8        192.168.4.106      100      0      BE
          AS PATH: 65001 4355 1
3    10.60.212.0/22    192.168.4.106      100      0      BE
          AS PATH: 65001 4355 701 1 189
4    10.6.0.0/8         192.168.4.106      100      0      BE
          AS PATH: 65001 4355 3356 7170 1455
5    10.2.0.0/16        192.168.4.106      100      0      BE
          AS PATH: 65001 4355 701
```

Syntax: **show ip bgp routes best**

Displaying the best BGP4 routes that are not in the IP route table

When the device has multiple routes to a destination from different sources (such as BGP4, OSPF, RIP, or static routes), the device selects the route with the lowest administrative distance as the best route, and installs that route in the IP route table.

To display the BGP4 routes that are the "best" routes to their destinations but are not installed in the device IP route table, enter a command such as the following at any level of the CLI.

```
device#show ip bgp routes not-installed-best
Searching for matching routes, use ^C to quit...
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED EBGP D:DAMPED
      E:EBGP H:History I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
      S:SUPPRESSED F:FILTERED s:STALE
      Prefix      Next Hop      Metric      LocPrf      Weight Status
1    192.168.4.0/24    192.168.4.106      0      100      0      bE
          AS PATH: 65001
```

Each of the displayed routes is a valid path to its destination, but the device received another path from a different source (such as OSPF, RIP, or a static route) that has a lower administrative distance. The device always selects the path with the lowest administrative distance to install in the IP route table.

Notice that the route status in this example is the new status, "b".

Syntax: **show ip bgp routes not-installed-best**

NOTE

To display the routes that the device has selected as the best routes and installed in the IP route table, display the IP route table using the **show ip route** command.

Displaying BGP4 routes whose destinations are unreachable

To display BGP4 routes whose destinations are unreachable using any of the BGP4 paths in the BGP4 route table, enter a command such as the following at any level of the CLI.

```
device# show ip bgp routes unreachable
Searching for matching routes, use ^C to quit...
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED s:STALE
Prefix      Next Hop      Metric      LocPrf      Weight Status
1  10.8.8.0/24  192.168.5.1      0          101          0
AS_PATH: 65001 4355 1
```

Syntax: **show ip bgp routes unreachable**

Displaying information for a specific route

To display BGP4 network information by specifying an IP address within the network, enter a command such as the following at any level of the CLI.

```
device# show ip bgp 10.3.4.0
Number of BGP Routes matching display condition : 1
Status codes: s suppressed, d damped, h history, * valid, > best, i internal
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Next Hop      Metric LocPrf Weight Path
*> 10.3.4.0/24    192.168.4.106    100    0      65001 4355 1 1221 ?
Last update to IP routing table: 0h11m38s, 1 path(s) installed:
Gateway          Port
192.168.2.1      1/2/1
Route is advertised to 1 peers:
10.20.20.2(65300)
```

Syntax: **show ip bgp [route] ip-addr/prefix [longer-prefixes] | ip-addr**

If you use the **route** option, the display for the information is different, as shown in the following example.

```
device# show ip bgp route 10.3.4.0
Number of BGP Routes matching display condition : 1
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH S:SUPPRESSED F:FILTERED s:STALE
Prefix      Next Hop      MED LocPrf Weight Status
1  10.3.4.0/24  192.168.4.106    100    0      BE
AS_PATH: 65001 4355 1 1221
Last update to IP routing table: 0h12m1s, 1 path(s) installed:
Gateway          Port
192.168.2.1      1/2/1
Route is advertised to 1 peers:
10.20.20.2(65300)
```

TABLE 99 **show ip bgp route output descriptions**

This field	Displays
Number of BGP4 Routes matching display condition	The number of routes that matched the display parameters you entered. This is the number of routes displayed by the command.
Status codes	A list of the characters the display uses to indicate the route's status. The status code appears in the left column of the display, to the left of each route. The status codes are described in the command's output.

TABLE 99 show ip bgp route output descriptions (continued)

This field	Displays
	<p>NOTE This field appears only if you <i>do not</i> enter the route option.</p>
Prefix	The network address and prefix.
Next Hop	The next-hop device for reaching the network.
Metric	The value of the route's MED attribute. If the route does not have a metric, this field is blank.
LocPrf	The degree of preference for this route relative to other routes in the local AS. When the BGP4 algorithm compares routes on the basis of local preferences, the route with the higher local preference is chosen. The preference can have a value from 0 - 4294967295.
Weight	The value that this device associates with routes from a specific neighbor. For example, if the device receives routes to the same destination from two BGP4 neighbors, the device prefers the route from the neighbor with the larger weight.
Path	<p>The route AS path.</p> <p>NOTE This field appears only if you <i>do not</i> enter the route option.</p>
Origin code	<p>A character that indicates the route origin. The origin code appears to the right of the AS path (Path field). The origin codes are described in the command output.</p> <p>NOTE This field appears only if you <i>do not</i> enter the route option.</p>
Status	<p>The route status, which can be one or more of the following:</p> <ul style="list-style-type: none"> • A - AGGREGATE. The route is an aggregate route for multiple networks. • B - BEST. BGP4 has determined that this is the optimal route to the destination. <p>NOTE If the "b" is lowercase, the software was not able to install the route in the IP route table.</p> <ul style="list-style-type: none"> • b - NOT-INSTALLED-BEST. The routes received from the neighbor are the best BGP4 routes to their destinations, but were not installed in the IP route table because the device received better routes from other sources (such as OSPF, RIP, or static IP routes). • C - CONFED_EBGP. The route was learned from a neighbor in the same confederation and AS, but in a different sub-AS within the confederation. • D - DAMPED. This route has been dampened (by the route dampening feature), and is currently unusable. • H - HISTORY. Route dampening is configured for this route, and the route has a history of flapping and is unreachable now. • I - INTERNAL. The route was learned through BGP4. • L - LOCAL. The route originated on this device.

TABLE 99 show ip bgp route output descriptions (continued)

This field	Displays
	<ul style="list-style-type: none"> • M - MULTIPATH. BGP4 load sharing is enabled and this route was selected as one of the best ones to the destination. The best route among the multiple paths also is marked with "B". <p>NOTE If the "m" is lowercase, the software was not able to install the route in the IP route table.</p> <ul style="list-style-type: none"> • S - SUPPRESSED. This route was suppressed during aggregation and thus is not advertised to neighbors. <p>NOTE This field appears only if you enter the route option.</p>

Displaying route details

This example shows the information displayed when you use the **detail** option. In this example, the information for one route is shown.

```
device# show ip bgp routes detail 2
Number of BGP Routes matching display condition : 1
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED s:STALE
1   Prefix: 10.5.5.5/32, Status: BE, Age: 0h2m10s
    NEXT_HOP: 10.0.0.1, Metric: 0, Learned from Peer: 10.0.0.1 (3)
    LOCAL_PREF: 100, MED: none, ORIGIN: igrp, Weight: 0
    AS_PATH: 3
        Adj_RIB_out count: 2, Admin distance 20
    Last update to IP routing table: 0h2m10s, 1 path(s) installed:
    Route is advertised to 2 peers:
        10.0.0.3(65002)          10.0.0.5(65002)
```

Syntax: show ip bgp routes detail

TABLE 100 show ip bgp routes detail output descriptions

This field	Displays
Total number of BGP4 Routes	The number of BGP4 routes.
Status codes	A list of the characters that indicate route status. The status code is appears in the left column of the display, to the left of each route. The status codes are described in the command's output.
Prefix	The network prefix and mask length.
Status	<p>The route status, which can be one or more of the following:</p> <ul style="list-style-type: none"> • A - AGGREGATE.The route is an aggregate route for multiple networks. • B - BEST. BGP4 has determined that this is the optimal route to the destination. <p>NOTE If the "b" is lowercase, the software was not able to install the route in the IP route table.</p> <ul style="list-style-type: none"> • b - NOT-INSTALLED-BEST. The routes received from the neighbor are the best BGP4 routes to their destinations, but were not installed in the IP route table because the device

TABLE 100 show ip bgp routes detail output descriptions (continued)

This field	Displays
	<p>received better routes from other sources (such as OSPF, RIP, or static IP routes).</p> <ul style="list-style-type: none"> • C - CONFED_EBGP. The route was learned from a neighbor in the same confederation and AS, but in a different sub-AS within the confederation. • D - DAMPED. This route has been dampened (by the route dampening feature), and is currently unusable. • H - HISTORY. Route dampening is configured for this route, and the route has a history of flapping and is unreachable now. • I - INTERNAL. The route was learned through BGP4. • L - LOCAL. The route originated on this device. • M - MULTIPATH. BGP4 load sharing is enabled and this route was selected as one of the best ones to the destination. The best route among the multiple paths also is marked with "B". <p>NOTE If the "m" is lowercase, the software was not able to install the route in the IP route table.</p> <ul style="list-style-type: none"> • S - SUPPRESSED. This route was suppressed during aggregation and thus is not advertised to neighbors.
Age	The last time an update occurred.
Next_Hop	The next-hop device for reaching the network.
Learned from Peer	The IP address of the neighbor that sent this route.
Local_Pref	The degree of preference for this route relative to other routes in the local AS. When the BGP4 algorithm compares routes on the basis of local preferences, the route with the higher local preference is chosen. The preference can have a value from 0 through 4294967295.
MED	The route metric. If the route does not have a metric, this field is blank.
Origin	<p>The source of the route information. The origin can be one of the following:</p> <ul style="list-style-type: none"> • EGP - The routes with these attributes came to BGP4 through EGP. • IGP - The routes with these attributes came to BGP4 through IGP. • INCOMPLETE - The routes came from an origin other than one of the above. For example, they may have been redistributed from OSPF or RIP. <p>When BGP4 compares multiple routes to select the best route, IGP is preferred over EGP and both are preferred over INCOMPLETE.</p>
Weight	The value this device associates with routes from a specific neighbor. For example, if the device receives routes to the same destination from two BGP4 neighbors, the device prefers the route from the neighbor with the larger weight.
Atomic	<p>Whether network information in this route has been aggregated and this aggregation has resulted in information loss.</p> <p>NOTE Information loss under these circumstances is a normal part of BGP4 and does not indicate an error.</p>

TABLE 100 show ip bgp routes detail output descriptions (continued)

This field	Displays
Aggregation ID	The device that originated this aggregation.
Aggregation AS	The AS in which the network information was aggregated. This value applies only to aggregated routes and is otherwise 0.
Originator	The originator of the route in a route reflector environment.
Cluster List	The route-reflector clusters through which this route has passed.
Learned From	The IP address of the neighbor from which the device learned the route.
Admin Distance	The administrative distance of the route.
Adj_RIB_out	The number of neighbors to which the route has been or will be advertised. This is the number of times the route has been selected as the best route and placed in the Adj-RIB-Out (outbound queue) for a BGP4 neighbor.
Communities	The communities the route is in.

Displaying BGP4 route-attribute entries

The route-attribute entries table lists the sets of BGP4 attributes stored in device memory. Each set of attributes is unique and can be associated with one or more routes. In fact, the device typically has fewer route attribute entries than routes.

To display the IP route table, enter the following command.

```
device# show ip bgp attribute-entries
```

Syntax: show ip bgp attribute-entries

This example shows the information displayed by this command. A zero value indicates that the attribute is not set.

```
device# show ip bgp attribute-entries
      Total number of BGP Attribute Entries: 7753
1      Next Hop :192.168.11.1      MED :0          Origin:IGP
      Originator:0.0.0.0      Cluster List:None
      Aggregator:AS Number :0      Router-ID:0.0.0.0      Atomic:FALSE
      Local Pref:100      Communities:Internet
      AS Path :(65002) 65001 4355 2548 3561 5400 6669 5548
2      Next Hop :192.168.11.1      Metric :0          Origin:IGP
      Originator:0.0.0.0      Cluster List:None
      Aggregator:AS Number :0      Router-ID:0.0.0.0      Atomic:FALSE
      Local Pref:100      Communities:Internet
      AS Path :(65002) 65001 4355 2548
```

TABLE 101 show ip bgp attribute-entries output descriptions

This field	Displays
Total number of BGP4 Attribute Entries	The number of routes contained in this BGP4 route table.
Next Hop	The IP address of the next-hop device for routes that have this set of attributes.
Metric	The cost of the routes that have this set of attributes.
Origin	The source of the route information. The origin can be one of the following: <ul style="list-style-type: none"> • EGP - The routes with these attributes came to BGP4 through EGP. • IGP - The routes with these attributes came to BGP4 through IGP.

TABLE 101 show ip bgp attribute-entries output descriptions (continued)

This field	Displays
	<ul style="list-style-type: none"> INCOMPLETE - The routes came from an origin other than one of the above. For example, they may have been redistributed from OSPF or RIP. <p>When BGP4 compares multiple routes to a destination to select the best route, IGP is preferred over EGP and both are preferred over INCOMPLETE.</p>
Originator	The originator of the route in a route reflector environment.
Cluster List	The route-reflector clusters through which this set of attributes has passed.
Aggregator	<p>Aggregator information:</p> <ul style="list-style-type: none"> AS Number shows the AS in which the network information in the attribute set was aggregated. This value applies only to aggregated routes and is otherwise 0. Router-ID shows the device that originated this aggregator.
Atomic	<p>Whether the network information in this set of attributes has been aggregated <i>and</i> this aggregation has resulted in information loss.</p> <ul style="list-style-type: none"> TRUE - Indicates information loss has occurred FALSE - Indicates no information loss has occurred <p>NOTE Information loss under these circumstances is a normal part of BGP4 and does not indicate an error.</p>
Local Pref	The degree of preference for routes that use these attributes relative to other routes in the local AS.
Communities	The communities to which routes with these attributes belong.
AS Path	The autonomous systems through which routes with these attributes have passed. The local AS is shown in parentheses.

Displaying the routes BGP4 has placed in the IP route table

The IP route table indicates the routes it has received from BGP4 by listing "BGP" as the route type.

To display the IP route table, enter the following command.

```
device# show ip route
```

Syntax: show ip route [ip-addr | num | bgp | ospf | rip]

This example shows the information displayed by this command. Notice that most of the routes in this example have type "B", indicating that their source is BGP4.

```
device# show ip route
Total number of IP routes: 50834
B:BGP D:Directly-Connected O:OSPF  R:RIP  S:Static
  Network Address NetMask      Gateway    Port     Cost   Type
  10.0.0.1        255.0.0.0    192.168.13.2  1/1/1    0       B
  10.0.0.2        255.0.0.0    192.168.13.2  1/1/1    0       B
  10.0.1.1        255.255.128.0 192.168.13.2  1/1/1    0       B
  10.1.0.0        255.255.0.0   0.0.0.0      1/1/1    1       D
  10.10.11.0      255.255.255.0 0.0.0.0      1/2/24   1       D
  10.2.97.0       255.255.255.0 192.168.13.2  1/1/1    0       B
  10.3.63.0       255.255.255.0 192.168.13.2  1/1/1    0       B
  10.3.123.0      255.255.255.0 192.168.13.2  1/1/1    0       B
  10.5.252.0      255.255.254.0 192.168.13.2  1/1/1    0       B
```

```
10.6.42.0      255.255.254.0    192.168.13.2    1/1/1      0      B
remaining 50824 entries not shown...
```

Displaying route flap dampening statistics

To display route dampening statistics or all the damped routes, enter the following command at any level of the CLI.

```
device# show ip bgp flap-statistics
Total number of flapping routes: 414
  Status Code  >:best d:damped h:history *:valid
  Network        From       Flaps Since     Reuse     Path
h> 10.50.206.0/23 10.90.213.77 1   0 :0 :13 0 :0 :0 65001 4355 1 701
h> 10.255.192.0/20 10.90.213.77 1   0 :0 :13 0 :0 :0 65001 4355 1 7018
h> 10.252.165.0/24 10.90.213.77 1   0 :0 :13 0 :0 :0 65001 4355 1 7018
h> 10.50.208.0/23 10.90.213.77 1   0 :0 :13 0 :0 :0 65001 4355 1 701
h> 10.33.0.0/16   10.90.213.77 1   0 :0 :13 0 :0 :0 65001 4355 1 701
*> 10.17.220.0/24 10.90.213.77 1   0 :1 :4 0 :0 :0 65001 4355 701 62
```

Syntax: **show ip bgp flap-statistics [regular-expression regular-expression | address mask [longer-prefixes] | neighbor ip-addr | filter-list num ...]**

The **regular-expression** parameter is a regular expression. The regular expressions are the same ones supported for BGP4 AS-path filters.

The **address mask** parameters specify a particular route. If you also use the optional **longer-prefixes** parameter, all statistics for routes that match the specified route or have a longer prefix than the specified route are displayed. For example, if you specify **10.157.0.0 longer**, all routes with the prefix 10.157 or that have a longer prefix (such as 10.157.22) are displayed.

The **neighborip-addr** parameter displays route flap dampening statistics only for routes learned from the specified neighbor. You can also display route flap statistics for routes learned from a neighbor by entering the **show ip bgp neighbor flap-statistics** command.

The **filter-listnum** parameter specifies one or more filters. Only routes that have been dampened and that match the specified filters are displayed.

TABLE 102 show ip bgp flap-statistics output descriptions

This field	Displays
Total number of flapping routes	The total number of routes in the BGP4 route table that have changed state and have been marked as flapping routes.
Status code	The dampening status of the route, which can be one of the following: <ul style="list-style-type: none"> • > - This is the best route among those in the BGP4 route table to the route destination. • d - This route is currently damped, and thus unusable. • h - The route has a history of flapping and is unreachable now. • * - The route has a history of flapping but is currently usable.
Network	The destination network of the route.
From	The neighbor that sent the route to this device.
Flaps	The number of flaps (state changes) the route has experienced.
Since	The amount of time since the first flap of this route.
Reuse	The amount of time remaining until this route will be un-suppressed and thus be usable again.
Path	The AS-path information for the route.

You can display all dampened routes by entering the **show ip bgp dampened-paths** command.

Displaying the active route map configuration

You can view the active route map configuration (contained in the running configuration) without displaying the entire running configuration by entering the following command at any level of the CLI.

```
device# show route-map
route-map permitnet4 permit 10
  match ip address prefix-list plist1
route-map permitnet1 permit 1
  match ip address prefix-list plist2
route-map setcomm permit 1
  set community 1234:2345 no-export
route-map test111 permit 111
  match address-filters 11
  set community 11:12 no-export
route-map permit1122 permit 12
  match ip address 11
route-map permit1122 permit 13
  match ip address std_22
```

This example shows that the running configuration contains six route maps. Notice that the match and set statements within each route map are listed beneath the command for the route map itself. In this simplified example, each route map contains only one match or set statement.

To display the active configuration for a specific route map, enter a command such as the following, which specifies a route map name.

```
device# show route-map setcomm
route-map setcomm permit 1
  set community 1234:2345 no-export
```

This example shows the active configuration for a route map named "setcomm".

Syntax: **show route-map [map-name]**

Displaying BGP4 graceful restart neighbor information

To display BGP4 restart information for BGP4 neighbors, enter the **show ip bgp neighbors** command.

```
device# show ip bgp neighbors
  Total number of BGP Neighbors: 6
1  IP Address: 10.50.50.10, AS: 20 (EBGP), RouterID: 10.10.10.20, VRF: default
    State: ESTABLISHED, Time: 0h0m18s, KeepAliveTime: 60, HoldTime: 180
    KeepAliveTimer Expire in 34 seconds, HoldTimer Expire in 163 seconds
    Minimum Route Advertisement Interval: 0 seconds
    RefreshCapability: Received
    GracefulRestartCapability: Received
      Restart Time 120 sec, Restart bit 0
      afi/safi 1/1, Forwarding bit 0
    GracefulRestartCapability: Sent
      Restart Time 120 sec, Restart bit 0
      afi/safi 1/1, Forwarding bit 1
  Messages:     Open      Update   KeepAlive   Notification   Refresh-Req
```

....

Displaying AS4 details

This section describes the use of the following **show** commands, which produce output that includes information about AS4s.

- **show ip bgp neighbor** shows whether the AS4 capability is enabled.
- **show ip bgp attribute-entries** shows AS4 path values.
- **show ip bgp** shows the route entries with two and AS4 path information.
- **show route-map** shows the presence of any AS4 configuration data.
- **show ip as-path-access-lists** shows the presence of any AS4 configuration data.
- **show ip bgp config** shows the presence of any AS4 configuration data.

Route entries with four-byte path information

The **show ip bgp** command without of any optional parameters display AS4 path information.

```
device# show ip bgp
Total number of BGP Routes: 1
Status codes: s suppressed, d damped, h history, * valid, > best, i internal, S
stale
Origin codes: i - IGP, e - EGP, ? - incomplete
      Network          Next Hop          Metric LocPrf Weight Path
*> 10.1.1.0/24    192.168.1.5      1       100      0     90000 100 200 65535
65536 65537 65538 65539 75000
```

Syntax: show ip bgp

Current AS numbers

To display current AS numbers, use the **show ip bgp neighbors** command at any level of the CLI.

```
device# show ip bgp neighbors
neighbors                         Details on TCP and BGP neighbor connections
Total number of BGP Neighbors: 1
1  IP Address: 192.168.1.1, AS: 7701000 (IBGP), RouterID: 192.168.1.1, VRF: default-vrf
  State: ESTABLISHED, Time: 0h3m33s, KeepAliveTime: 60, HoldTime: 180
    KeepAliveTimer Expire in 49 seconds, HoldTimer Expire in 177 seconds
  Minimal Route Advertisement Interval: 0 seconds
    RefreshCapability: Received
  Messages:   Open      Update   KeepAlive  Notification Refresh-Req
    Sent       : 1        0         5           0           0
    Received: 1        1         5           0           0
  Last Update Time: NLRI          Withdraw          NLRI          Withdraw
    Tx: ---        ---          Rx: 0h3m33s        ---
  Last Connection Reset Reason:Unknown
  Notification Sent: Unspecified
  Notification Received: Unspecified
  Neighbor NLRI Negotiation:
    Peer Negotiated IPV4 unicast capability
    Peer configured for IPV4 unicast Routes
  Neighbor AS4 Capability Negotiation:
    Peer Negotiated AS4 capability
    Peer configured for AS4 capability

As-path attribute count: 1
  Outbound Policy Group:
    ID: 1, Use Count: 1
  TCP Connection state: ESTABLISHED, flags:00000044 (0,0)
    Maximum segment size: 1460
    TTL check: 0, value: 0, rcvd: 64
    Byte Sent: 148, Received: 203
    Local host: 192.168.1.2, Local Port: 179
    Remote host: 192.168.1.1, Remote Port: 8041
```

Configuring BGP4 (IPv4)

Displaying BGP4 information

```
ISentSeq: 1656867 SendNext: 1657016 TotUnAck: 0
TotSent: 149 ReTrans: 19 UnAckSeq: 1657016
IRcvSeq: 1984547 RcvNext: 1984751 SendWnd: 64981
TotalRcv: 204 DupliRcv: 313 RcvWnd: 65000
SendQue: 0 RcvQue: 0 CngstWnd: 5840
```

Syntax: show ip bgp neighbors

TABLE 103 show ip bgp neighbors output descriptions

Field	Description
Total number of BGP Neighbors	Shows the total number of BGP neighbors.
IP Address	Shows the IPv4 address of the neighbor.
AS	Shows the Autonomous System (AS) in which the neighbor resides.
EBGP or IBGP	<p>Shows whether the neighbor session is an IBGP session, an EBGP session, or a confederation EBGP session:</p> <ul style="list-style-type: none"> • EBGP - The neighbor is in another AS. • EBGP_Conf - The neighbor is a member of another sub-AS in the same confederation. • IBGP - The neighbor is in the same AS.
RouterID	Shows the device ID of the neighbor.
VRF	Shows the status of the VRF instance.
State	<p>Shows the state of the device session with the neighbor. The states are from the device's perspective of the session, not the neighbor's perspective. The state can be one of the following values:</p> <ul style="list-style-type: none"> • IDLE - The BGP4 process is waiting to be started. Usually, enabling BGP4 or establishing a neighbor session starts the BGP4 process. A minus sign (-) indicates that the session has gone down and the software is clearing or removing routes. • ADMND - The neighbor has been administratively shut down. A minus sign (-) indicates that the session has gone down and the software is clearing or removing routes. • CONNECT - BGP4 is waiting for the connection process for the TCP neighbor session to be completed. • ACTIVE - BGP4 is waiting for a TCP connection from the neighbor. <p>NOTE If the state frequently changes between CONNECT and ACTIVE, there may be a problem with the TCP connection.</p> <ul style="list-style-type: none"> • OPEN SENT - BGP4 is waiting for an Open message from the neighbor. • OPEN CONFIRM - BGP4 has received an Open message from the neighbor and is now waiting for either a KeepAlive or Notification message. If the device receives a KeepAlive message from the neighbor, the state changes to ESTABLISHED. If the message is a Notification, the state changes to IDLE. • ESTABLISHED - BGP4 is ready to exchange Update messages with the neighbor. <p>If there is more BGP data in the TCP receiver queue, a plus sign (+) is also displayed.</p>
Time	Shows the amount of time this session has been in its current state.
KeepAliveTime	Shows the keepalive time, which specifies how often this device sends KeepAlive messages to the neighbor.

TABLE 103 show ip bgp neighbors output descriptions (continued)

Field	Description
HoldTime	Shows the hold time, which specifies how many seconds the device will wait for a KeepAlive or Update message from a BGP4 neighbor before deciding that the neighbor is dead.
KeepAliveTimer Expire	Shows the time when the keepalive timer is set to expire.
HoldTimer Expire	Shows the time when the hold timer is set to expire.
Minimal Route Advertisement Interval	Shows the minimum time elapsed between the route advertisements to the same neighbor.
RefreshCapability	Shows whether the device has received confirmation from the neighbor that the neighbor supports the dynamic refresh capability.
Messages Sent and Received	Shows the number of messages this device has sent to and received from the neighbor. The display shows statistics for the following message types: <ul style="list-style-type: none"> • Open • Update • KeepAlive • Notification • Refresh-Req
Last Update Time	Shows the list of last time updates were sent and received for the following: <ul style="list-style-type: none"> • NLRI • Withdraws
Last Connection Reset Reason	Shows the reason for ending the previous session with this neighbor. The reason can be one of the following: <ul style="list-style-type: none"> • No abnormal error has occurred. • Reasons described in the BGP specifications: <ul style="list-style-type: none"> - Message Header Error - Connection Not Synchronized - Bad Message Length - Bad Message Type - OPEN Message Error - Unsupported Version Number - Bad Peer AS Number - Bad BGP Identifier - Unsupported Optional Parameter - Authentication Failure - Unacceptable Hold Time - Unsupported Capability - UPDATE Message Error - Malformed Attribute List - Unrecognized Well-known Attribute - Missing Well-known Attribute - Attribute Flags Error - Attribute Length Error - Invalid ORIGIN Attribute - Invalid NEXT_HOP Attribute
Last Connection Reset Reason (continued)	<ul style="list-style-type: none"> • Reasons described in the BGP specifications (continued): <ul style="list-style-type: none"> - Optional Attribute Error - Invalid Network Field - Malformed AS_PATH - Hold Timer Expired - Finite State Machine Error - Rcv Notification - Reset All Peer Sessions

TABLE 103 show ip bgp neighbors output descriptions (continued)

Field	Description
	<ul style="list-style-type: none"> - User Reset Peer Session - Port State Down - Peer Removed - Peer Shutdown - Peer AS Number Change - Peer AS Confederation Change - TCP Connection KeepAlive Timeout - TCP Connection Closed by Remote <p>TCP Data Stream Error Detected</p>
Notification Sent	<p>Shows an error code corresponding to one of the following errors if the device sends a Notification message from the neighbor. Some errors have subcodes that clarify the reason for the error. The subcode messages are listed underneath the error code messages, wherever applicable.</p> <ul style="list-style-type: none"> • Message Header Error <ul style="list-style-type: none"> - Connection Not Synchronized - Bad Message Length - Bad Message Type - Unspecified • Open Message Error <ul style="list-style-type: none"> - Unsupported Version - Bad Peer AS - Bad BGP Identifier - Unsupported Optional Parameter - Authentication Failure - Unacceptable Hold Time - Unspecified • Update Message Error <ul style="list-style-type: none"> - Malformed Attribute List - Unrecognized Attribute - Missing Attribute - Attribute Flag Error - Attribute Length Error - Invalid Origin Attribute - Invalid NextHop Attribute - Optional Attribute Error - Invalid Network Field - Malformed AS Path - Unspecified • Hold Timer Expired • Finite State Machine Error • Cease • Unspecified
Notification Received	<p>Shows an error code corresponding to one of the listed errors in the Notification Sent field if the device receives a Notification message from the neighbor.</p>
Neighbor NLRI Negotiation	<p>Shows the state of the device's NLRI negotiation with the neighbor. The states can be one of the following:</p> <ul style="list-style-type: none"> • Peer negotiated IPV4 unicast capability • Peer negotiated IPV6 unicast capability • Peer configured for IPV4 unicast routes • Peer configured for IPV6 unicast routes

TABLE 103 show ip bgp neighbors output descriptions (continued)

Field	Description
Neighbor AS4 Capability Negotiation	Shows the state of the device's AS4 capability negotiation with the neighbor. The states can be one of the following: <ul style="list-style-type: none"> Peer negotiated AS4 capability Peer configured for AS4 capability
As-path attribute count	Shows the count of the AS-path attribute.
Outbound Policy Group	Shows the ID and the count used in the outbound policy group.
TCP Connection state	Shows the state of the connection with the neighbor. The connection can have one of the following states: <ul style="list-style-type: none"> LISTEN - Waiting for a connection request. SYN-SENT - Waiting for a matching connection request after having sent a connection request. SYN-RECEIVED - Waiting for a confirming connection request acknowledgment after having both received and sent a connection request. ESTABLISHED - Data can be sent and received over the connection. This is the normal operational state of the connection. FIN-WAIT-1 - Waiting for a connection termination request from the remote TCP, or an acknowledgment of the connection termination request previously sent. FIN-WAIT-2 - Waiting for a connection termination request from the remote TCP. CLOSE-WAIT - Waiting for a connection termination request from the local user. CLOSING - Waiting for a connection termination request acknowledgment from the remote TCP. LAST-ACK - Waiting for an acknowledgment of the connection termination request previously sent to the remote TCP (which includes an acknowledgment of its connection termination request). TIME-WAIT - Waiting for the specific time to ensure that the remote TCP received the acknowledgment of its connection termination request. CLOSED - There is no connection state.
Maximum segment size	Shows the TCP maximum segment size.
TTL check	Shows the TCP TTL check.
Byte Sent	Shows the number of bytes sent.
Byte Received	Shows the number of bytes received.
Local host	Shows the IPv4 address of the device.
Local port	Shows the TCP port that the device is using for the BGP4 TCP session with the neighbor.
Remote host	Shows the IPv4 address of the neighbor.
Remote port	Shows the TCP port the neighbor is using for the BGP4 TCP session with the device.
ISentSeq	Shows the initial send sequence number for the session.
SendNext	Shows the next sequence number to be sent.
TotUnAck	Shows the count of sequence numbers sent by the device that have not been acknowledged by the neighbor.
TotSent	Shows the count of the sequence numbers sent to the neighbor.

TABLE 103 show ip bgp neighbors output descriptions (continued)

Field	Description
ReTrans	Shows the count of the sequence numbers that the device retransmitted because they were not acknowledged.
UnAckSeq	Shows the current acknowledged sequence number.
IRcvSeq	Shows the initial receive sequence number for the session.
RcvNext	Shows the next sequence number expected from the neighbor.
SendWnd	Shows the size of the send window.
TotalRcv	Shows the count of the sequence numbers received from the neighbor.
DupliRcv	Shows the count of the duplicate sequence numbers received from the neighbor.
RcvWnd	Shows the size of the receive window.
SendQue	Shows the count of the sequence numbers in the send queue.
RcvQue	Shows the count of the sequence numbers in the receive queue.
CngstWnd	Shows the number of times the window has changed.

Attribute entries

Use the **show ip bgp attribute-entries** command to see AS4 path values, as the following example illustrates.

```
device# show ip bgp attribute-entries
      Total number of BGP Attribute Entries: 18 (0)
1      Next Hop   :192.168.1.6          MED :1           Origin:INCOMP
      Originator:0.0.0.0                 Cluster List:None
      Aggregator:AS Number :0          Router-ID:0.0.0.0    Atomic:None
      Local Pref:100                  Communities:Internet
AS Path   :90000 80000 (length 11)
)
      Address: 0x10e4e0c4 Hash:489 (0x03028536), PeerIdx 0
      Links: 0x00000000, 0x00000000, nlri: 0x10f4804a
      Reference Counts: 1:0:1, Magic: 51
2      Next Hop   :192.168.1.5          Metric :1          Origin:INCOMP
      Originator:0.0.0.0                 Cluster List:None
      Aggregator:AS Number :0          Router-ID:0.0.0.0    Atomic:None
      Local Pref:100                  Communities:Internet
AS Path   :90000 75000 (length 11)
      Address: 0x10e4e062 Hash:545 (0x0301e8f6), PeerIdx 0
      Links: 0x00000000, 0x00000000, nlri: 0x10f47ff0
      Reference Counts: 1:0:1, Magic: 49
```

Syntax: **show ip bgp attribute-entries**

Running configuration

AS4s appear in the display of a running configuration, as shown.

```
device# show ip bgp config
Current BGP configuration:
router bgp
  local-as 7701000
  confederation identifier 120000
  confederation peers 80000
  neighbor 192.168.1.2 remote-as 80000
```

Access lists that contain AS4s

AS4s that exist in access lists are displayed by the command, as shown.

```
device# show ip as-path-access-lists
ip as-path access list abc: 1 entries
  seq 10 permit _75000_
ip as-path access list def: 1 entries
  seq 5 permit _80000_
```

Formats of AS4s in show command output

To display the asdot and asdot+ notation for AS4s, enter the **as-format asdot** or **as-format asdot+** commands before you enter the **show ip bgp** command.

```
device# as-format asdot
device-mu2(config)# show ip bgp
Total number of BGP Routes: 1
Status codes: s suppressed, d damped, h history, * valid, > best, i internal, S stale
Origin codes: i - IGP, e - EGP, ? - incomplete
      Network      Next Hop      Metric LocPrf Weight Path
*> 10.1.1.0/24    192.168.1.5    1        100      0     1.24464 100 200 655
5 1.0 1.1 1.2 1.3 1.9464 ?
```

Syntax: as-format asdot

```
device# as-format asdot+
device# show ip bgp
Total number of BGP Routes: 1
Status codes: s suppressed, d damped, h history, * valid, > best, i internal, S stale
Origin codes: i - IGP, e - EGP, ? - incomplete
      Network      Next Hop      Metric LocPrf Weight Path
*> 10.1.1.0/24    192.168.1.5    1        100      0     1.24464 0.100 0.200
0.65535 1.0 1.1 1.2 1.3 1.9464?
```

Syntax: as-format asdot+

Updating route information and resetting a neighbor session

The following sections describe how to update route information with a neighbor, reset a session with a neighbor, and close a session with a neighbor.

Any change to a policy (ACL, route map, and so on) is automatically applied to outbound routes that are learned from a BGP4 neighbor or peer group after the policy change occurs. However, you must reset the neighbor to update existing outbound routes.

Any change to a policy is automatically applied to inbound routes that are learned after the policy change occurs. However, to apply the changes to existing inbound routes (those inbound routes that were learned before the policy change), you must reset the neighbors to update the routes using one of the following methods:

- Request the complete BGP4 route table from the neighbor or peer group. You can use this method if the neighbor supports the refresh capability (RFCs 2842 and 2858). Most devices today support this capability.
- Clear (reset) the session with the neighbor or peer group. This is the only method you can use if soft reconfiguration is enabled for the neighbor.

You also can clear and reset the BGP4 routes that have been installed in the IP route table.

Using soft reconfiguration

The soft reconfiguration feature applies policy changes without resetting the BGP4 session. Soft reconfiguration does not request the neighbor or group to send the entire BGP4 table, nor does the feature reset the session with the neighbor or group. Instead, soft reconfiguration stores all the route updates received from the neighbor or group. When you request a soft reset of inbound routes, the software performs route selection by comparing the policies against the stored route updates, instead of requesting the neighbor BGP4 route table or resetting the session with the neighbor.

When you enable the soft reconfiguration feature, it sends a refresh message to the neighbor or group if the neighbor or group supports dynamic refresh. Otherwise, the feature resets the neighbor session. This step is required to ensure that the soft reconfiguration feature has a complete set of updates to use, and occurs only once, when you enable the feature. The feature accumulates all the route updates from the neighbor, eliminating the need for additional refreshes or resets when you change policies in the future.

To use soft reconfiguration:

- Enable the feature.
- Make the policy changes.
- Apply the changes by requesting a soft reset of the inbound updates from the neighbor or group.

Enabling soft reconfiguration

To configure a neighbor for soft reconfiguration, enter a command such as the following.

```
device(config-bgp)# neighbor 10.10.200.102 soft-reconfiguration inbound
```

This command enables soft reconfiguration for updates received from 10.10.200.102. The software dynamically resets the session with the neighbor, then retains all route updates from the neighbor following the reset.

Syntax: [no] neighbor ip-addr | peer-group-name soft-reconfiguration inbound

NOTE

The syntax related to soft reconfiguration is shown.

Placing a policy change into effect

To place policy changes into effect, enter a command such as the following.

```
device(config-bgp)# clear ip bgp neighbor 10.10.200.102 soft in
```

This command updates the routes by comparing the route policies against the route updates that the device has stored. The command does not request additional updates from the neighbor or otherwise affect the session with the neighbor.

Syntax: clear ip bgp neighbor ip-addr | peer-group-name soft in

NOTE

If you do not specify **in**, the command applies to both inbound and outbound updates.

NOTE

The syntax related to soft reconfiguration is shown.

Displaying the filtered routes received from the neighbor or peer group

When you enable soft reconfiguration, the device saves all updates received from the specified neighbor or peer group, including updates that contain routes that are filtered out by the BGP4 route policies in effect on the device. To display the routes that have been filtered out, enter the following command at any level of the CLI.

```
device# show ip bgp filtered-routes
Searching for matching routes, use ^C to quit...
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
    E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
    S:SUPPRESSED F:FILTERED s:STALE
    Prefix      Next Hop      MED      LocPrf      Weight      Status
1  10.3.0.0/8      192.168.4.106      100      0      EF
      AS PATH: 65001 4355 701 80
2  10.4.0.0/8      192.168.4.106      100      0      EF
      AS PATH: 65001 4355 1
3  10.60.212.0/22  192.168.4.106      100      0      EF
      AS PATH: 65001 4355 701 1 189
```

The routes displayed are the routes that were filtered out by the BGP4 policies on the device. The device did not place the routes in the BGP4 route table, but did keep the updates. If a policy change causes these routes to be permitted, the device does not need to request the route information from the neighbor, but instead uses the information in the updates.

Syntax: **show ip bgp filtered-routes [ip-addr] | [as-path-access-list num] | [detail] | [prefix-list string] [longer-prefixes]**

The **ip-addr** parameter specifies the IP address of the destination network.

The **as-path-access-list num** parameter specifies an AS-path ACL. Only the routes permitted by the AS-path ACL are displayed.

The **detail** parameter displays detailed information for the routes. (The example shows summary information.) You can specify any of the other options after **detail** to further refine the display request.

The **prefix-list string** parameter specifies an IP prefix list. Only routes permitted by the prefix list are displayed.

If you also use the optional **longer-prefixes** parameter, then all statistics for routes that match the specified route or have a longer prefix than the specified route are displayed. For example, if you specify 10.157.0.0 longer, then all routes with the prefix 10.157 or that have a longer prefix (such as 10.157.22) are displayed.

Displaying all the routes received from the neighbor

To display all the route information received in route updates from a neighbor since you enabled soft reconfiguration, enter a command such as the following at any level of the CLI.

```
device# show ip bgp neighbor 192.168.4.106 routes
There are 97345 received routes from neighbor 192.168.4.106
Searching for matching routes, use ^C to quit...
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
    E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
    S:SUPPRESSED F:FILTERED s:STALE
    Prefix      Next Hop      MED      LocPrf      Weight      Status
1  10.3.0.0/8      192.168.4.106      100      0      BE
      AS PATH: 65001 4355 701 80
2  10.4.0.0/8      192.168.4.106      100      0      BE
      AS PATH: 65001 4355 1
3  10.60.212.0/22  192.168.4.106      100      0      BE
      AS PATH: 65001 4355 701 1 189
4  10.6.0.0/8      192.168.4.106      0      BE

device# show ip bgp neighbor 192.168.4.106 routes
There are 97345 received routes from neighbor 192.168.4.106
Searching for matching routes, use ^C to quit...
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
    E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH S:SUPPRESSED F:FILTERED
    Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
    E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH S:SUPPRESSED F:FILTERED
```

Configuring BGP4 (IPv4)

Displaying BGP4 information

	Prefix	Next Hop	MED	LocPrf	Weight	Status
1	10.3.0.0/8	192.168.4.106		100	0	BE
	AS PATH: 65001 4355 701 8					
2	10.4.0.0/8	192.168.4.106		100	0	BE
	AS PATH: 65001 4355 1					
3	10.60.212.0/22	192.168.4.106		100	0	BE
	AS PATH: 65001 4355 701 1 189					
4	10.6.0.0/8	192.168.4.106		100	0	BE

Syntax: `show ip bgp neighbors ip-addr received-routes [detail]`

The **detail** parameter displays detailed information for the routes. This example shows summary information.

NOTE

The syntax for displaying received routes is shown. For complete command syntax, refer to [Displaying BGP4 neighbor information](#) on page 447.

Dynamically requesting a route refresh from a BGP4 neighbor

You can easily apply changes to filters that control BGP4 routes received from or advertised to a neighbor, without resetting the BGP4 session between the device and the neighbor. For example, if you add, change, or remove a BGP4 IP prefix list that denies specific routes received from a neighbor, you can apply the filter change by requesting a route refresh from the neighbor. If the neighbor also supports dynamic route refreshes, the neighbor resends its Adj-RIB-Out, its table of BGP4 routes. Using the route refresh feature, you do not need to reset the session with the neighbor.

The route refresh feature is based on the following specifications:

- RFC 2842. This RFC specifies the Capability Advertisement, which a BGP4 device uses to dynamically negotiate a capability with a neighbor.
- RFC 2858 for Multi-protocol Extension.
- RFC 2918, which describes the dynamic route refresh capability

The dynamic route refresh capability is enabled by default and cannot be disabled. When the device sends a BGP4 OPEN message to a neighbor, the device includes a Capability Advertisement to inform the neighbor that the device supports dynamic route refresh.

NOTE

The option for dynamically refreshing routes received from a neighbor requires the neighbor to support dynamic route refresh. If the neighbor does not support this feature, the option does not take effect and the software displays an error message. The option for dynamically re-advertising routes to a neighbor does not require the neighbor to support dynamic route refresh.

Dynamically refreshing routes

The following sections describe how to refresh BGP4 routes dynamically to put new or changed filters into effect.

To request a dynamic refresh of all routes from a neighbor, enter a command such as the following.

```
device(config-bgp-router)# clear ip bgp neighbor 192.168.1.170 soft in
```

This command asks the neighbor to send its BGP4 table (Adj-RIB-Out) again. The device applies its filters to the incoming routes and adds, modifies, or removes BGP4 routes as necessary.

Syntax: `clear ip bgp neighbor all | ip-addr | peer-group-name | as-num [soft-outbound | soft [in | out]]`

The **all** , *ip-addr* , *peer-group-name* , and *as-num* parameters specify the neighbor. The *ip-addr* parameter specifies a neighbor by its IP interface with the device. The *peer-group-name* specifies all neighbors in a specific peer group. The *as-num* parameter specifies all neighbors within the specified AS. The **all** parameter specifies all neighbors.

The **soft-outbound** parameter updates all outbound routes by applying the new or changed filters, but sends only the existing routes affected by the new or changed filters to the neighbor.

The **soft in** and **soft out** parameters specify whether you want to refresh the routes received from the neighbor or sent to the neighbor:

- **soft in** does one of the following:
 - If you enabled soft reconfiguration for the neighbor or peer group, **soft in** updates the routes by comparing the route policies against the route updates that the device has stored. Soft reconfiguration does not request additional updates from the neighbor or otherwise affect the session with the neighbor.
 - If you did not enable soft reconfiguration, **soft in** requests the entire BGP4 route table for the neighbor (Adj-RIB-Out), then applies the filters to add, change, or exclude routes.
 - If a neighbor does not support dynamic refresh, **soft in** resets the neighbor session.
- **soft out** updates all outbound routes, then sends the entire BGP4 router table for the device (Adj-RIB-Out) to the neighbor, after changing or excluding the routes affected by the filters.

If you do not specify **in** or **out** , the device performs both options.

NOTE

The **soft-outbound** parameter updates all outbound routes by applying the new or changed filters, but sends only the existing routes affected by the new or changed filters to the neighbor. The **soft out** parameter updates all outbound routes, then sends the entire BGP4 route table for the device (Adj-RIB-Out) to the neighbor, after changing or excluding the routes affected by the filters. Use **soft-outbound** if only the outbound policy is changed.

To dynamically resend all the device BGP4 routes to a neighbor, enter a command such as the following.

```
device(config-bgp)# clear ip bgp neighbor 192.168.1.170 soft out
```

This command applies filters for outgoing routes to the device BGP4 route table (Adj-RIB-Out), changes or excludes routes accordingly, then sends the resulting Adj-RIB-Out to the neighbor.

NOTE

The Ruckus device does not automatically update outbound routes using a new or changed outbound policy or filter when a session with the neighbor goes up or down. Instead, the device applies a new or changed policy or filter when a route is placed in the outbound queue (Adj-RIB-Out). To place a new or changed outbound policy or filter into effect, you must enter a **clear ip bgp neighbor** command regardless of whether the neighbor session is up or down. You can enter the command without optional parameters or with the **soft out** or **soft-outbound** option. Either way, you must specify a parameter for the neighbor (*ip-addr*, *as-num* , *peer-group-name*, or **all**).

Displaying dynamic refresh information

You can use the **show ip bgp neighbors** command to display information for dynamic refresh requests. For each neighbor, the display lists the number of dynamic refresh requests the device has sent to or received from the neighbor and indicates whether the device received confirmation from the neighbor that the neighbor supports dynamic route refresh.

The RefreshCapability field indicates whether this device has received confirmation from the neighbor that the neighbor supports the dynamic refresh capability. The statistics in the Message Sent and Message Received rows under Refresh-Req

Configuring BGP4 (IPv4)

Displaying BGP4 information

indicate how many dynamic refreshes have been sent to and received from the neighbor. The statistic is cumulative across sessions.

```
device(config-bgp)# show ip bgp neighbor 10.4.0.2
1  IP Address: 10.4.0.2, AS: 5 (EBGP), RouterID: 100.0.0.1
    Description: neighbor 10.4.0.2
    State: ESTABLISHED, Time: 0h1m0s, KeepAliveTime: 0, HoldTime: 0
    PeerGroup: pg1
    Multihop-EBGP: yes, ttl: 1
    RouteReflectorClient: yes
    SendCommunity: yes
    NextHopSelf: yes
    DefaultOriginate: yes (default sent)
    MaximumPrefixLimit: 90000
    RemovePrivateAs: : yes
    RefreshCapability: Received
    Route Filter Policies:
        Distribute-list: (out) 20
        Filter-list: (in) 30
        Prefix-list: (in) pf1
        Route-map: (in) setnp1 (out) setnp2
    Messages:      Open      Update      KeepAlive      Notification      Refresh-Req
    Sent : 1       1          1          0          0
    Received: 1     8          1          0          0
    Last Update Time: NLRI           Withdraw
                    Tx: 0h0m59s ---           Rx: 0h0m59s ---
    Last Connection Reset Reason: Unknown
        Notification Sent: Unspecified
        Notification Received: Unspecified
    TCP Connection state: ESTABLISHED
        Byte Sent: 115, Received: 492
        Local host: 10.4.0.1, Local Port: 179
        Remote host: 10.4.0.2, Remote Port: 8053
        ISentSeq: 52837276 SendNext: 52837392 TotUnAck: 0
        TotSent: 116 ReTrans: 0 UnAckSeq: 52837392
        IRcvSeq: 2155052043 RcvNext: 2155052536 SendWnd: 16384
        TotalRcv: 493 DupliRcv: 0 RcvWnd: 16384
        SendQue: 0 RcvQue: 0 CngstWnd: 1460
```

Closing or resetting a neighbor session

You can close a neighbor session or resend route updates to a neighbor.

If you make changes to filters or route maps and the neighbor does not support dynamic route refresh, use the following methods to ensure that neighbors contain only the routes you want them to contain:

- If you close a neighbor session, the device and the neighbor clear all the routes they learned from each other. When the device and neighbor establish a new BGP4 session, they exchange route tables again. Use this method if you want the device to relearn routes from the neighbor and resend its own route table to the neighbor.
- If you use the soft-outbound option, the device compiles a list of all the routes it would normally send to the neighbor at the beginning of a session. However, before sending the updates, the device also applies the filters and route maps you have configured to the list of routes. If the filters or route maps result in changes to the list of routes, the device sends updates to advertise, change, or even withdraw routes on the neighbor as needed. This ensures that the neighbor receives only the routes you want it to contain. Even if the neighbor already contains a route learned from the device that you later decided to filter out, using the soft-outbound option removes that route from the neighbor.

You can specify a single neighbor or a peer group.

To close a neighbor session and thus flush all the routes exchanged by the device and the neighbor, enter the following command.

```
device# clear ip bgp neighbor all
```

Syntax: `clear ip bgp neighbor all | ip-addr | peer-group-name | as-num [soft-outbound | soft [in | out]]`

The `all`, `ip-addr`, `peer-group-name`, and `as-num` parameters specify the neighbor. The `ip-addr` parameter specifies a neighbor by its IP interface with the device. The `peer-group-name` specifies all neighbors in a specific peer group. The `as-num` parameter specifies all neighbors within an AS and has a range of 1 through 4294967295. The `all` keyword specifies all neighbors.

To resend routes to a neighbor without closing the neighbor session, enter a command such as the following.

```
device# clear ip bgp neighbor 10.0.0.1 soft out
```

Clearing and resetting BGP4 routes in the IP route table

To clear BGP4 routes from the IP route table and reset the routes, enter a command such as the following.

```
device# clear ip bgp routes
```

Syntax: `clear ip bgp routes [ip-addr/prefix-length]`

Clearing traffic counters

You can clear the counters (reset them to 0) for BGP4 messages.

To clear the BGP4 message counter for all neighbors, enter the following command.

```
device# clear ip bgp traffic
```

Syntax: `clear ip bgp traffic`

To clear the BGP4 message counter for a specific neighbor, enter a command such as the following.

```
device# clear ip bgp neighbor 10.0.0.1 traffic
```

To clear the BGP4 message counter for all neighbors within a peer group, enter a command such as the following.

```
device# clear ip bgp neighbor PeerGroup1 traffic
```

Syntax: `clear ip bgp neighbor all | ip-addr | peer-group-name | as-num traffic`

The `all`, `ip-addr`, `peer-group-name`, and `as-num` parameters specify the neighbor. The `ip-addr` parameter specifies a neighbor by its IP interface with the device. The `peer-group-name` specifies all neighbors in a specific peer group. The `as-num` parameter specifies all neighbors within the specified AS. The `all` parameter specifies all neighbors.

Clearing diagnostic buffers

The device stores the following BGP4 diagnostic information in buffers:

- The first 400 bytes of the last packet received that contained an error
- The last NOTIFICATION message either sent or received by the device

To display these buffers, use options with the `show ip bgp neighbors` command.

This information can be useful if you are working with Ruckus Technical Support to resolve a problem. The buffers do not identify the system time when the data was written to the buffer. If you want to ensure that diagnostic data in a buffer is recent, you can clear the buffers. You can clear the buffers for a specific neighbor or for all neighbors.

If you clear the buffer containing the first 400 bytes of the last packet that contained errors, all the bytes are changed to zeros. The Last Connection Reset Reason field of the BGP4 neighbor table also is cleared.

If you clear the buffer containing the last NOTIFICATION message sent or received, the buffer contains no data.

You can clear the buffers for all neighbors, for an individual neighbor, or for all the neighbors within a specific peer group.

To clear these buffers for neighbor 10.0.0.1, enter the following commands.

```
device# clear ip bgp neighbor 10.0.0.1 last-packet-with-error  
device# clear ip bgp neighbor 10.0.0.1 notification-errors
```

Syntax: clear ip bgp neighbor **all | *ip-addr* | *peer-group-name* | *as-num* **last-packet-with-error** | **notification-errors****

The The **all** , *ip-addr* , *peer-group-name* , and *as-num* parameters specify the neighbor. The *ip-addr* parameter specifies a neighbor by its IP interface with the device. The *peer-group-name* specifies all neighbors in a specific peer group. The *as-num* parameter specifies all neighbors within the specified AS. The **all** parameter specifies all neighbors.

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BGP4+ overview

The implementation of IPv6 supports multiprotocol BGP (MBGP) extensions that allow Border Gateway Protocol version 4 plus (BGP4+) to distribute routing information. BGP4+ supports all of the same features and functionality as IPv4 BGP (BGP4).

IPv6 MBGP enhancements include:

- An IPv6 unicast address family and network layer reachability information (NLRI)
- Next hop attributes that use IPv6 addresses

NOTE

The implementation of BGP4+ supports the advertising of routes among different address families. However, it supports BGP4+ unicast routes only; it does not currently support BGP4+ multicast routes.

BGP global mode

Configurations that are not specific to address family configuration are available in the BGP global configuration mode.

```
device(config-bgp-router) # ?
```

Possible completions:

address-family	Enter Address Family command mode
address-filter	Configure IP address filters
aggregate-address	Configure BGP aggregate entries
always-compare-med	Allow comparing MED from different neighbors
always-propagate	Allow readvertisement of best BGP routes not in IP forwarding table
as-path-filter	Configure autonomous system path filters
as-path-ignore	Ignore AS_PATH length info for best route selection
bgp-redistribute-internal	Allow redistribution of iBGP routes into IGP
capability	Set capability
clear	Clear table/statistics/keys

Configuring BGP4+

IPv6 unicast address family

client-to-client-reflection	Configure client to client route reflection
cluster-id	Configure Route-Reflector Cluster-ID
community-filter	Configure community list filters
compare-routerid	Compare router-id for identical BGP paths
confederation	Configure AS confederation parameters
dampening	Enable route-flap dampening
default-information-originate	
default-local-preference	Configure default local preference value
default-metric	Set metric of redistributed routes
distance	Define an administrative distance
enforce-first-as	Enforce the first AS for EBGP routes
fast-external-failover	Reset session if link to EBGP peer goes down
graceful-restart	Enables the BGP graceful restart capability
local-as	Configure local AS number
maximum-paths	Forward packets over multiple paths
med-missing-as-worst	Consider routes missing MED attribute as least desirable
multipath	Enable multipath for ibgp or ebpg neighbors only
neighbor	Specify a neighbor router
network	Specify a network to announce via BGP
next-hop-enable-default	Enable default route for BGP next-hop lookup
next-hop-recursion	Perform next-hop recursive lookup for BGP route
readvertise	Allow readvertisement of best BGP routes not in IP forwarding table
redistribute	Redistribute information from another routing protocol
table-map	Map external entry attributes into routing table
timers	Adjust routing timers
update-time	Configure igrp route update interval

IPv6 unicast address family

The IPv6 unicast address family configuration level provides access to commands that allow you to configure BGP4+ unicast routes. The commands that you enter at this level apply only to the IPv6 unicast address family.

BGP4+ supports the IPv6 address family configuration level.

You can generate a configuration for BGP4+ unicast routes that is separate and distinct from configurations for IPv4 unicast routes.

The commands that you can access while at the IPv6 unicast address family configuration level are also available at the IPv4 unicast address family configuration levels. Each address family configuration level allows you to access commands that apply to that particular address family only.

Where relevant, this chapter discusses and provides IPv6-unicast-specific examples. You must first configure IPv6 unicast routing for any IPv6 routing protocol to be active.

The following configurations are allowed under BGP IPv6 address family unicast mode:

device(config-bgp-ipv6u) # ?	
Possible completions:	
aggregate-address	Configure BGP aggregate entries
always-propagate	Allow readvertisement of best BGP routes not in IP Forwarding table
bgp-redistribute-internal	Allow redistribution of iBGP routes into IGP
client-to-client-reflection	Configure client to client route reflection
dampening	Enable route-flap dampening
default-information-originate	Originate Default Information
default-metric	Set metric of redistributed routes
graceful-restart	Enables the BGP graceful restart capability
maximum-paths	Forward packets over multiple paths
multipath	Enable multipath for ibgp or ebpg neighbors

neighbor	only
network	Specify a neighbor router
next-hop-enable-default	Specify a network to announce via BGP
next-hop-recursion	Enable default route for BGP next-hop lookup
	Perform next-hop recursive lookup for BGP route
redistribute	Redistribute information from another routing protocol
table-map	Map external entry attributes into routing table
update-time	Configure igrp route update interval

BGP4+ neighbors

BGP4+ neighbors can be configured using link-local addresses or global addresses.

BGP4+ neighbors can be created using link-local addresses for peers in the same link. For link-local peers, the neighbor interface over which the neighbor and local device exchange prefixes is specified through the **neighbor update-source** command, and a route map is configured to set up a global next hop for packets destined for the neighbor.

To configure BGP4+ neighbors that use link-local addresses, you must do the following:

- Add the IPv6 address of a neighbor in a remote autonomous system (AS) to the BGP4+ neighbor table of the local device.
- Identify the neighbor interface over which the neighbor and local device will exchange prefixes using the **neighbor update-source** command.
- Configure a route map to set up a global next hop for packets destined for the neighbor.

The neighbor should be activated in the IPv6 address family configuration mode using the **neighbor activate** command.

BGP4+ neighbors can also be configured using a global address. The global IPv6 address of a neighbor in a remote AS must be added, and the neighbor should be activated in the IPv6 address family configuration mode using the **neighbor activate** command.

BGP4+ peer groups

Neighbors having the same attributes and parameters can be grouped together by means of the **peer-group** command.

You must first create a peer group, after which you can associate neighbor IPv6 addresses with the peer group. All of the attributes that are allowed on a neighbor are allowed on a peer group as well.

BGP4+ peers and peer groups are activated in the IPv6 address family configuration mode to establish the BGP4+ peering sessions.

An attribute value configured explicitly for a neighbor takes precedence over the attribute value configured on the peer group. In the case where neither the peer group nor the individual neighbor has the attribute configured, the default value for the attribute is used.

NOTE

BGP4 neighbors are established and the prefixes are advertised using the **neighbor IP address remote-as** command in router BGP mode. However, when establishing BGP4+ peer sessions and exchanging IPv6 prefixes, neighbors must also be activated using the **neighbor IPv6 address activate** command in IPv6 address family configuration mode.

NOTE

You can add IPv6 neighbors only to an IPv6 peer group. You cannot add an IPv4 neighbor to an IPv6 peer group and vice versa. IPv4 and IPv6 peer groups must remain separate.

BGP4+ next hop recursion

A device can find the IGP route to the next-hop gateway for a BGP4+ route.

For each BGP4+ route learned, the device performs a route lookup to obtain the IPv6 address of the next hop for the route. A BGP4+ route is eligible for addition in the IPv6 route table only if the following conditions are true:

- The lookup succeeds in obtaining a valid next-hop IPv6 address for the route.
- The path to the next-hop IPv6 address is an IGP path or a static route path.

By default, the software performs only one lookup for the next-hop IPv6 address for the BGP4+ route. If the next hop lookup does not result in a valid next hop IPv6 address, or the path to the next hop IPv6 address is a BGP4+ path, the BGP4+ route destination is considered unreachable. The route is not eligible to be added to the IPv6 route table.

The BGP4+ route table can contain a route with a next hop IPv6 address that is not reachable through an IGP route, even though the device can reach a hop farther away through an IGP route. This can occur when the IGPs do not learn a complete set of IGP routes, so the device learns about an internal route through IBGP instead of through an IGP. In this case, the IPv6 route table will not contain a route that can be used to reach the BGP4+ route destination.

To enable the device to find the IGP route to the next-hop gateway for a BGP4+ route, enable recursive next-hop lookups. With this feature enabled, if the first lookup for a BGP4+ route results in an IBGP path that originated within the same AS, rather than an IGP path or static route path, the device performs a lookup on the next hop IPv6 address for the next hop gateway. If this second lookup results in an IGP path, the software considers the BGP4+ route to be valid and adds it to the IPv6 route table. Otherwise, the device performs another lookup on the next hop IPv6 address of the next hop for the next hop gateway, and so on, until one of the lookups results in an IGP route.

You must configure a static route or use an IGP to learn the route to the EBGP multihop peer.

BGP4+ NLRI and next hop attributes

BGP4+ introduces new attributes to handle multiprotocol extensions for BGP.

Multiprotocol BGP (MBGP) is an extension to BGP that enables BGP to carry routing information for multiple address families.

BGP4+ introduces new attributes to handle multiprotocol extensions for BGP:

- Multiprotocol reachable Network Layer Reachability Information (MP_REACH_NLRI): Used to carry the set of reachable destinations, together with the next hop information, to be used for forwarding to these destinations.
- Multiprotocol unreachable NLRI (MP_UNREACH_NLRI): Used to carry the set of unreachable destinations.

MP_REACH_NLRI and MP_UNREACH_NLRI are optional and non-transitive, so that a BGP4+ speaker that does not support the multiprotocol capabilities ignores the information carried in these attributes, and does not pass it to other BGP4+ speakers. A BGP speaker that uses multiprotocol extensions for IPv6 uses the capability advertisement procedures to determine whether the speaker can use multiprotocol extensions with a particular peer.

The next hop information carried in the MP_REACH_NLRI path attribute defines the network layer address of the border router that will be used as the next hop to the destinations listed in the MP_NLRI attribute in the UPDATE message.

MP_REACH_NLRI and MP_UNREACH_NLRI carry IPv6 prefixes.

BGP4+ route reflection

A BGP device can act as a route-reflector client or as a route reflector. You can configure a BGP peer as a route-reflector client from the device that is going to reflect the routes and act as the route reflector using the **neighbor route-reflector-client** command.

When there is more than one route reflector, they should all belong to the same cluster. By default, the value for **cluster-id** is used as the device ID. The device ID can be changed using the **cluster-id** command.

The route-reflector server reflects the routes as follows:

- Routes from the client are reflected to the client as well as to nonclient peers.
- Routes from nonclient peers are reflected only to client peers.

If route-reflector clients are connected in a full IBGP mesh, you can disable client-to-client reflection on the route reflector using the **no client-to-client-reflection** command.

A BGP device advertises only those routes that are preferred ones and are installed into the Routing Table Manager (RTM). When a route cannot be installed into the RTM because the routing table is full, the route reflector may not reflect that route. In cases where the route reflector is not placed directly in the forwarding path, you can configure the route reflector to reflect routes even though those routes are not in the RTM using the **always-propagate** command.

BGP4+ route aggregation

A device can be configured to aggregate routes in a range of networks into a single IPv6 prefix.

By default, a device advertises individual BGP4+ routes for all the networks. The aggregation feature allows you to configure a device to aggregate routes in a range of networks into a single IPv6 prefix. For example, without aggregation, a device will individually advertise routes for networks 2001:db8:0001:0000::/64, 2001:db8:0002:0000::/64, 2001:db8:0003:0000::/64, and so on. You can configure the device to send a single, aggregate route for the networks instead so that the aggregate route would be advertised as 2001:db8::/32 to BGP4 neighbors.

BGP4+ multipath

The BGP4+ multipath feature can be used to enable load-balancing across different paths.

BGP4+ selects only one best path for each IPv6 prefix it receives before installing it in the IP routing table. If you need load-balancing across different paths, you must enable BGP4+ multipath using the **maximum-paths** command under IPv6 address family configuration mode.

IBGP paths and EBGP paths can be exclusively selected, or a combination of IBGP and EBGP paths can be selected.

The following attributes of parallel paths must match for them to be considered for multipathing:

- Weight
- Local Preference
- Origin
- AS-Path Length
- MED
- Neighbor AS (EBGP multipath)
- AS-PATH match (for IBGP multipath)

- IGP metric to BGP next hop

Route maps

Route maps must be applied to IPv6 unicast address prefixes in IPv6 address family configuration mode.

By default, route maps that are applied under IPv4 address family configuration mode using the **neighbor route-map** command are applied to only IPv4 unicast address prefixes. To apply route maps to IPv6 unicast address prefixes, the **neighbor route-map** command must be used in IPv6 address family configuration mode. The route maps are applied as the inbound or outbound routing policy for neighbors under the specified address family. Configuring separate route maps under each address family type simplifies managing complicated or different policies for each address family.

BGP4+ outbound route filtering

The BGP4+ Outbound Route Filtering (ORF) feature is used to minimize the number of BGP updates sent between BGP peers.

When the ORF feature is enabled, unwanted routing updates are filtered out, reducing the amount of system resources required for generating and processing routing updates. The ORF feature is enabled through the advertisement of ORF capabilities to peer routers. The locally configured BGP4+ inbound prefix filters are sent to the remote peer so that the remote peer applies the filter as an outbound filter for the neighbor.

The ORF feature can be configured with send and receive ORF capabilities. The local peer advertises the ORF capability in send mode, indicating that it will accept a prefix list from a neighbor and apply the prefix list to locally configured ORFs. The local peer exchanges the ORF capability in send mode with a remote peer for a prefix list that is configured as an inbound filter for that peer locally. The remote peer only sends the first update once it receives a ROUTEREFRESH request or BGP ORF with IMMEDIATE from the peer. The local and remote peers exchange updates to maintain the ORF on each router.

BGP4+ confederations

A large autonomous system (AS) can be divided into multiple subautonomous systems and grouped into a single BGP4+ confederation.

Each subautonomous system must be uniquely identified within the confederation AS by a subautonomous system number. Within each subautonomous system, all the rules of internal BGP (IBGP) apply. For example, all BGP routers inside the subautonomous system must be fully meshed. Although EBGP is used between subautonomous systems, the subautonomous systems within the confederation exchange routing information like IBGP peers. Next hop, Multi Exit Discriminator (MED), and local preference information is preserved when crossing subautonomous system boundaries. To the outside world, a confederation looks like a single AS.

The AS path list is a loop-avoidance mechanism used to detect routing updates leaving one subautonomous system and attempting to re-enter the same subautonomous system. A routing update attempting to re-enter a subautonomous system it originated from is detected because the subautonomous system sees its own subautonomous system number listed in the update's AS path.

BGP4+ extended community

The BGP4+ extended community feature filters routes based on a regular expression specified when a route has multiple community values in it.

A BGP community is a group of destinations that share a common property. Community information identifying community members is included as a path attribute in BGP UPDATE messages. You can perform actions on a group using community and extended community attributes to trigger routing decisions. All communities of a particular type can be filtered out, or certain values can be specified for a particular type of community. You can also specify whether a particular community is transitive or non-transitive across an autonomous system (AS) boundary.

An extended community is an 8-octet value and provides a larger range for grouping or categorizing communities. BGP extended community attributes are specified in RFC 4360.

You define the extended community list using the **ip extcommunity-list** command. The extended community can then be matched or applied to the neighbor through the route map. The route map must be applied on the neighbor to which routes need to carry the extended community attributes. The "send-community" should be enabled for the neighbor configuration to start including the attributes while sending updates to the neighbor.

BGP4+ graceful restart

BGP4+ graceful restart (GR) allows for restarts where neighboring devices participate in the restart, helping to ensure that no route and topology changes occur in the network for the duration of the restart.

The GR feature provides a routing device with the capability to inform its neighbors and peers when it is performing a restart.

When a BGP session is established, GR capability for BGP is negotiated by neighbors and peers through the BGP OPEN message. If the neighbor also advertises support for GR, GR is activated for that neighbor session. If both peers do not exchange the GR capability, the session is not GR-capable. If the BGP session is lost, the BGP peer router, known as a GR helper, marks all routes associated with the device as "stale" but continues to forward packets to these routes for a set period of time. The restarting device also continues to forward packets for the duration of the graceful restart. When the graceful restart is complete, routes are obtained from the helper so that the device is able to quickly resume full operation.

When the GR feature is configured on a device, both helper router and restarting router functionalities are supported. It is not possible to disable helper functionality explicitly.

GR is enabled by default in both IPv4 and IPv6 address families.

NOTE

BGP4 GR can be configured for a global routing instance or for a specified VRF instance.

NOTE

BGP4 GR is supported in FSX 800 and FSX 1600 devices with dual management modules, FCX switches in a stack, and ICX switches in a stack. If the switch functions as a restart helper device only, a secondary management module and stacking are not required.

Configuring BGP4+

Configuring BGP4+ neighbors using global IPv6 addresses

BGP4+ neighbors can be configured using global IPv6 addresses.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router)# local-as 1000
```

4. Enter the **neighbor ipv6-address remote-as** command to specify the ASN in which the remote neighbor resides.

```
device(config-bgp-router)# neighbor 2001:db8:93e8:cc00::1 remote-as 1001
```

5. Enter the **address family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

6. Enter the **neighbor ipv6-address activate** command to enable the exchange of information with the neighbor.

```
device(config-bgp-ipv6u)# neighbor 2001:db8:93e8:cc00::1 activate
```

The following example configures a neighbor using a global IPv6 address.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# local-as 1000
device(config-bgp-router)# neighbor 2001:db8:93e8:cc00::1 remote-as 1001
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor 2001:db8:93e8:cc00::1 activate
```

Configuring BGP4+ neighbors using link-local addresses

BGP4+ neighbors can be configured using link-local addresses.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router)# local-as 1000
```

4. Enter the **neighbor ipv6-address remote-as** command to specify the ASN in which the remote neighbor resides.

```
device(config-bgp-router)# neighbor fe80:4398:ab30:45de::1 remote-as 1001
```

5. Enter the **neighbor** *ipv6-address update-source* command to specify an interface.

```
device(config-bgp-router) # neighbor fe80:4398:ab30:45de::1 update-source ethernet 1/3/1
```

6. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router) # address-family ipv6 unicast
```

7. Enter the **neighbor** *ipv6-address activate* command to enable the exchange of information with the neighbor.

```
device(config-bgp-ipv6u) # neighbor fe80:4398:ab30:45de::1 activate
```

8. Enter the **neighbor** *ipv6-address route-map* command and specify the **out** keyword to apply a route map to outgoing routes.

```
device(config-bgp-ipv6u) # neighbor fe80:4398:ab30:45de::1 route-map out myroutemap
```

9. Enter the **exit** command until you return to global configuration mode.

```
device(config-bgp-ipv6u) # exit
```

10. Enter the **route-map** *name permit* command to define the route map and enter route map configuration mode.

```
device(config) # route-map myroutemap permit 10
```

11. Enter the **set ipv6 next-hop** command and specify an IPv6 address to set the IPv6 address of the next hop.

```
device(config-route-map myroutemap) # set ipv6 next-hop 2001::10
```

The following example configures a neighbor using a link-local address and configures a route map to set up a global next hop for packets destined for the neighbor.

```
device# configure terminal
device(config) # router bgp
device(config-bgp-router) # local-as 1000
device(config-bgp-router) # neighbor fe80:4398:ab30:45de::1 remote-as 1001
device(config-bgp-router) # neighbor fe80:4398:ab30:45de::1 update-source ethernet 1/3/1
device(config-bgp-router) # address-family ipv6 unicast
device(config-bgp-ipv6u) # neighbor fe80:4398:ab30:45de::1 activate
device(config-bgp-ipv6u) # neighbor fe80:4398:ab30:45de::1 route-map out myroutemap
device(config-bgp-ipv6u) # exit
device(config) # route-map myroutemap permit 10
device(config-route-map myroutemap) # set ipv6 next-hop 2001::10
```

Configuring BGP4+ peer groups

A peer group can be created and neighbor IPv6 addresses can be associated with the peer group. The peer group is then activated in the IPv6 address family configuration mode.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config) # router bgp
```

3. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router) # local-as 1000
```

4. Enter the **neighbor peer-group-name peer-group** command to create a peer group.

```
device(config-bgp-router) # neighbor mypeergroup1 peer-group
```

5. Enter the **neighbor peer-group-name remote-as** command to specify the ASN of the peer group.

```
device(config-bgp-router) # neighbor mypeergroup1 remote-as 11
```

6. Enter the **neighbor ipv6-address peer-group** command to associate a neighbor with the peer group.

```
device(config-bgp-router) # neighbor 2001:2018:8192::125 peer-group mypeergroup1
```

7. Enter the **neighbor ipv6-address peer-group** command to associate a neighbor with the peer group.

```
device(config-bgp-router) # neighbor 2001:2018:8192::124 peer-group mypeergroup1
```

8. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router) # address-family ipv6 unicast
```

9. Enter the **neighbor peer-group-name activate** command to establish an IPv6 BGP session with the peer group.

```
device(config-bgp-ipv6u) # neighbor mypeergroup1 activate
```

The following example creates a peer group, specifying two neighbors to belong to the peer group, and activates the peer group.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router) # local-as 1000
device(config-bgp-router) # neighbor mypeergroup1 peer-group
device(config-bgp-router) # neighbor mypeergroup1 remote-as 11
device(config-bgp-router) # neighbor 2001:2018:8192::125 peer-group mypeergroup1
device(config-bgp-router) # neighbor 2001:2018:8192::124 peer-group mypeergroup1
device(config-bgp-router) # address-family ipv6 unicast
device(config-bgp-ipv6u) # neighbor mypeergroup1 activate
```

Configuring a peer group with IPv4 and IPv6 peers

A peer group that contains both IPv4 and IPv6 peers can be configured.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router) # local-as 1000
```

4. Enter the **neighbor peer-group-name peer-group** command to create a peer group.

```
device(config-bgp-router) # neighbor p1 peer-group
```

5. Enter the **neighbor peer-group-name remote-as** command to specify the ASN of the peer group.

```
device(config-bgp-router) # neighbor p1 remote-as 11
```

6. Enter the **neighbor ipv6-address peer-group** command to associate a neighbor with the peer group.

```
device(config-bgp-router) # neighbor 2001:2018:8192::124 peer-group p1
```

7. Enter the **neighbor ip address peer-group** command to associate a neighbor with the peer group.

```
device(config-bgp-router) # neighbor 10.0.0.1 peer-group p1
```

8. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router) # address-family ipv6 unicast
```

9. Enter the **neighbor peer-group-name activate** command to establish an IPv6 BGP session with the peer group.

```
device(config-bgp-ipv6u) # neighbor p1 activate
```

The following example creates a peer group with both IPv6 and IPv4 peers and activates the peer group in the IPv6 address family.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router) # local-as 1000
device(config-bgp-router) # neighbor p1 peer-group
device(config-bgp-router) # neighbor p1 remote-as 11
device(config-bgp-router) # neighbor 2001:2018:8192::124 peer-group p1
device(config-bgp-router) # neighbor 10.0.0.1 peer-group p1
device(config-bgp-router) # address-family ipv6 unicast
device(config-bgp-ipv6u) # neighbor p1 activate
```

Importing routes into BGP4+

Routes can be explicitly specified for advertisement by BGP.

The routes imported into BGP4+ must first exist in the IPv6 unicast route table.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config) # router bgp
```

3. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router) # address-family ipv6 unicast
```

4. Enter the **network** command and specify a *network/mask* to import the specified prefix into the BGP4+ database.

```
device(config-bgp-ipv6u) # network 2001:db8::/32
```

The following example imports the 2001:db8::/32 prefix in to the BGP4+ database for advertising.

```
device# configure terminal  
device(config)# router bgp  
device(config-bgp-router)# neighbor fe80:4398:ab30:45de::1 remote-as 1001  
device(config-bgp-router)# address-family ipv6 unicast  
device(config-bgp-ipv6u)# network 2001:db8::/32
```

Advertising the default BGP4+ route

A BGP device can be configured to advertise the default IPv6 route to all BGP4+ neighbors and to install that route in the local BGP4+ route table.

The default route must be present in the local IPv6 route table.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

4. Enter the **default-information-originate** command to advertise the default IPv6 route to all BGP4+ neighbors and to install that route in the local BGP4+ route table.

```
device(config-bgp-ipv6u)# default-information-originate
```

The following example enables a BGP4+ device to advertise the default IPv6 route to all BGP4+ neighbors and to install that route in the local BGP4+ route table.

```
device# configure terminal  
device(config)# router bgp  
device(config-bgp-router)# address-family ipv6 unicast  
device(config-bgp-ipv6u)# default-information-originate
```

Advertising the default BGP4+ route to a specific neighbor

A BGP device can be configured to advertise the default IPv6 route to a specific neighbor.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router)# local-as 1000
```

4. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router) # address-family ipv6 unicast
```

5. Enter the **neighbor default-originate** command and specify an IPv6 address to enable the BGP4+ device to advertise the default IPv6 route to a specific neighbor.

```
device(config-bgp-ipv6u) # neighbor 2001:db8:93e8:cc00::1 default-originate
```

The following example enables a BGP4+ device to advertise the default IPv6 route to a specific neighbor.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router) # local-as 1000
device(config-bgp-router) # address-family ipv6 unicast
device(config-bgp-ipv6u) # neighbor 2001:db8:93e8:cc00::1 default-originate
```

Using the IPv6 default route as a valid next hop for a BGP4+ route

In certain cases, such as when a device is acting as an edge device, it can be configured to use the default route as a valid next hop.

By default, a device does not use a default route to resolve a BGP4+ next-hop route. If the IPv6 route lookup for the BGP4+ next-hop does not result in a valid IGP route (including static or direct routes), the BGP4+ next-hop is considered to be unreachable and the BGP4+ route is not used. You can configure the device to use the default route as a valid next hop.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router) # address-family ipv6 unicast
```

4. Enter the **next-hop-enable-default** command to configure the device to use the default route as a valid next hop.

```
device(config-bgp-ipv6u) # next-hop-enable-default
```

The following example configures a BGP4+ device to use the default route as a valid next hop.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router) # address-family ipv6 unicast
device(config-bgp-ipv6u) # next-hop-enable-default
```

Enabling next-hop recursion

Next hop recursion can be enabled so that a device can find the IGP route to the next hop gateway for a BGP4+ route.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

4. Enter the **next-hop-recursion** command to enable recursive next hop lookups.

```
device(config-bgp-ipv6u)# next-hop-recursion
```

The following example enables recursive next hop lookups.

```
device# configure terminal  
device(config)# router bgp  
device(config-bgp-router)# address-family ipv6 unicast  
device(config-bgp-ipv6u)# next-hop-recursion
```

Configuring a cluster ID for a route reflector

The cluster ID can be changed if there is more than one route reflector, so that all route reflectors belong to the same cluster.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router)# local-as 1000
```

4. Enter the **cluster-id** command and specify a value to change the cluster ID of a device from the default device ID.

```
device(config-bgp-router)# cluster-id 321
```

The following example changes the cluster ID of a device from the default device ID to 321.

```
device# configure terminal  
device(config)# router bgp  
device(config-bgp-router)# cluster-id 321
```

Configuring a route reflector client

A BGP peer can be configured as a route reflector client.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router) # local-as 1000
```

4. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router) # address-family ipv6 unicast
```

5. Enter the **neighbor** *ipv6-address route-reflector-client* command to configure a specified neighbor to be a route reflector client.

```
device(config-bgp-ipv6u) # neighbor 2001:db8:e0ff:783a::4 route-reflector-client
```

The following example configures a neighbor with the IPv6 address 2001:db8:e0ff:783a::4 to be a route reflector client.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router) # local-as 1000
device(config-bgp-router) # address-family ipv6 unicast
device(config-bgp-ipv6u) # neighbor 2001:db8:e0ff:783a::4 route-reflector-client
```

Aggregating routes advertised to BGP neighbors

A device can be configured to aggregate routes in a range of networks into a single IPv6 prefix.

The route-map should already be defined.

You can aggregate BGP4+ routes, for example 2001:db8:0001:0000::/64, 2001:db8:0002:0000::/64, 2001:db8:0003:0000::/64 into a single network prefix: 2001:db8::/24.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router) # address-family ipv6 unicast
```

4. Enter the **aggregate-address** command to aggregate the routes from a range of networks into a single network prefix.

```
device(config-bgp-ipv6u) # aggregate-address 2001:db8::/32
```

The following example enables a BGP4+ device to advertise the default route and send the default route to a specified neighbor.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router) # address-family ipv6 unicast
device(config-bgp-ipv6u) # aggregate-address 2001:db8::/32
```

Enabling load-balancing across different paths

The BGP4+ multipath feature can be configured, enabling load-balancing across different paths.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

4. Do one of the following:

- Enter the **maximum-paths** command and specify a value to set the maximum number of BGP4+ shared paths.
- Enter the **maximum-paths** command using the **use-load-sharing** keyword to set the maximum number of BGP4+ shared paths to that of the value already configured by means of the **ip load-sharing** command.

```
device(config-bgp-ipv6u)# maximum-paths 8
```

or

```
device(config-bgp-ipv6u)# maximum-paths use-load-sharing
```

The following example sets the maximum number of BGP4+ shared paths to 8.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# maximum-paths 8
```

The following example sets the maximum number of BGP4+ shared paths to that of the value already configured using the **ip load-sharing** command.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# maximum-paths use-load-sharing
```

Configuring a route map for BGP4+ prefixes

Route maps can be applied to IPv6 unicast address prefixes either as the inbound or outbound routing policy for neighbors under the specified address family.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **ipv6 prefix-list** command and enter a name to configure an IPv6 prefix list.

```
device(config)# ipv6 prefix-list myprefixlist seq 10 permit 2001:db8::/32
```

The prefix list name, sequence number, and permits packets are specified.

3. Enter the **route-map name permit** command to define the route map and enter route map configuration mode.

```
device(config)# route-map myroutemap permit 10
```

4. Enter the **match ipv6 address** command and specify the name of a prefix list.

```
device(config-route-map-myrouemap)# match ipv6 address prefix-list myprefixlist
```

5. Enter the **exit** command to return to global configuration mode.

```
device(config-route-map-myrouemap)# exit
```

6. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

7. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router)# local-as 1000
```

8. Enter the **neighbor ipv6-address remote-as** command to specify the ASN in which the remote neighbor resides.

```
device(config-bgp-router)# neighbor fe80:4398:ab30:45de::1 remote-as 1001
```

9. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

10. Enter the **neighbor ipv6-address activate** command to enable the exchange of information with the neighbor.

```
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 activate
```

11. Enter the **neighbor ipv6-address route-map** command and specify the **out** keyword to apply a route map to outgoing routes.

```
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 route-map out myroutemap
```

The following example applies a route map, "myroutemap", as the outbound routing policy for a neighbor.

```
device# configure terminal
device(config)# ipv6 prefix-list myprefixlist seq 10 permit 2001:db8::/32
device(config)# route-map myroutemap permit 10
device(config-route-map-myrouemap)# match ipv6 address prefix-list myprefixlist
device(config-route-map-myrouemap)# exit
device(config)# router bgp
device(config-bgp-router)# local-as 1000
device(config-bgp-router)# neighbor fe80:4398:ab30:45de::1 remote-as 1001
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 activate
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 route-map out myroutemap
```

Redistributing prefixes into BGP4+

Various routes can be redistributed into BGP.

Static, connected, OSPF, and RIPng routes can be redistributed into BGP. This task redistributes RIPng routes into BGP4+.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **address-family unicast** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

4. Enter the **redistribute** command using the **rip** keyword to redistribute IPv6 RIP routes.

```
device(config-bgp-ipv6u)# redistribute rip
```

The following example redistributes RIPng prefixes into BGP4+.

```
device# configure terminal  
device(config)# router bgp  
device(config-bgp-router)# address-family ipv6 unicast  
device(config-bgp-ipv6u)# redistribute rip
```

Configuring BGP4+ outbound route filtering

The BGP4+ Outbound Route Filtering (ORF) prefix list capability can be configured in receive mode, send mode, or both send and receive modes, minimizing the number of BGP updates exchanged between BGP peers.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

4. Enter the **neighbor ipv6-address activate** command to add a neighbor.

```
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 activate
```

5. Enter the **neighbor ipv6-address prefix-list** command and specify the **in** keyword to filter the incoming route updates from a specified BGP neighbor.

```
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 prefix-list myprefixlist in
```

6. Do one of the following:

- Enter the **neighbor capability orf prefixlist** command and specify the **send** keyword to advertise ORF send capabilities.

```
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 capability orf prefixlist send
```

- Enter the **neighbor capability orf prefixlist** command and specify the **receive** keyword to advertise ORF receive capabilities.

```
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 capability orf prefixlist receive
```

- Enter the **neighbor capability orf prefixlist** command to configure ORF capability in both send and receive modes.

```
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 capability orf prefixlist
```

The following example configures ORF in receive mode.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 activate
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 capability orf prefixlist receive
```

The following example configures ORF in send mode.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 activate
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 prefix-list myprefixlist in
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 capability orf prefixlist send
```

The following example configures ORF in both send and receive modes.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 activate
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 prefix-list myprefixlist in
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 capability orf prefixlist
```

Configuring BGP4+ confederations

BGP4+ confederations, composed of multiple subautonomous systems, can be created.

- Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

- Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

- Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router)# local-as 65520
```

- Enter the **confederation identifier** command and specify an ASN to configure a BGP confederation identifier.

```
device(config-bgp-router)# confederation identifier 100
```

5. Enter the **confederation peers** command and specify as many ASNs as needed to list all BGP peers that will belong to the confederation.

```
device(config-bgp-router) # confederation peers 65520 65521 65522
```

The following example creates a confederation with the confederation ID “100” and adds three subautonomous systems to the confederation.

```
device# configure terminal  
device(config)# router bgp  
device(config-bgp-router) # local-as 65520  
device(config-bgp-router) # confederation identifier 100  
device(config-bgp-router) # confederation peers 65520 65521 65522
```

Defining a community ACL

A BGP community ACL can be configured, and BGP community attributes set in a route map instance.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **ip community-list extended** command using the **permit** keyword to configure a BGP community ACL.

```
device(config) # ip community-list extended 1 permit ^[1-2]23
```

3. Enter the **route-map name** command to create and define a route map and enter route map configuration mode.

```
device(config) # route-map ComRmap permit 10
```

4. Enter the **match community** command and specify a community list name.

```
device(config-route-map-ComRmap) # match community 1
```

5. Enter the **set community** command to set the BGP community attributes.

```
device(config-route-map-ComRmap) # set community 323:1 additive
```

6. Enter the **exit** command to return to global configuration mode.

```
device(config-route-map-ComRmap) # exit
```

7. Enter the **route-map name** command to define a route map and enter route map configuration mode.

```
device(config) # route-map sendComRmap permit 10
```

8. Enter the **set community** command to set the BGP community attributes.

```
device(config-route-map-sendComRmap) # set community 3:3
```

The following example configures a BGP community ACL and sets the BGP community attributes in a route map instance.

```
device# configure terminal  
device(config) # ip community-list extended 1 permit ^[1-2]23  
device(config) # route-map ComRmap permit 10  
device(config-route-map-ComRmap) # match community 1  
device(config-route-map-ComRmap) # set community 323:1 additive  
device(config-route-map-ComRmap) # exit  
device(config) # route-map sendComRmap permit 10  
device(config-route-map-sendComRmap) # set community 3:3
```

Applying a BGP extended community filter

A BGP extended community filter can be applied.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **ip community-list extended** command using the **permit** keyword to configure a BGP community ACL.

```
device(config)# ip community-list extended 1 permit ^[1-2]23
```

3. Enter the **route-map name** command to create and define a route map and enter route map configuration mode.

```
device(config)# route-map ComRmap permit 10
```

4. Enter the **match community** command and specify a community list name.

```
device(config-route-map-ComRmap)# match community 1
```

5. Enter the **set local-preference** command and specify a value to set a BGP local-preference path attribute.

```
device(config-route-map-ComRmap)# set local-preference 200
```

6. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

7. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router)# local-as 1000
```

8. Enter the **neighbor ipv6-address remote-as** command to specify the ASN in which the remote neighbor resides.

```
device(config-bgp-router)# neighbor fe80:4398:ab30:45de::1 remote-as 1001
```

9. Enter the **neighbor ipv6-address update-source** command to specify an interface.

```
device(config-bgp-router)# neighbor fe80:4398:ab30:45de::1 update-source ve 1000
```

10. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

11. Enter the **neighbor ipv6-address activate** command to enable the exchange of information with the neighbor.

```
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 activate
```

12. Enter the **neighbor ipv6-address route-map** command and specify the **in** keyword to apply a route map to incoming routes.

```
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 route-map in ComRmap
```

13. Enter the **neighbor ipv6-address send-community** command to enable the sending of standard and extended attributes in updates to the specified BGP neighbor.

```
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 send-community
```

The following example applies a BGP extended community filter.

```
device# configure terminal
device(config)# ip community-list extended 1 permit ^[1-2]23
device(config)# route-map ComRmap permit 10
device(config-route-map-ComRmap)# match community 1
device(config-route-map-ComRmap)# set local-preference 200
device(config)# router bgp
device(config-bgp-router)# local-as 1000
device(config-bgp-router)# neighbor fe80:4398:ab30:45de::1 remote-as 1001
device(config-bgp-router)# neighbor fe80:4398:ab30:45de::1 update-source ve 1000
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 activate
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 route-map in ComRmap
device(config-bgp-ipv6u)# neighbor fe80:4398:ab30:45de::1 send-community
```

Disabling BGP4+ graceful restart

The BGP4+ graceful restart (GR) feature is enabled by default, and can be disabled on a routing device.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. (Optional) Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

4. Enter the **no graceful restart** command to disable graceful restart at the IPv6 address family configuration level.

```
device(config-bgp-ipv6u))# no graceful-restart
```

In the following example, the graceful restart feature is disabled at the IPv6 address family configuration level.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# address-family ipv4 unicast
device(config-bgp-ipv6u))# no graceful-restart
```

Re-enabling BGP4+ graceful restart

If the BGP4+ graceful restart (GR) feature is disabled on a routing device, it can be re-enabled, providing it with the capability to inform its neighbors and peers when it is performing a restart.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **local-as** command to configure the autonomous system number (ASN) in which your device resides.

```
device(config-bgp-router)# local-as 1000
```

4. Enter the **neighbor** *ipv6-address* **remote-as** command to specify the autonomous system ASN in which the remote neighbor resides.

```
device(config-bgp-router)# neighbor 1000::1 remote-as 2
```

5. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

6. Enter the **neighbor** *ipv6-address* **activate** command to add a neighbor.

```
device(config-bgp-ipv6u)# neighbor 1000::1 activate
```

7. Enter the **graceful-restart** command to enable the graceful restart feature.

```
device(config-bgp-ipv6u)# graceful-restart
```

8. Do any of the following:

- Enter the **graceful-restart** command using the **purge-time** keyword to overwrite the default purge-time value.

```
device(config-bgp-ipv6u)# graceful-restart purge-time 300
```

- Enter the **graceful-restart** command using the **restart-time** keyword to overwrite the default restart-time advertised to graceful restart-capable neighbors.

```
device(config-bgp-ipv6u)# graceful-restart restart-time 180
```

- Enter the **graceful-restart** command using the **stale-routes-time** keyword to overwrite the default amount of time that a helper device will wait for an EOR message from a peer.

```
device(config-bgp-ipv6u)# graceful-restart stale-routes-time 100
```

The following example re-enables the graceful restart feature.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# local-as 1
device(config-bgp-router)# neighbor 1000::1 remote-as 2
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor 1000::1 activate
device(config-bgp-ipv6u)# graceful-restart
```

The following example re-enables the graceful restart feature and sets the purge time to 300 seconds, overwriting the default value.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# local-as 1
device(config-bgp-router)# neighbor 1000::1 remote-as 2
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor 1000::1 activate
device(config-bgp-ipv6u)# graceful-restart purge-time 300
```

Configuring BGP4+

Configuring BGP4+

The following example re-enables the graceful restart feature and sets the restart time to 180 seconds, overwriting the default value.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# local-as 1
device(config-bgp-router)# neighbor 1000::1 remote-as 2
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor 1000::1 activate
device(config-bgp-ipv6u)# graceful-restart restart-time 180
```

The following example re-enables the graceful restart feature and sets the stale-routes time to 100 seconds, overwriting the default value.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# local-as 1
device(config-bgp-router)# neighbor 1000::1 remote-as 2
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor 1000::1 activate
device(config-bgp-ipv6u)# graceful-restart stale-routes-time 100
```

Use the **clear ipv6 bgp neighbor** command with the **all** parameter for the changes to the graceful restart parameters to take effect immediately.

Disabling the BGP AS_PATH check function

A device can be configured so that the AS_PATH check function for routes learned from a specific location is disabled, and routes that contain the recipient BGP speaker's AS number are not rejected.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **router bgp** command to enable BGP routing.

```
device(config)# router bgp
```

3. Enter the **address-family** command and specify the **ipv6** and **unicast** keywords to enter IPv6 address family configuration mode.

```
device(config-bgp-router)# address-family ipv6 unicast
```

4. Enter the **neighbor ipv6-address allowas-in** command and specify a **number** to disable the BGP AS_PATH check function, and specify the number of times that the AS path of a received route may contain the recipient BGP speaker's AS number and still be accepted.

```
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 allowas-in 3
```

This example specifies that the AS path of a received route may contain the recipient BGP speaker's AS number three times and still be accepted.

```
device# configure terminal
device(config)# router bgp
device(config-bgp-router)# address-family ipv6 unicast
device(config-bgp-ipv6u)# neighbor 2001:db8:e0ff:783a::4 allowas-in 3
```

Displaying BGP4+ statistics

Various **show ipv6 bgp** commands verify information about BGP4+ configurations.

Use one or more of the following commands to verify BGP4+ information. The commands do not have to be entered in this order.

1. Enter the **show ipv6 bgp summary** command.

```
device# show ipv6 bgp summary

BGP4 Summary
Router ID: 122.122.122.122 Local AS Number: 122
Confederation Identifier: not configured
Confederation Peers:
Cluster ID: 122
Maximum Number of IP ECMP Paths Supported for Load Sharing: 1
Number of Neighbors Configured: 20, UP: 15
Number of Routes Installed: 219, Uses 20805 bytes
Number of Routes Advertising to All Neighbors: 2802 (440 entries), Uses 26400 bytes
Number of Attribute Entries Installed: 31, Uses 2852 bytes
Neighbor Address AS# State Time Rt:Accepted Filtered Sent ToSend
2001:54:54::54 122 ESTAB 0h19m58s 0 0 146 0
2001:55:55::55 122 ESTAB 0h19m54s 1 0 146 0
2001:122:53::53 6000 ESTAB 0h22m39s 50 0 147 0
2001:122:534:2::534
534 ESTAB 0h 3m20s 10 0 137 0
2001:125:125::125 122 CONN 0h11m33s 0 0 0 -
```

This example output gives summarized BGP4+ information.

2. Enter the **show ipv6 bgp attribute-entries** command.

```
device# show ipv6 bgp attribute-entries

Total number of BGP Attribute Entries: 2
1 Next Hop : 2001::1 MED :1 Origin:IGP
Originator:0.0.0.0 Cluster List:None
Aggregator:AS Number :0 Router-ID:0.0.0.0 Atomic:None
Local Pref:1 Communities:Internet
AS Path : (length 0)
Address: 0x1205c75c Hash:268 (0x01000000)
Links: 0x00000000, 0x00000000
Reference Counts: 2:0:0, Magic: 1
2 Next Hop : :: MED :1 Origin:IGP
Originator:0.0.0.0 Cluster List:None
Aggregator:AS Number :0 Router-ID:0.0.0.0 Atomic:None
Local Pref:100 Communities:Internet
AS Path : (length 0)
AsPathLen: 0 AsNum: 0, SegmentNum: 0, Neighboring As: 0, Source As 0
Address: 0x1205c7cc Hash:365 (0x01000000)
Links: 0x00000000, 0x00000000
Reference Counts: 1:0:1, Magic: 2
```

This example shows information about two route-attribute entries that are stored in device memory.

Configuring BGP4+

Configuring BGP4+

3. Enter the **show ipv6 bgp peer-group** command.

```
device# show ipv6 bgp peer-group

1 BGP peer-group is P1, Remote AS: 1
Address family : IPV4 Unicast
activate
Address family : IPV4 Multicast
no activate
Address family : IPV6 Unicast
activate
Address family : IPV6 Multicast
no activate
Address family : VPNV4 Unicast
no activate
Address family : L2VPN VPLS
no activate
Members:
IP Address: 2001::1
IP Address: 2001::0:1::1
IP Address: 10.1.0.1
```

This example shows output for a peer group called "P1".

4. Enter the **show ipv6 bgp routes** command.

```
device# show ipv6 bgp routes
Total number of BGP Routes: 6
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
S:SUPPRESSED F:FILTERED s:STALE
Prefix          Next Hop      MED     LocPrf    Weight Status
1   57:7000:3:22:abc:1::/128  2001:700:122:57::57
                                         100      0        BE
          AS_PATH: 7000 322
2   57:7000:3:22:abc:1:0:2/128  2001:700:122:57::57
                                         100      0        BE
          AS_PATH: 7000 322
3   57:7000:3:22:abc:1:0:4/128  2001:700:122:57::57
                                         100      0        BE
          AS_PATH: 7000 322
4   57:7000:3:22:abc:1:0:6/128  2001:700:122:57::57
                                         100      0        BE
          AS_PATH: 7000 322
5   57:7000:3:22:abc:1:0:8/128  2001:700:122:57::57
                                         100      0        BE
          AS_PATH: 7000 322
6   57:7000:3:22:abc:1:0:a/128  2001:700:122:57::57
                                         100      0        BE
          AS_PATH: 7000 322
```

This example shows general BGP4+ route information.

5. Enter the **show ipv6 bgp routes** command, using the **summary** keyword.

```
device# show ipv6 bgp routes summary

Total number of BGP routes (NLRIs) Installed      : 558
Distinct BGP destination networks                : 428
Filtered bgp routes for soft reconfig           : 0
Routes originated by this router                 : 19
Routes selected as BEST routes                  : 417
BEST routes not installed in IP forwarding table: 0
Unreachable routes (no IGP route for NEXTHOP)   : 22
IBGP routes selected as best routes            : 102
EBGP routes selected as best routes            : 296
```

This example shows summarized BGP4+ route information.

6. Enter the **show ipv6 bgp routes** command, using the **local** keyword.

```
device# show ipv6 bgp routes local
Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
      E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH m:NOT-INSTALLED-MULTIPATH
      S:SUPPRESSED F:FILTERED s:STALE
      Prefix          Next Hop        MED     LocPrf    Weight Status
      1 131::1/128      ::           1       100      32768   BL
      AS_PATH:
      2 2001:107:6133:2007:1::/112 2001:2007::201
                                     107      100      32768   BL
      AS_PATH:
      3 2001:107:6133:2007:2::/112 2001:2007::202
                                     107      100      32768   BL
      AS_PATH:
      4 2001:107:6133:2007:3::/112 2001:2007::203
                                     107      100      32768   BL
      AS_PATH:
      5 2001:107:6133:2007:4::/112 2001:2007::204
                                     107      100      32768   BL
      AS_PATH:
      6 2001:107:6133:2007:5::/112 2001:2007::205
                                     107      100      32768   BL
      AS_PATH:
      7 2001:107:6133:2007:6::/112 2001:2007::206
                                     107      100      32768   BL
```

This example shows information about local routes.

Displaying BGP4+ neighbor statistics

Various **show ipv6 bgp neighbor** commands verify information about BGP4+ neighbor configurations.

Use one or more of the following commands to verify BGP4+ neighbor information. The commands do not have to be entered in this order.

1. Enter the **show ipv6 bgp neighbors** command.

```
device# show ipv6 bgp neighbors
Total number of BGP Neighbors: 2
IP Address: 2001::1, AS: 2 (EBGP), RouterID: 192.0.0.1, VRF: default-vrf
State: ESTABLISHED, Time: 0h0m27s, KeepAliveTime: 30, HoldTime: 90
KeepAliveTimer Expire in 3 seconds, HoldTimer Expire in 62 seconds
Minimal Route Advertisement Interval: 0 seconds
Messages: Open Update KeepAlive Notification Refresh-Req
Sent : 5 2 7 3 0
Received: 5 4 11 1 0
Last Update Time: NLRI Withdraw NLRI Withdraw
Tx: 0h0m23s --- Rx: 0h0m27s ---
Last Connection Reset Reason:Rcv Notification
Notification Sent: Cease/CEASE Message
Notification Received: Cease/CEASE Message
Neighbor NLRI Negotiation:
Peer Negotiated IPV6 unicast capability
Peer configured for IPV6 unicast Routes
Neighbor ipv6 MPLS Label Capability Negotiation:
Neighbor AS4 Capability Negotiation:
Outbound Policy Group:
ID: 2, Use Count: 2
Update running at: 0.0.0.0/0
Last update time was 104 sec ago
Byte Sent: 158, Received: 0
Local host: 2001::2, Local Port: 8168
Remote host: 2001::1, Remote Port: 179
```

This example output gives summarized information about BGP4+ neighbors.

Configuring BGP4+

Configuring BGP4+

2. Enter the **show ipv6 bgp neighbors advertised-routes** command.

```
device# show ipv6 bgp neighbor 2001:db8::10 advertised-routes
      There are 7 routes advertised to neighbor 2001:db8::10
      Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST E:EBGP I:IBGP L:LOCAL
      Prefix          Next Hop     MED   LocPrf   Weight Status
      1    fd80:122:122:122:101:101:0:122/128 2001:122:122::122
           0             100        101     BL
      AS_PATH:
      2    fd80:122:122:122:103:103:0:122/128 2001:122:122::122
           0             100        103     BL
      AS_PATH:
      3    fd80:122:122:122:105:105:0:122/128 2001:122:122::122
           0             100        105     BL
      AS_PATH:
      4    131::1/128          2001:122:122::122
           1             100        32768   BL
      AS_PATH:
      5    2001:122:131:125:131:1::/96 2001:3002::732
           1             100        0       BE
      AS_PATH: 65530
      6    2001:abcd:1234:1234:1:2:1:0/112 2001:3002::733
           1             100        0       BE
      AS_PATH: 65530
      7    2001:abcd:1234:1234:1:2:2:0/112 2001:3002::733
           1             100        0       BE
```

This example shows information about all the routes the BGP4+ networking device advertised to the neighbor.

3. Enter the **show ipv6 bgp neighbors last-packet-with-error** command.

```
device# show ipv6 bgp neighbor last-packet-with-error
Total number of BGP Neighbors: 67
1 IP Address: 153::2
  Last error:
    BGP4: 0 bytes hex dump of packet that contains error
```

This example shows information about the last packet that contained an error from any of a device's neighbors.

4. Enter the **show ipv6 bgp neighbors received-routes** command.

```
device# show ipv6 bgp neighbor 2001:db8::10 received-routes
      There are 4 received routes from neighbor 2001:db8::10
      Searching for matching routes, use ^C to quit...
      Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST C:CONFED_EBGP D:DAMPED
      E:EBGP H:HISTORY I:IBGP L:LOCAL M:MULTIPATH S:SUPPRESSED F:FILTERED
      Prefix          Next Hop     Metric   LocPrf   Weight   Status
      1    2001:db8:2002::/64 2001:db8::10     0     100      0       BE
      AS_PATH: 400
      2    2001:db8:2003::/64 2001:db8::10     1     100      0       BE
      AS_PATH: 400
      3    2001:db8:2004::/64 2001:db8::10     1     100      0       BE
      AS_PATH: 400
      4    2001:db8:2005::/64 2001:db8::10     1     100      0       BE
      AS_PATH: 400
```

This example lists all route information received in route updates from BGP4+ neighbors of the device since the soft-reconfiguration feature was enabled.

5. Enter the **show ipv6 bgp neighbors rib-out-routes** command.

```
device# show ipv6 bgp neighbors 2001:db8::10 rib-out-routes
      There are 150 RIB_out routes for neighbor 2001:db8::10
      Status A:AGGREGATE B:BEST b:NOT-INSTALLED-BEST E:EBGP I:IBGP L:LOCAL
      Prefix          Next Hop     MED    LocPrf   Weight Status
      1   fd80:122:122:122:101:101:0:122/128  ::       0       100     101   BL
          AS_PATH:
      2   fd80:122:122:122:103:103:0:122/128  ::       0       100     103   BL
          AS_PATH:
      3   fd80:122:122:122:105:105:0:122/128  ::       0       100     105   BL
          AS_PATH:
      4   131::1/128      ::       1       100     32768  BL
          AS_PATH:
      5   2001:122:131:125:131:1::/96  2001:3002::732
                                     1       100     0       BE
          AS_PATH: 65530
      6   2001:abcd:1234:1234:1:2:1:0/112 2001:3002::733
                                     1       100     0       BE
          AS_PATH: 65530
      7   2001:abcd:1234:1234:1:2:2:0/112 2001:3002::733
                                     1       100     0       BE
          AS_PATH: 65530
```

This example shows information about BGP4+ outbound RIB routes.

Clearing BGP4+ dampened paths

BGP4+ suppressed routes can be reactivated using a CLI command.

The **show ipv6 bgp dampened-paths** command is entered to verify that there are BGP4+ dampened routes. The **clear ipv6 bgp dampening** command is entered to reactivate all suppressed BGP4+ routes. The **show ipv6 bgp dampened-paths** command is re-entered to verify that the suppressed BGP4+ routes have been reactivated.

1. Enter the **exit** command until you return to Privileged EXEC mode.

```
device(config)# exit
```

2. Enter the **show ipv6 bgp dampened-paths** command to display all BGP4+ dampened routes.

```
device# show ipv6 bgp dampened-paths

      Network           From        Flaps   Since    Reuse    Path
      *d  2001:db8:8::/45  2001:db8:1::1  1       0 :1 :14  0 :2 :20  100 1002 1000
      *d  2001:db8:1::/48  2001:db8:1::1  1       0 :1 :14  0 :2 :20  100 1002 1000
      *d  2001:db8:4::/46  2001:db8:1::1  1       0 :1 :14  0 :2 :20  100 1002 1000
      *d  2001:db8:2::/47  2001:db8:1::1  1       0 :1 :14  0 :2 :20  100 1002 1000
      *d  2001:db8:0:8000::/49  2001:db8:1::1  1       0 :1 :14  0 :2 :20  100 1002 1000
      *d  2001:db8:17::/64  2001:db8:1::1  1       0 :1 :18  0 :2 :20  100
```

3. Enter the **clear ipv6 bgp dampening** command to reactivate all suppressed BGP4+ routes.

```
device# clear ipv6 bgp dampening
```

4. Enter the **show ipv6 bgp dampened-paths** command to verify that there are no BGP4+ dampened routes.

```
device# show ipv6 bgp dampened-paths
device#
```

Configuring BGP4+

Configuring BGP4+

The following example reactivates all suppressed BGP4+ routes and verifies that there are no suppressed routes.

```
device(config-bgp-router) # exit
device(config) # exit
device# show ipv6 bgp dampened-paths
device# clear ipv6 bgp dampening
device# show ipv6 bgp dampened-paths
```

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Overview

This chapter describes how to configure Ruckus Layer 3 switch with the following router redundancy protocols:

- Virtual Router Redundancy Protocol (VRRP) - The standard router redundancy protocol described in RFC 2338. The FastIron devices support VRRP version 2 (v2) and VRRP version 3 (v3). VRRP v2 supports the IPv4 environment, and VRRP v3 supports the IPv4 and IPv6 environments. Configuring VRRPv3 for IPv4 enables the code for a version compatible with RFC 5798. VRRPv3 has no authentication mechanism and the advertisement interval uses different metrics and range.
- VRRP Extended (VRRP-E) - An enhanced version of VRRP that overcomes limitations in the standard protocol. The FastIron devices support VRRP-E v2 and VRRP-E v3. VRRP-E v2 supports the IPv4 environment, and VRRP-E v3 supports the IPv6 environment.

NOTE

VRRP and VRRP-E are separate protocols. You cannot use them together.

NOTE

You can use a Ruckus Layer 3 switch configured for VRRP with another Ruckus device or a third-party router that is also configured for VRRP. However, you can use a Ruckus device configured for VRRP-E only with another Ruckus Layer 3 switch that also is configured for VRRP-E.

NOTE

The maximum number of supported VRRP or VRRP-E router instances is 255 for IPv4 environments. The maximum number of supported VRRP or VRRP-E router instances is 128 for IPv6 environments.

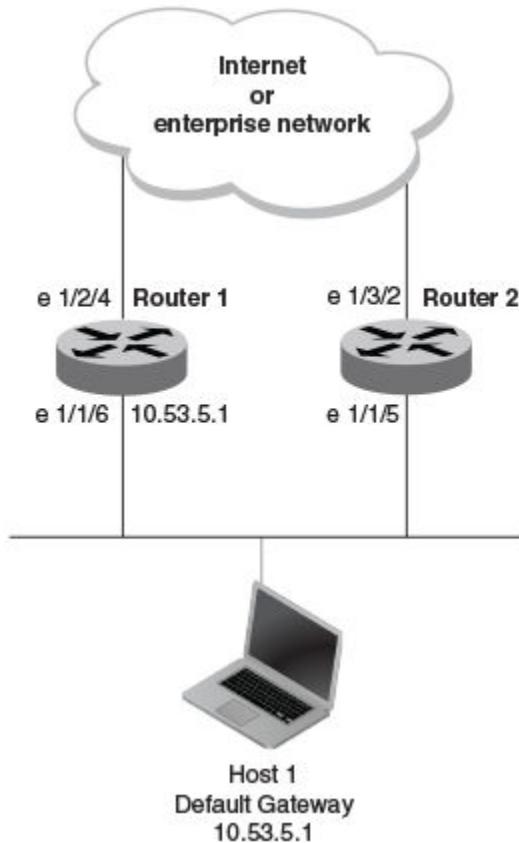
VRRP and VRRP-E overview

The following sections describe VRRP and VRRP-E. The protocols both provide redundant paths for IP addresses. However, the protocols differ in a few important ways. For clarity, each protocol is described separately.

VRRP overview

Virtual Router Redundancy Protocol (VRRP) provides redundancy to routers within a LAN. VRRP allows you to provide alternate router paths for a host without changing the IP address or MAC address by which the host knows its gateway.

FIGURE 34 Router 1 is the Host1 default gateway but is a single point of failure

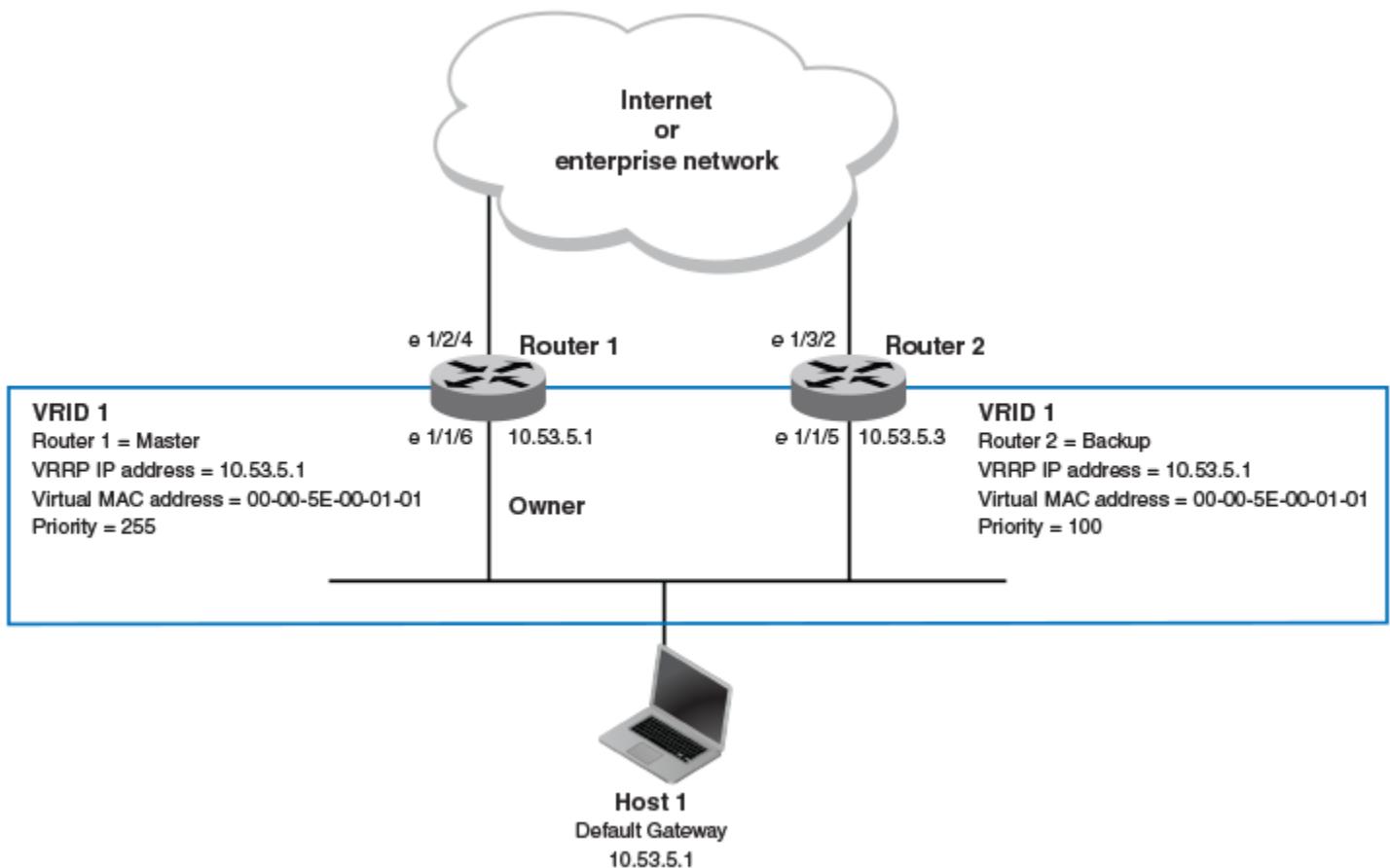


Router 1 is the host default gateway out of the subnet. If this interface goes down, Host1 is cut off from the rest of the network. Router 1 is thus a single point of failure for Host1's access to other networks.

If Router 1 fails, you could configure Host1 to use Router 2. Configuring one host with a different default gateway might not require too much extra administration. However, consider a more realistic network with dozens or even hundreds of hosts per subnet; reconfiguring the default gateways for all the hosts is impractical. It is much simpler to configure a VRRP virtual router on Router 1 and Router 2 to provide a redundant path for the hosts.

The examples show the same sample networks, but a VRRP virtual router is configured on Router 1 and Router 2 in the second example.

FIGURE 35 Router 1 and Router 2 configured as VRRP virtual routers for redundant network access for Host1



The dashed box represents a VRRP virtual router. When you configure a virtual router, one of the configuration parameters is the virtual router ID (VRID), which can be a number from 1 through 255. In this example, the VRID is 1.

NOTE

You can provide more redundancy by also configuring a second VRID with Router 2 as the Owner and Router 1 as the Backup. This type of configuration is sometimes called Multigroup VRRP.

Virtual router ID

A virtual router ID (VRID) consists of one Master router and one or more Backup routers. The Master router is the router that owns the IP addresses you associate with the VRID. For this reason, the Master router is sometimes called the "Owner". Configure the VRID on the router that owns the default gateway interface. The other router in the VRID does not own the IP addresses associated with the VRID but provides the backup path if the Master router becomes unavailable.

Virtual router MAC address

Notice the MAC address associated with VRID1 in [VRRP overview](#) on page 512. The first five octets of the address are the standard MAC prefix for VRRP packets, as described in RFC 2338. The last octet is the VRID. The VRID number becomes the final octet in the virtual MAC address associated with the virtual router.

When you configure a VRID, the software automatically assigns its MAC address. When a VRID becomes active, the Master router broadcasts a gratuitous ARP request containing the virtual router MAC address for each IP address associated with the virtual router. In [VRRP overview](#) on page 512, Switch 1 sends a gratuitous ARP request with MAC address 00-00-5E-00-01-01 and IP address 192.53.5.1. Hosts use the virtual router MAC address in routed traffic they send to their default IP gateway (in this example, 192.53.5.1).

Virtual router IP address

VRRP does not use virtual IP addresses. Thus, there is no virtual IP address associated with a virtual router. Instead, you associate the virtual router with one or more real interface IP addresses configured on the router that owns the real IP addresses. In [VRRP overview](#) on page 512, the virtual router with VRID1 is associated with real IP address 192.53.5.1, which is configured on interface e1/1/6 on Switch 1. VRIDs are interface-level parameters, not system-level parameters, so the IP address you associate with the VRID must already be a real IP address configured on the Owner interface.

NOTE

You can associate a virtual router with a virtual interface. A virtual interface is a named set of physical interfaces.

When you configure the Backup router for the VRID, specify the same IP address as the one you specify on the Owner. This is the IP address used by the host as its default gateway. The IP address cannot also exist on the Backup router. The interface on which you configure the VRID on the Backup router must have an IP address in the same subnet.

NOTE

If you delete a real IP address used by a VRRP entry, the VRRP entry also is deleted automatically.

NOTE

When a Backup router takes over forwarding responsibilities from a failed Master router, the Backup forwards traffic addressed to the VRID MAC address, which the host believes is the MAC address of the router interface for its default gateway. However, the Backup router cannot reply to IP pings sent to the IP addresses associated with the VRID. Because the IP addresses are owned by the Owner, if the Owner is unavailable, the IP addresses are unavailable as packet destinations.

Master negotiation

The routers within a VRID use the VRRP priority values associated with each router to determine which router becomes the Master. When you configure the VRID on a router interface, you specify whether the router is the Owner of the IP addresses you plan to associate with the VRID or a Backup router. If you indicate that the router is the Owner of the IP addresses, the software automatically sets the router VRRP priority for the VRID to 255, the highest VRRP priority. The router with the highest priority becomes the Master.

Backup routers can have a priority from 3 through 254, which you assign when you configure the VRID on the Backup router interfaces. The default VRRP priority for Backup routers is 100.

Because the router that owns the IP addresses associated with the VRID always has the highest priority, when all the routers in the virtual router are operating normally, the negotiation process results in the Owner of the VRID IP addresses becoming the Master router. Thus, the VRRP negotiation results in the normal case, in which the host's path to the default route is to the router that owns the interface for that route.

Hello messages

Virtual routers use Hello messages for negotiation to determine the Master router. Virtual routers send Hello messages to IP Multicast address 224.0.0.18. The frequency with which the Master sends Hello messages is the Hello interval. Only the Master sends Hello messages. However, a Backup router uses the Hello interval you configure for the Backup router if it becomes the Master.

The Backup routers wait for a period of time called the dead interval for a Hello message from the Master. If a Backup router does not receive a Hello message by the time the dead interval expires, the Backup router assumes that the Master router is dead and negotiates with the other Backup routers to select a new Master router. The Backup router with the highest priority becomes the new Master.

Master and Owner backup routers

If the Owner becomes unavailable, but then comes back online, the Owner again becomes the Master router. The Owner becomes the Master router again because it has the highest priority. The Owner always becomes the Master again when the Owner comes back online.

NOTE

If you configure a track port on the Owner and the track port is down, the Owner priority is changed to the track priority. In this case, the Owner does not have a higher priority than the Backup router that is acting as the Master router and the Owner therefore does not resume its position as the Master router.

By default, if a Backup is acting as the Master, and the original Master is still unavailable, another Backup can "preempt" the Backup that is acting as the Master. This can occur if the new Backup router has a higher priority than the Backup router that is acting as the Master. You can disable this behavior. When you disable preemption, a Backup router that has a higher priority than the router that is currently acting as the Master does not preempt the new Master by initiating a new Master negotiation.

NOTE

Regardless of the setting for the preempt parameter, the Owner always becomes the Master again when it comes back online.

Track ports and track priority

The Ruckus implementation of VRRP enhances the protocol by giving a VRRP router the capability to monitor the state of the interfaces on the other end of the route path through the router. For example, in [VRRP overview](#) on page 512, interface e1/1/6 on Switch 1 owns the IP address to which Host1 directs route traffic on its default gateway. The exit path for this traffic is through the Switch 1 e1/2/4 interface.

Suppose interface e1/2/4 goes down. Even if interface e1/1/6 is still up, Host1 is cut off from other networks. In conventional VRRP, Switch 1 would continue to be the Master router despite the unavailability of the exit interface for the path the router is supporting. However, if you configure interface e1/1/6 to track the state of interface e1/2/4, if e1/2/4 goes down, interface e1/1/6 responds by changing the Switch 1 VRRP priority to the value of the track priority. In the configuration shown in [VRRP overview](#) on page 512, the Switch 1 priority changes from 255 to 20. One of the parameters contained in the Hello messages the Master router sends to its Backup routers is the Master router priority. If the track port feature results in a change in the Master router priority, the Backup routers quickly become aware of the change and initiate a negotiation to become the Master router.

In [VRRP overview](#) on page 512, the track priority results in the Switch 1 VRRP priority becoming lower than the Switch 2 VRRP priority. As a result, when Switch 2 learns that it now has a higher priority than Switch 1, Switch 2 initiates negotiation to become the Master router and becomes the new Master router, thus providing an open path for the Host1 traffic. To take advantage of the track port feature, make sure the track priorities are always lower than the VRRP priorities. The default track priority for the router that owns the VRID IP addresses is 2. The default track priority for Backup routers is 1. If you change the track port

priorities, make sure you assign a higher track priority to the Owner of the IP addresses than the track priority you assign on the Backup routers.

Suppression of RIP advertisements for backed-up interfaces

The Ruckus implementation also enhances VRRP by allowing you to configure the protocol to suppress RIP advertisements for the backed-up paths from Backup routers. Normally, a VRRP Backup router includes route information for the interface it is backing up in RIP advertisements. As a result, other routers receive multiple paths for the interface and might sometimes unsuccessfully use the path to the Backup router rather than the path to the Master router. If you enable the Ruckus implementation of VRRP to suppress the VRRP Backup routers from advertising the backed-up interface in RIP, other routers learn only the path to the Master router for the backed-up interface.

Authentication

The Ruckus implementations of VRRP and VRRP-E can use simple passwords to authenticate VRRP and VRRP-E packets. VRRP-E can also use HMAC-MD5-96 to authenticate VRRP-E packets.

VRRP and VRRP-E authentication is configured on the router interfaces. The VRRP authentication configuration of every router interface must match. For example, if you want to use simple passwords to authenticate VRRP traffic within a router, you must configure VRRP simple password authentication with the same password on all of the participating router interfaces.

NOTE

The HMAC-MD5-96 authentication type is supported for VRRP-E, but not supported for VRRP.

NOTE

Authentication is not supported for VRRP v3.

Independent operation of VRRP alongside RIP, OSPF, and BGP4

VRRP operation is independent of RIP, OSPF, and BGP4; therefore, RIP, OSPF, and BGP4 are not affected if VRRP is enabled on one of these interfaces.

Dynamic VRRP configuration

All VRRP global and interface parameters take effect immediately. You do not need to reset the system to place VRRP configuration parameters into effect.

VRRP-E overview

The most important difference between VRRP and VRRP-E is that all VRRP-E routers are Backup routers; there is no Owner router. VRRP-E overcomes the limitations in standard VRRP by removing the Owner.

The following points explain how VRRP-E differs from VRRP:

- Owners and Backup routers
 - VRRP has an Owner and one or more Backup routers for each VRID. The Owner is the router on which the VRID's IP address is also configured as a real address. All the other routers supporting the VRID are Backup routers.
 - VRRP-E does not use Owners. All routers are Backup routers for a given VRID. The router with the highest priority becomes the Master. If there is a tie for highest priority, the router with the highest IP address becomes the Master. The elected Master owns the virtual IP address and answers pings and ARP requests.

- VRID's IP address
 - VRRP requires that the VRID's IP address also be a real IP address configured on the VRID's interface on the Owner.
 - VRRP-E requires only that the VRID be in the same subnet as an interface configured on the VRID's interface. VRRP-E does not allow you to specify a real IP address configured on the interface as the VRID IP address.
- VRID's MAC address
 - VRRP uses the source MAC address as a virtual MAC address defined as 00-00-5E-00-01--*vrid* , where *vrid* is the VRID. The Master owns the virtual MAC address.
 - VRRP-E uses the MAC address of the interface as the source MAC address. The MAC address is *hash-value-vrid* , where *hash-value* is a two-octet hashed value for the IP address and *vrid* is the VRID.
- Hello packets
 - VRRP sends Hello messages to IP Multicast address 224.0.0.18.
 - VRRP-E uses UDP to send Hello messages in IP multicast messages. The Hello packets use the MAC address of the interface and the IP address as the source addresses. The destination MAC address is 01-00-5E-00-00-02, and the destination IP address is 224.0.0.2 (the well-known IP multicast address for "all routers"). Both the source and destination UDP port number is 8888. VRRP-E messages are encapsulated in the data portion of the packet.
- Track ports and track priority
 - VRRP changes the priority of the VRID to the track priority, which typically is lower than the VRID priority and lower than the VRID priorities configured on the Backup routers. For example, if the VRRP interface priority is 100 and a tracked interface with track priority 20 goes down, the software changes the VRRP interface priority to 20.
 - VRRP-E reduces the priority of a VRRP-E interface by the amount of a tracked interface priority if the tracked interface link goes down. For example, if the VRRP-E interface priority is 200 and a tracked interface with track priority 20 goes down, the software changes the VRRP-E interface priority to 180. If another tracked interface goes down, the software reduces the VRID priority again, by the amount of the tracked interface track priority.
- VRRP-E can use HMAC-MD5-96 for authenticating VRRP-E packets. VRRP can use only simple passwords.

ARP behavior with VRRP-E

In the VRRP-E implementation, the source MAC address of the gratuitous Address Resolution Protocol (ARP) request sent by the VRRP-E Master router is the VRRP-E virtual MAC address. When the router (either the Master or Backup router) sends an ARP request or reply packet, the sender's MAC address becomes the MAC address of the interface on the router. When an ARP request packet for the virtual router IP address is received by the Backup router, it is forwarded to the Master router to resolve the ARP request. Only the Master router answers the ARP request for the virtual router IP address.

Comparison of VRRP and VRRP-E

This section compares router redundancy protocols.

VRRP

VRRP is a standards-based protocol, described in RFC 2338. The Ruckus implementation of VRRP contains the features in RFC 2338. The Ruckus implementation also provides the following additional features:

- Track ports - A Ruckus feature that enables you to diagnose the health of all the Layer 3 switch ports used by the backed-up VRID, instead of only the port connected to the client subnet.

VRRP and VRRP-E

VRRP and VRRP-E parameters

- Suppression of RIP advertisements on Backup routers for the backed-up interface - You can enable the Layer 3 switches to advertise only the path to the Master router for the backed-up interface. Normally, a VRRP Backup router includes route information for the interface it is backing up in RIP advertisements.

Ruckus Layer 3 switches configured for VRRP can interoperate with third-party routers using VRRP.

VRRP-E

VRRP-E is a Ruckus protocol that provides the benefits of VRRP without the limitations. VRRP-E is unlike VRRP in the following ways:

- There is no "Owner" router. You do not need to use an IP address configured on one of the Layer 3 switches as the virtual router ID (VRID), which is the address you are backing up for redundancy. The VRID is independent of the IP interfaces configured in the Layer 3 switches. As a result, the protocol does not have an "Owner" as VRRP does.
- There is no restriction on which router can be the default Master router. In VRRP, the "Owner" (the Layer 3 switch on which the IP interface that is used for the VRID is configured) must be the default Master.

Ruckus Layer 3 switches configured for VRRP-E can interoperate only with other Brocade Layer 3 switches.

Architectural differences between VRRP and VRRP-E

The protocols have the following architectural differences.

Management protocol

- VRRP - VRRP routers send VRRP Hello and Hello messages to IP Multicast address 224.0.0.18.
- VRRP-E - VRRP-E sends messages to destination MAC address 01-00-5E-00-00-02 and destination IP address 224.0.0.2 (the standard IP multicast address for "all routers").

Virtual router IP address (the address you are backing up)

- VRRP - The virtual router IP address is the same as an IP address or virtual interface configured on one of the Layer 3 switches, which is the "Owner" and becomes the default Master.
- VRRP-E - The virtual router IP address is the gateway address you want to back up, but does not need to be an IP interface configured on one of the Layer 3 switch ports or a virtual interface.

Master and Backup routers

- VRRP - The "Owner" of the IP address of the VRID is the default Master and has the highest priority (255). The precedence of the Backup routers is determined by their priorities. The default Master is always the Owner of the IP address of the VRID.
- VRRP-E - The Master and Backup routers are selected based on their priority. You can configure any of the Layer 3 switches to be the Master by giving it the highest priority. There is no Owner.

VRRP and VRRP-E parameters

Most of the parameters and default values are the same for both protocols.

TABLE 104 VRRP and VRRP-E parameters

Parameter	Description	Default
Protocol	The Virtual Router Redundancy Protocol (VRRP) based on RFC 2338 or VRRP-Extended, the Ruckus-enhanced implementation of VRRP.	Disabled NOTE Only one of the protocols can be enabled at a time.
VRRP or VRRP-E router	The Ruckus Layer 3 switch active participation as a VRRP or VRRP-E router. Enabling the protocol does not activate the Layer 3 switch for VRRP or VRRP-E. You must activate the switch as a VRRP or VRRP-E router after you configure the VRRP or VRRP-E parameters.	Inactive
Virtual Router ID (VRID)	The ID of the virtual router you are creating by configuring multiple routers to back up an IP interface. You must configure the same VRID on each router that you want to use to back up the address.	None
Virtual Router IP address	This is the address you are backing up. <ul style="list-style-type: none"> • VRRP - The virtual router IP address must be a real IP address configured on the VRID interface on one of the VRRP routers. This router is the IP address Owner and is the default Master. • VRRP-E - The virtual router IP address must be in the same subnet as a real IP address configured on the VRRP-E interface, but cannot be the same as a real IP address configured on the interface. 	None
VRID MAC address	The source MAC address in VRRP or VRRP-E packets sent from the VRID interface, and the destination for packets sent to the VRID: <ul style="list-style-type: none"> • VRRP - A virtual MAC address defined as 00-00-5E-00-01-vrid for IPv4 VRRP, and 00-00-5E-00-02-vrid for VRRP v3. The Master owns the virtual MAC address. • VRRP-E - A virtual MAC address defined as 02-E0-52- hash-value - vrid for IPv4 VRRP-E and IPv6 VRRP-E, where hash-value is a two-octet hashed value for the IP address and vrid is the ID of the virtual router. 	Not configurable
Authentication type	The type of authentication the VRRP or VRRP-E interfaces use to validate VRRP or VRRP-E packets. <ul style="list-style-type: none"> • No authentication - The interfaces do not use authentication. This is the VRRP default. • Simple - The interface uses a simple text-string as a password in packets sent on the interface. If the interface uses simple password authentication, the VRID configured on the interface must use the same 	No authentication

VRRP and VRRP-E

VRRP and VRRP-E parameters

TABLE 104 VRRP and VRRP-E parameters (continued)

Parameter	Description	Default
	<p>authentication type and the same password.</p> <ul style="list-style-type: none"> • HMAC-MD5-96 (VRRP-E only) - The interface uses HMAC-MD5-96 authentication for VRRP-E packets. <p>NOTE Authentication is not supported for VRRP v3.</p>	
Router type	<p>Whether the router is an Owner or a Backup.</p> <ul style="list-style-type: none"> • Owner (VRRP only) - The router on which the real IP address used by the VRID is configured. • Backup - Routers that can provide routing services for the VRID but do not have a real IP address matching the VRID. 	<p>VRRP - The Owner is always the router that has the real IP address used by the VRID. All other routers for the VRID are Backups.</p> <p>VRRP-E - All routers for the VRID are Backups.</p>
Backup priority	<p>A numeric value that determines a Backup router's preferability for becoming the Master for the VRID. During negotiation, the router with the highest priority becomes the Master.</p> <ul style="list-style-type: none"> • VRRP - The Owner has the highest priority (255); other routers (backups) can have a priority from 3 through 254. • VRRP-E - All routers are Backups and can have priority from 6 through 255. <p>If two or more Backups are tied with the highest priority, the Backup interface with the highest IP address becomes the Master for the VRID.</p>	<p>VRRP v2 and IPv6 VRRP v3 - The value is 255 for the Owner and 100 for the Backups.</p> <p>VRRP-E v2 and IPv6 VRRP-E v3 -The value is 100 for all Backups.</p>
Suppression of RIP advertisements	<p>A router that is running RIP normally advertises routes to a backed-up VRID even when the router is not currently the active router for the VRID. Suppression of these advertisements helps ensure that other routers do not receive invalid route paths for the VRID.</p> <p>NOTE Suppression of RIP advertisements is not supported for VRRP v3 and VRRP-E v3.</p>	Disabled
Hello interval	<p>The number of seconds or milliseconds between Hello messages from the Master to the Backups for a given VRID. The interval can be from 1 through 84 seconds for VRRP v2, VRRP-E v2, and IPv6 VRRP-E. The interval for VRRP v3 can be from 100 through 8400 milliseconds.</p>	<p>One second (VRRP v2 and VRRP-E v2, and IPv6 VRRP-E)</p> <p>1000 milliseconds (VRRP v3).</p>
Dead interval	<p>The number of seconds or milliseconds a Backup waits for a Hello message from the</p>	<p>If the value for the dead interval is not configured, then the current dead interval is equal to three times the Hello interval plus</p>

TABLE 104 VRRP and VRRP-E parameters (continued)

Parameter	Description	Default
	<p>Master for the VRID before determining that the Master is no longer active.</p> <p>If the Master does not send a Hello message before the dead interval expires, the Backups negotiate (compare priorities) to select a new Master for the VRID.</p>	the Skew time (where Skew time is equal to (256 - priority) divided by 256).
Backup Hello interval	<p>The number of seconds between Hello messages from a Backup to the Master.</p> <p>The message interval can be from 60 through 3600 seconds.</p> <p>You must enable the Advertise backup to send the messages. The messages are disabled by default on Backups. The current Master (whether the VRRP Owner or a Backup) sends Hello messages by default.</p>	Disabled 60 seconds when enabled
Track port	<p>Another Layer 3 switch port or virtual interface whose link status is tracked by the VRID interface.</p> <p>If the link for a tracked interface goes down, the VRRP or VRRP-E priority of the VRID interface is changed, causing the devices to renegotiate for the Master.</p> <p>NOTE Track port is not supported by IPv6 VRRP v3 owner.</p>	None
Track priority	<p>A VRRP or VRRP-E priority value assigned to the tracked ports. If a tracked port link goes down, the VRID port VRRP or VRRP-E priority changes:</p> <ul style="list-style-type: none"> • VRRP - The priority changes to the value of the tracked port priority. • VRRP-E - The VRID port priority is reduced by the amount of the tracked port priority. <p>NOTE Track priority is not supported by VRRP v3.</p>	VRRP - 2 VRRP-E - 5
Backup preempt mode	Prevents a Backup with a higher VRRP priority from taking control of the VRID from another Backup that has a lower priority but has already assumed control of the VRID.	Enabled
Timer scale	Adjusts the timers for the Hello interval, Dead interval, Backup Hello interval, and Hold-down interval.	1
VRRP-E slow start timer	Causes a specified amount of time to elapse between the time the original Master is restored and when it takes over from the	Disabled

TABLE 104 VRRP and VRRP-E parameters (continued)

Parameter	Description	Default
	Backup. This interval allows time for OSPF convergence when the Master is restored. For VRRP-E only.	
Short-path forwarding	Enables VRRP-E extension for server virtualization. If enabled, the traffic that is destined to the clients travels through the short-path forwarding path to reach the client. With Short-Path-Fowarding enabled, a Brocade device bypasses the VRRP-E Master router and directly forward packets to their destinations through interfaces on the Backup router if it is the shortest path to the destination.	Disabled

Note regarding disabling VRRP or VRRP-E

NOTE

Disabling VRRP or VRRP-E is supported by IPv4 VRRP v2, and IPv6 VRRP and IPv6 VRRP-E v3.

If you disable VRRP or VRRP-E, the Layer 3 switch removes all the configuration information for the disabled protocol from the running-config file. Moreover, when you save the configuration to the startup-config file after disabling one of these protocols, all the configuration information for the disabled protocol is removed from the startup-config file.

The CLI displays a warning message such as the following.

```
Brocade Router1(config-vrrp-router)#no router vrrp
router vrrp mode now disabled. All vrrp config data will be lost when writing to flash!
```

If you have disabled the protocol but have not yet saved the configuration to the startup-config file and reloaded the software, you can restore the configuration information by re-entering the command to enable the protocol (for example, **router vrrp**). If you have already saved the configuration to the startup-config file and reloaded the software, the information is gone.

If you are testing a VRRP or VRRP-E configuration and are likely to disable and re-enable the protocol, you may want to make a backup copy of the startup-config file containing the protocol configuration information. This way, if you remove the configuration information by saving the configuration after disabling the protocol, you can restore the configuration by copying the backup copy of the startup-config file onto the flash memory.

Basic VRRP parameter configuration

To implement a simple VRRP configuration using all the default values, enter the commands shown in the following sections.

Configuration rules for VRRP

- The interfaces of all routers in a VRID must be in the same IP subnet.
- The IP addresses associated with the VRID must already be configured on the router that will be the Owner.
- An IP address associated with the VRID must be on only one router.
- The Hello interval must be set to the same value on the Owner and Backup routers for the VRID.
- The dead interval must be set to the same value on the Owner and Backup routers for the VRID.

- The track priority on a router must be lower than the router VRRP priority. Also, the track priority on the Owner must be higher than the track priority on the Backup routers.

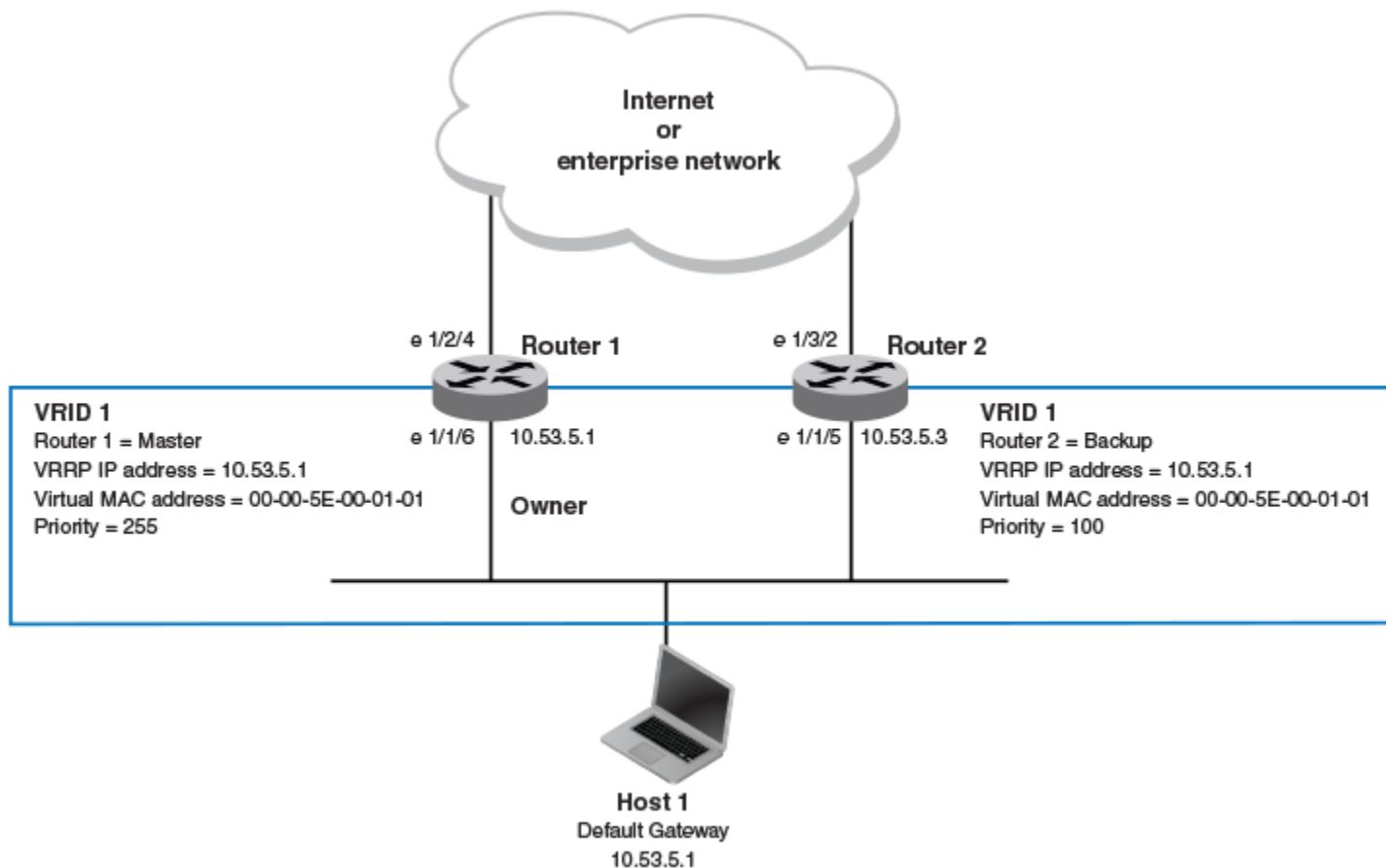
NOTE

When you use the **router vrrp** or the **ipv6 router vrrp** command to enter the VRRP configuration mode, the command prompt does not change and results in the following general configuration command prompt: `(config) #`. This differs from entering the VRRP extended mode, where entering the **router vrrp-extended** command results in a command prompt such as the following: `(config-vrrpe-router) #`. For IPv6 VRRP extended mode, when entering the **ipv6 router vrrp-extended** command, this results in a command prompt such as the following: `(config-ipv6-vrrpe-router) #`.

Enabling an owner VRRP device

This task is performed on the device that is designated as the owner VRRP device because the IP address of one of its physical interfaces is assigned as the IP address of the virtual router. For example, Router 1 is the owner VRRP device In the diagram below. For each VRRP session there are master and backup routers, the owner router is elected, by default, as the master router.

FIGURE 36 Basic VRRP topology



1. On the device designated as the owner VRRP device, from privileged EXEC mode, enter configuration mode by issuing the **configure terminal** command.

```
device# configure terminal
```

2. Globally enable the VRRP protocol.

```
device(config)# router vrrp
```

3. Configure the ethernet interface link for Router 1.

```
device(config)# interface ethernet 1/1/6
```

4. Configure the IP address of the interface.

```
device(config-if-e1000-1/1/6)# ip address 10.53.5.1/24
```

5. Assign Router 1 to the virtual router ID (VRID) 1.

```
device(config-if-e1000-1/1/6)# ip vrrp vrid 1
```

NOTE

You can assign a VRID number in the range of 1 through 255.

6. Designate this router as the VRRP owner device.

```
device(conf-if-e1000-1/1/6-vrid-1)# owner
```

7. Configure the VRRP version.

```
device(conf-if-e1000-1/1/6-vrid-1)# version 2
```

8. Configure the IP address of the VRID.

```
device(conf-if-e1000-1/1/6-vrid-1)# ip-address 10.53.5.1
```

9. Enable the VRRP session.

```
device(conf-if-e1000-1/1/6-vrid-1)# activate
```

The following example configures a VRRP owner device.

```
device# configure terminal
device(config)# router vrrp
device(config)# interface ethernet 1/1/6
device(conf-if-e1000-1/1/6)# ip address 10.53.5.1/24
device(conf-if-e1000-1/1/6)# ip vrrp vrid 1
device(conf-if-e1000-1/1/6-vrid-1)# owner
device(conf-if-e1000-1/1/6-vrid-1)# version 2
device(conf-if-e1000-1/1/6-vrid-1)# ip-address 10.53.5.1
device(conf-if-e1000-1/1/6-vrid-1)# activate
VRRP router 1 for this interface is activating
```

Enabling an IPv6 VRRPv3 owner device

This task is performed on the device that is designated as the owner VRRP device because the IPv6 address of one of its physical interfaces is assigned as the IP address of the virtual router. For each VRRP session there are master and backup routers, the owner router is elected, by default, as the master router.

NOTE

When implementing IPv6 VRRPv3 across a network with devices from other vendors, be aware of a potential interoperability issue with IPv6 VRRPv3 and other vendor equipment. Brocade has implemented IPv6 VRRPv3 functionality to comply with RFC 5798 and will interoperate comfortably with other vendors that support RFC 5798.

1. On the device designated as the owner VRRP device, from privileged EXEC mode, enter configuration mode by issuing the **configure terminal** command.

```
device# configure terminal
```

2. Before enabling IPv6 VRRP, you must globally enable IPv6 routing.

```
device(config)# ipv6 unicast-routing
```

3. Globally enable the IPv6 VRRP protocol.

```
device(config)# ipv6 router vrrp
```

4. Configure the ethernet interface link for the owner device.

```
device(config)# interface ethernet 1/1/5
```

VRRP and VRRP-E

Basic VRRP parameter configuration

- Configure the IPv6 address of the interface.

```
device(config-if-e1000-1/1/5)# ipv6 address 3013::2/64
```

- Assign the owner device to the virtual router ID (VRID) 2.

```
device(conf-if-e1000-1/1/5)# ipv6 vrrp vrid 2
```

NOTE

You can assign a VRID number in the range of 1 through 255.

- Designate this router as the VRRP owner device.

```
device(conf-if-e1000-1/1/5-vrid-1)# owner
```

- Configure the VRRP version.

```
device(conf-if-e1000-1/1/5-vrid-2)# version 3
```

- Assign an IPv6 link-local address to the VRID for use in the local network.

```
device(conf-if-e1000-1/1/5-vrid-2)# ipv6-address fe80::768e:f8ff:fe2a:0099
```

- Assign a global IPv6 address to the VRID.

```
device(conf-if-e1000-1/1/5-vrid-2)# ipv6-address 3013::2
```

- Enable the VRRP session.

```
device(conf-if-e1000-1/1/5-vrid-2)# activate
```

The following example configures a VRRP owner device.

```
device# configure terminal
device(config)# ipv6 unicast-routing
device(config)# ipv6 router vrrp
device(config-ipv6-vrrp-router)# interface ethernet 1/1/5
device(conf-if-e1000-1/1/5)# ipv6 address 3013::2/64
device(conf-if-e1000-1/1/5)# ipv6 vrrp vrid 2
device(conf-if-e1000-1/1/5-vrid-2)# owner
device(conf-if-e1000-1/1/5-vrid-2)# version 3
device(conf-if-e1000-1/1/5-vrid-2)# ipv6-address fe80::768e:f8ff:fe2a:0099
device(conf-if-e1000-1/1/5-vrid-2)# ipv6-address 3013::2
device(conf-if-e1000-1/1/5-vrid-2)# activate
```

Enabling a backup VRRP device

This task is performed on any device that is designated as a backup VRRP device. For each VRRP virtual routing instance there is one master device and all other devices are backups. For example, Router 2 in [Figure 36](#) on page 524 is assigned as a backup device. Repeat this task for all devices that are to be designated as backup devices.

- On the device designated as a backup VRRP device, from privileged EXEC mode, enter configuration mode by issuing the **configure terminal** command.

```
device# configure terminal
```

- Globally enable the VRRP protocol.

```
device(config)# router vrrp
```

3. Configure the ethernet interface link.

```
device(config)# interface ethernet 1/1/5
```

4. Configure the IP address of the interface for Router 2. All devices configured for the same virtual router ID (VRID) must be on the same subnet.

```
device(conf-if-e1000-1/1/5)# ip address 10.53.5.3/24
```

5. Assign Router 2 to VRID 1, the same VRID as Router 1.

```
device(conf-if-e1000-1/1/5)# ip vrrp vrid 1
```

NOTE

You can assign a VRID number in the range of 1 through 255.

6. Designate this router as a backup VRRP device.

```
device(conf-if-e1000-1/1/5-vrid-1)# backup priority 110
```

While configuring a backup device, you can set a priority that is used when a master VRRP device goes offline. The backup device with the highest priority will assume the role of master device.

7. Configure the VRRP version.

```
device(conf-if-e1000-1/1/5-vrid-1)# version 2
```

8. Configure the number of seconds between hello messages.

```
device(conf-if-e1000-1/1/5-vrid-1)# hello-interval 10
```

9. By default, backup VRRP devices do not send hello messages to advertise themselves to the master. Use the following command to enable a backup router to send hello messages to the master VRRP device.

```
device(conf-if-e1000-1/1/5-vrid-1)# advertise backup
```

10. Configure the IP address of the VRID.

```
device(conf-if-e1000-1/1/5-vrid-1)# ip-address 10.53.5.1
```

The VRID IP address is the same virtual IP addresses you used for Router 1.

11. Enable the VRRP session.

```
device(conf-if-e1000-1/1/5-vrid-1)# activate
VRRP router 1 for this interface is activating
```

The following example configures a VRRP owner device.

```
device# configure terminal
device(config)# router vrrp
device(config)# interface ethernet 1/1/5
device(conf-if-e1000-1/1/5)# ip address 10.53.5.3/24
device(conf-if-e1000-1/1/5)# ip vrrp vrid 1
device(conf-if-e1000-1/1/5-vrid-1)# backup priority 110
device(conf-if-e1000-1/1/5-vrid-1)# version 2
device(conf-if-e1000-1/1/5-vrid-1)# hello-interval 10
device(conf-if-e1000-1/1/5-vrid-1)# advertise backup
device(conf-if-e1000-1/1/5-vrid-1)# ip-address 10.53.5.1
device(conf-if-e1000-1/1/5-vrid-1)# activate
VRRP router 1 for this interface is activating
```

Enabling an IPv6 VRRPv3 backup device

This task is performed on all the devices that are designated as backup VRRPv3 devices. Initially a backup priority is set to 100. For each VRRPv3 session there are master and backup routers, the IPv6 address assigned here to the VRID is the IPv6 address of the master router. The task is repeated on each backup VRRPv3 device with corresponding changes to the interface number and IPv6 address of the interface.

NOTE

When implementing IPv6 VRRPv3 across a network with devices from other vendors, be aware of a potential interoperability issue with IPv6 VRRPv3 and other vendor equipment. Brocade has implemented IPv6 VRRPv3 functionality to comply with RFC 5798 and will interoperate comfortably with other vendors that support RFC 5798.

1. On the device designated as a backup VRRPv3 device, from privileged EXEC mode, enter configuration mode by issuing the **configure terminal** command.

```
device# configure terminal
```

2. Globally enable the IPv6 VRRP protocol.

```
device(config)# ipv6 router vrrp
```

3. Configure the ethernet interface link for the owner device.

```
device(config)# interface ethernet 1/1/4
```

4. Configure the IPv6 address of the interface.

```
device(config-if-e1000-1/1/4)# ipv6 address 3013::3/64
```

5. Assign the backup device to the virtual router ID (VRID) 2.

```
device(conf-if-e1000-1/1/4)# ipv6 vrrp vrid 2
```

NOTE

You can assign a VRID number in the range of 1 through 255.

6. Designate this router as the VRRPv3 backup device and assign a priority of 100.

```
device(conf-if-e1000-1/1/4-vrid-1)# backup priority 100
```

7. Configure the VRRP version.

```
device(conf-if-e1000-1/1/4-vrid-2)# version 3
```

8. By default, backup VRRP devices do not send hello messages to advertise themselves to the master. Use the following command to enable a backup router to send hello messages to the master VRRP device.

```
device(conf-if-e1000-1/1/4-vrid-1)# advertise backup
```

9. Assign the IPv6 link-local address to the VRID for use in the local network.

```
device(conf-if-e1000-1/1/4-vrid-2)# ipv6-address fe80::768e:f8ff:fe2a:0099
```

10. Assign the global IPv6 address to the VRID.

```
device(conf-if-e1000-1/1/4-vrid-2)# ipv6-address 3013::2
```

11. Enable the VRRP session.

```
device(conf-if-e1000-1/1/4-vrid-2) # activate
```

The following example configures an IPv6 VRRPv3 backup device.

```
device# configure terminal
device(config)# ipv6 router vrrp
device(config-ipv6-vrrp-router)# interface ethernet 1/1/4
device(config-if-e1000-1/1/4)# ipv6 address 3013::3/64
device(config-if-e1000-1/1/4)# ipv6 vrrp vrid 2
device(config-if-e1000-1/1/4-vrid-2)# backup priority 100
device(config-if-e1000-1/1/4-vrid-2)# version 3
device(config-if-e1000-1/1/4-vrid-1)# advertise backup
device(config-if-e1000-1/1/4-vrid-2)# ipv6-address fe80::768e:f8ff:fe2a:0099
device(config-if-e1000-1/1/4-vrid-2)# ipv6-address 3013::2
device(config-if-e1000-1/1/4-vrid-2)# activate
```

Assigning an auto-generated link-local IPv6 address for a VRRPv3 cluster

The default VRRPv3 implementation allows only the link-local address that is configured on a physical interface, to be used as the virtual IPv6 address of a VRRPv3 instance. This limits configuring a link-local address for each VRRP instance on the same physical interface because there can be only one link-local address per physical interface.

To auto-generate and assign a virtual link-local IPv6 address as the virtual IPv6 address of a VRRPv3 cluster, use the **ipv6-address auto-gen-link-local** command in the VRRP configuration mode of the owner or backup router.

The following example shows the auto-generation of a virtual link-local IPv6 address and its allocation as the virtual IPv6 address of a VRRPv3 cluster on an owner router.

```
Brocade(config)# interface ve 3
Brocade(config-vif-3)# ipv6 vrrp vrid 2
Brocade(config-vif-3-vrid-2)# owner
Brocade(config-vif-3-vrid-2)# ipv6-address auto-gen-link-local
Brocade(config-vif-3-vrid-2)# activate
```

Enabling the v2 checksum computation method in a VRRPv3 IPv4 session

Configuring an alternate VRRPv2-style checksum in a VRRPv3 IPv4 session for compatibility with third-party network devices.

VRRPv3 uses the v3 checksum computation method by default for both IPv4 and IPv6 sessions on Brocade devices. Third-party devices may only have a VRRPv2-style checksum computation available for a VRRPv3 IPv4 session. The **use-v2-checksum** command is entered in interface configuration mode.

1. Use the **configure** command to enter global configuration mode.

```
device# configure
```

2. To enable VRRP globally enter the **router vrrp** command.

```
device(config)# router vrrp
```

3. Enter the **interface** command with an interface type and number.

```
device(config)# interface ethernet 1/2/4
```

VRRP and VRRP-E

Basic VRRP parameter configuration

4. To configure a VRRP virtual routing ID use the **ip vrrp vrid** command with an associated ID number.

```
device(config-if-e10000-1/2/4)# ip vrrp vrid 14
```

5. To enable VRRP version 3 (VRRPv3) enter the **version** command with version number of v3.

```
device(config-if-e10000-1/2/4-vrid-14)# version v3
```

6. To enable v2 checksum computation method in an IPv4 VRRPv3 session, use the **use-v2-checksum** command in the VRRP configuration mode.

```
device(config-if-e10000-1/2/4-vrid-14)# use-v2-checksum
```

7. Enter the IP address for the interface using the **ip-address** command.

```
device(config-if-e10000-1/2/4-vrid-14)# ip-address 10.14.14.99
```

8. To activate the interface, enter the **activate** command.

```
device(config-if-e10000-1/2/4-vrid-14)# activate
```

The following example shows the v2 checksum computation method enabled for an VRRPv3 IPv4 session on a Brocade device.

```
device# config
device(config)# router vrrp
device(config)# ethernet 1/2/4
device(config-if-e10000-1/2/4)# ip vrrp vrid 14
device(config-if-e10000-1/2/4-vrid-14)# version v3
device(config-if-e10000-1/2/4-vrid-14)# use-v2-checksum
device(config-if-e10000-1/2/4-vrid-14)# ip-address 10.14.14.99
device(config-if-e10000-1/2/4-vrid-14)# activate
```

Enabling accept mode in VRRP non-Owner Master router

To configure a non-Owner Master router to respond to ping, traceroute, and Telnet packets destined for the virtual IPv4 or IPv6 address of a VRRP cluster, use the **accept-mode** command in the VRRP configuration mode.

The following example shows the configuration of accept mode on an IPv6 Backup router.

```
Brocade(config)# interface ve 3
Brocade(config-vif-3)# ipv6 vrrp vrid 2
Brocade(config-vif-3-vrid-2)# backup
Brocade(config-vif-3-vrid-2)# advertise backup
Brocade(config-vif-3-vrid-2)# ipv6-address 2001:DB8::1
Brocade(config-vif-3-vrid-2)# accept-mode
Brocade(config-vif-3-vrid-2)# activate
```

Configuration considerations for IPv6 VRRP and IPv6 VRRP-E support on Ruckus devices

Consider the following when enabling IPv6 VRRP mode and IPv6 VRRP-E mode on Ruckus devices:

- You can configure only one protocol (Layer 3 VSRP, VRRP, or VRRP-E) on a router at a single time. However, VRRP or VRRP-E can be configured with IPv4 and IPv6 concurrently on a router.
- Scale timer configuration does not affect timer values, nor does it scale timer values for virtual routers configured with sub-second time values for IPv6 VRRP and IPv4 VRRP modes.

- Abdication of a VRRP Owner router in an IPv6 environment is not supported. Abdication of an Owner router is a Ruckus-specific enhancement to VRRP. Abdication of an Owner router is possible by changing the Owner's priority, or by configuring track ports for an Owner router.
 - For IPv6 VRRP only, the tracking port configuration is not allowed if the router is configured as the VRRP Owner. This conforms to RFC 5798.
 - For the IPv6 VRRP Owner router only, the priority configuration is not allowed. The Owner router priority is always 255. This conforms to RFC 5798.
- Interoperability is not supported for a VRID when VRRP routers are configured as VRRP v2 or v3.
- Ruckus does not recommend reuse of the same VRID across IPv6 VRRP or IPv4 VRRP or in the same broadcast domain.
- There is no specified restriction for configuring VRRP or VRRP-E instances if they are within the maximum VRID range.

Basic VRRP-E parameter configuration

The following sections describe the configuration of the parameters specific to IPv4 and IPv6 VRRP-E.

Configuration rules for VRRP-E

Consider the following rules when configuring VRRP-E:

- The interfaces of all routers in a VRID must be in the same IP subnet.
- The IP address associated with the VRID cannot be configured on any of the Layer 3 switches.
- The Hello interval must be set to the same value with in the same VRID.
- The dead interval must be set to the same value with in the same VRID.
- The track priority for a VRID must be lower than the VRRP-E priority.

Configuring IPv4 VRRP-E

VRRP-E is configured at the interface level. To implement a simple IPv4 VRRP-E configuration using all the default values, enter commands such as the following on each Layer 3 switch.

```
Brocade(config)#router vrrp-extended
Brocade(config)#interface ethernet 1/1/5
Brocade(config-if-1/1/5)#ip-address 192.53.5.3
Brocade(config-if-1/1/5)#ip vrrp-extended vrid 1
Brocade(config-if-1/1/5-vrid-1)#backup
Brocade(config-if-1/1/5-vrid-1)#advertise backup
Brocade(config-if-1/1/5-vrid-1)#ip-address 192.53.5.254
Brocade(config-if-1/1/5-vrid-1)#activate
```

Syntax: [no] router vrrp-extended

Syntax: [no] ip-address ip-address

Syntax: [no] ip vrrp-extended vrid vrid

Syntax: no backup [priority value] [track-priority value]

Syntax: [no] advertise backup

Syntax: [no] activate

The *vrid* variable specifies the virtual router ID.

VRRP and VRRP-E

Basic VRRP-E parameter configuration

The *ip-address* variable specifies the IPv4 address of the router.

You must identify a VRRP-E router as a Backup before you can activate the virtual router on a Ruckus device. However, after you configure the virtual router, you can use the **backup** command to change its priority or track priority.

The **priority value** option specifies the IPv4 VRRP-E priority for this virtual Backup router. You can specify a value from 3 through 254. The default is 100.

The **track-priority value** option changes the track port priority of a Backup router. You can specify a value from 1 through 254. The default is 5.

NOTE

You also can use the **enable** command to activate the configuration. This command does the same thing as the **activate** command.

Configuring IPv6 VRRP-E

To implement an IPv6 VRRP-E configuration using all the default values, enter the following commands.

NOTE

You must first configure the **ipv6 unicast-routing** command at the global configuration level to enable IPv6 VRRP-E on the router.

```
Brocade(config)# ipv6 unicast-routing
Brocade(config)# ipv6 router vrrp-extended
Brocade(config-ipv6-VRRP-E-router)# interface ethernet 1/1/5
Brocade(config-if-e10000-1/1/5)# ipv6-address 2001:DB8::2/64
Brocade(config-if-e10000-1/1/5)# ipv6 vrrp-extended vrid 1
Brocade(config-if-e10000-1/1/5-vrid-1)# backup priority 50 track-priority 10
Brocade(config-if-e10000-1/1/5-vrid-1)# ipv6-address 2001:DB8::99
Brocade(config-if-e10000-1/1/5-vrid-1)# activate
```

Syntax: [no] **ipv6 unicast-routing**

Syntax: [no] **ipv6 router vrrp-extended**

Syntax: [no] **ipv6-address** *ipv6-address*

Syntax: [no] **ipv6 vrrp-extended vrid** *vrid*

Syntax: [no] **backup** [**priority** *value*] [**track-priority** *value*]

Syntax: [no] **activate**

The *vrid* variable specifies the virtual router ID.

The *ipv6-address* variable specifies the IPv6 address of the router.

You must identify a VRRP-E router as a Backup before you can activate the virtual router on a Ruckus device. However, after you configure the virtual router, you can use the **backup** command to change its priority or track priority.

The **priority value** option specifies the IPv6 VRRP-E priority for this virtual Backup router. You can specify a value from 3 through 254. The default is 100.

The **track-priority value** option changes the track port priority of a Backup router. You can specify a value from 1 through 254. The default is 5.

NOTE

You also can use the **enable** command to activate the configuration. This command does the same thing as the **activate** command.

Additional VRRP and VRRP-E parameter configuration

You can modify the following VRRP and VRRP-E parameters on an individual VRID basis. These parameters apply to both protocols:

- Authentication type (if the interfaces on which you configure the VRID use authentication)
- Router type (Owner or Backup)

NOTE

For VRRP, change the router type only if you have moved the real IP address from one router to another or you accidentally configured the IP address Owner as a Backup. For VRRP-E, the router type is always Backup. You cannot change the type to Owner.

- Suppression of RIP advertisements on Backup routes for the backed-up interface
- Hello interval
- Dead interval
- Backup Hello messages and message timer (Backup advertisement)
- Track port
- Track priority
- Backup preempt mode
- Timer scale
- VRRP-E slow start timer
- VRRP-E extension for server virtualization (short-path forwarding)

VRRP and VRRP-E authentication types

This section describes VRRP and VRRP-E authentication parameters.

Configuring authentication type

The Ruckus implementation of VRRP and VRRP-E supports the following authentication types for authenticating VRRP and VRRP-E traffic:

- No authentication - The interfaces do not use authentication. This is the default for VRRP and VRRP-E both for IPv4 and IPv6.
- Simple - The interfaces use a simple text-string as a password in packets sent on the interface.
- All interfaces on the same VRID must use the same authentication type and the same password.

IPv4 VRRP-E and IPv6 VRRP-E supports the following authentication type:

- **HMAC-MD5-96** - The interfaces use HMAC-MD5-96 authentication for VRRP-E packets.

NOTE

HMAC-MD5-96 authentication is not supported for VRRP.

To configure the VRID interface on Switch 1 for simple password authentication using the password "ourpword", enter the following commands.

Configuring Switch 1

```
device Switch1(config)#interface ethernet 1/1/6
device Switch1(config-if-1/1/6)#ip vrrp auth-type simple-text-auth ourpwd
```

VRRP syntax

Syntax: **auth-type no-auth | simple-text-auth** *auth-data*

The **auth-type no-auth** option indicates that the VRID and the interface it is configured on do not use authentication.

The **simple-text-auth** *auth-data* option indicates that the VRID and the interface it is configured on use a simple text password for authentication. The *auth-data* variable is the password. If you use this variable, make sure all interfaces on all the routers supporting this VRID are configured for simple password authentication and use the same password.

NOTE

For VRRP v3, authentication is deprecated by RFC 5768.

VRRP-E syntax

For IPv4 VRRP-E:

Syntax: **ip vrrp-extended auth-type no-auth | simple-text-auth** *auth-data* | **md5-auth [0 | 1] key**

For IPv6 VRRP-E:

Syntax: **ipv6 vrrp-extended auth-type no-auth | simple-text-auth** *auth-data* | **md5-auth [0 | 1] key**

The values for the **no-auth** and **simple-text-auth** *auth-data* options are the same as for VRRP.

The **md5-auth** option configures the interface to use HMAC-MD5-96 for VRRP-E authentication.

The *key* variable is the MD5 encryption key, which can be up to 64 characters long. The optional **0** or **1** parameters configure whether the MD5 password is encrypted, as follows:

- If you do not enter this parameter and enter the key as clear text, the key appears encrypted in the device configuration and command outputs.
- If you enter **0** and enter the key as clear text, the key appears as clear text in the device configuration and command outputs.
- If you enter **1** and enter the key in encrypted format, the key appears in encrypted format in the device configuration and command outputs.

Syslog messages for VRRP-E HMAC-MD5-96 authentication

If an interface is configured with HMAC-MD5-96 authentication, all VRRP-E packets received on this interface are authenticated with the HMAC-MD5-96 algorithm using the shared secret key configured on the interface.

If a packet is received that fails this HMAC-MD5-96 authentication check, the packet gets dropped. Additionally, if syslog is enabled, a syslog message is generated to notify the administrator about an authentication failure. The message includes the VRID received in the packet's VRRP message and the interface on which the packet was received. These syslog messages will be rate limited to 20 log messages within a span of 5 minutes, starting from the first packet received that fails the HMAC-MD5-96 authentication check.

For Example:

```
SYSLOG: <13>Apr 30 14:14:57 ICX6610 VRRP: VRRPE authentication failure, intf v555, vrid 55, auth_type MD5
authentication
SYSLOG: <13>Apr 30 14:14:58 ICX6610 VRRP: VRRPE authentication failure, intf v555, vrid 55, auth_type MD5
```

```
authentication
SYSLOG: <13>Apr 30 14:14:59 ICX6610 VRRP: VRRPE authentication failure, intf v555, vrid 55, auth_type MD5
authentication
```

VRRP router type

A VRRP interface is either an Owner or a Backup router for a given VRID. By default, the Owner becomes the Master. A Backup router becomes the Master only if the Master becomes unavailable.

A VRRP-E interface is always a Backup router for its VRID. The Backup router with the highest VRRP priority becomes the Master.

This section describes how to specify the interface type, how to change the type for VRRP, and how to set or change the interface VRRP or VRRP-E priority and track priority for the VRID.

NOTE

You can force a VRRP Master router to abdicate (give away control) of the VRID to a Backup router by temporarily changing the Master VRRP priority to a value less than the Backup.

NOTE

The Owner type is not applicable to VRRP-E.

NOTE

For VRRP, the IP address you associate with the Owner must be real IP address on the interface where the VRIS is configured. To configure a Backup router, the interface must have a real IP address that is in the same subnet the Owner. The address must be unique.

Configuring Router 1 as VRRP VRID Owner

To configure Router1 as a VRRP VRID Owner, enter the following commands.

```
Router1(config)# interface ethernet 1/1/6
Router1(config)# ip address 10.1.1.1/24
Router1(config-if-1/1/6)# ip vrrp vrid 1
Router1(config-if-1/1/6-vrid-1)# owner
Router1(config-if-1/1/6-vrid-1)# ip-address 10.1.1.1
Router1(config-if-1/1/6-vrid-1)# activate
```

Configuring Router 2 as VRRP Backup

To configure Router2 as a VRRP Backup for the same VRID, enter the following commands.

```
device Router2(config)# interface ethernet 1/1/6
device Router2(config-if-1/1/6)# ip address 10.1.1.2/24
device Router2(config-if-1/1/6)# ip vrrp vrid 1
device Router2(config-if-1/1/6-vrid-1)# backup
device Router2(config-if-1/1/6-vrid-1)# ip-address 10.1.1.1
device Router2(config-if-1/1/6-vrid-1)# activate
```

Configuring Router 1 as IPv6 VRRP VRID Owner

To configure Router1 as a IPv6 VRRP VRID Owner, enter the following commands:

```
device Router1(config)# interface ethernet 1/1/7
device Router1(config-if-e1000-1/1/7)#ipv6 address 2002:AB3::1/64
device Router1(config-if-e1000-1/1/7)#ipv6 vrrp vrid 1
device Router1(config-if-e1000-1/1/7-vrid-1)#owner
device Router1(config-if-e1000-1/1/7-vrid-1)#ipv6-address 2002:AB3::1
device Router1(config-if-e1000-1/1/7-vrid-1)#activate
```

VRRP and VRRP-E

Additional VRRP and VRRP-E parameter configuration

Configuring Router 2 as IPv6 VRRP backup for a VRID

To configure an IPv6 VRRP interface as a Backup for a VRID, and set its backup and track priority, enter the following:

```
device Router2(config)# interface ethernet 1/1/7
device Router2(config-if-e1000-1/1/7)#ipv6 address 2002:AB3::2/64
device Router2(config-if-e1000-1/1/7)#ipv6 vrrp vrid 1
device Router2(config-if-e1000-1/1/7-vrid-1)#backup priority 50 track-priority 10
device Router2(config-if-e1000-1/1/7-vrid-1)#ipv6-address 2002:AB3::1
device Router2(config-if-e1000-1/1/7-vrid-1)#activate
```

Suppression of RIP advertisements

NOTE

Suppression of RIPng advertisements on Backup routers for the backup interface is not supported by IPv6 VRRP v3 and IPv6 VRRP-E v3.

Normally, a VRRP or VRRP-E Backup includes route information for the virtual IP address (the backed-up interface) in RIP advertisements. As a result, other routers receive multiple paths for the backed-up interface and might sometimes unsuccessfully use the path to the Backup router rather than the path to the Master.

You can prevent the Backup routers from advertising route information for the backed-up interface by enabling suppression of the advertisements.

Suppressing RIP advertisements for the backed-up interface in Router 2

To suppress RIP advertisements for the backed-up interface in Router 2, enter the following commands.

```
device Router2(config)#router rip
device Router2(config-rip-router)#use-vrrp-path
```

Syntax: use-vrrp-path

The syntax is the same for VRRP and VRRP-E.

Hello interval configuration

The Master periodically sends Hello messages to the Backup routers. The Backup routers use the Hello messages as verification that the Master is still online. If the Backup routers stop receiving the Hello messages for the period of time specified by the dead interval, the Backup routers determine that the Master router is dead. At this point, the Backup router with the highest priority becomes the new Master router.

NOTE

If the value for the dead interval is not configured, then the current dead interval is equal to three times the Hello interval plus the Skew time (where Skew time is equal to $(256 - \text{priority}) / 256$). Generally, if you change the Hello interval, you also should change the dead interval on the Backup routers.

To change the Hello interval on the Master to 10 seconds, enter the following commands.

```
device Router1(config)#interface ethernet 1/1/6
device Router1(config-if-1/1/6)#ip vrrp vrid 1
device Router1(config-if-1/1/6-vrid-1)#hello-interval 10
```

Syntax: [no] hello-interval seconds

The seconds variable specifies the Hello interval value from 1 through 84 seconds for IPv4 VRRP, VRRP-E, and IPv6 VRRP-E and 1 through 40 seconds for IPv4 VRRPv3. The default is 1 second.

To change the Hello interval on the Master to 200 milliseconds for IPv6 VRRP, enter the following commands.

```
device Router1(config)# interface ethernet 1/1/6
device Router1(config-if-1/1/6)# ipv6 vrrp vrid 1
device Router1(config-if-1/1/6-vrid-1)# hello-interval 200
```

Syntax: [no] **hello-interval** *milliseconds*

The *milliseconds* variable can be 100 milliseconds interval only. The default is 1000 milliseconds, and the range is 100 to 40900 milliseconds.

To change the Hello interval on the Master to 200 milliseconds for IPv4 VRRPv3, enter the following commands.

```
Router1(config)# interface ethernet 1/1/6
Router1(config-if-1/1/6)# ipv6 vrrp vrid 1
Router1(config-if-1/1/6-vrid-1)# hello-interval msec 200
```

Syntax: [no] **hello-interval msec** *milliseconds*

IPv4 VRRPv2 supports the hello-interval configuration in seconds, while IPv6 VRRP supports this configuration in milliseconds; both use the CLI **hello-interval xxx**. However IPv4 VRRPv3 supports both the seconds and milliseconds configuration using the **hello-interval xxx** and **hello-interval msec xxx** commands respectively.

Dead interval configuration

The dead interval is the number of seconds a Backup router waits for a Hello message from the Master before determining that the Master is dead. When Backup routers determine that the Master is dead, the Backup with the highest priority becomes the new Master.

If the value for the dead interval is not configured, then the current dead interval is equal to three times the Hello interval plus the Skew time (where Skew time is equal to (256 - priority) divided by 256).

To change the dead interval on a Backup to 30 seconds, enter the following commands.

```
device Router2(config)#interface ethernet 1/1/5
device Router2(config-if-e1000-1/1/5)#ip vrrp vrid 1
device Router2(config-if-e1000-1/1/5-vrid-1)#dead-interval 30
```

Syntax: **dead-interval** *value*

The *value* variable is from 1 through 84 seconds for VRRP v2 and VRRP-E v2. For other versions, the *value* variable is from 100 through 8400 milliseconds. The default is 3600 milliseconds.

NOTE

If the **dead-interval** command is not configured, then a zero value is displayed in the output of the **show ip vrrp** or **show ipv6 vrrp-extended** command.

Backup Hello message state and interval

By default, Backup routers do not send Hello messages to advertise themselves to the Master. You can enable these messages if desired and also change the message interval.

To enable a Backup router to send Hello messages to the Master, enter the following commands.

```
device(config)# router vrrp
device(config)# interface ethernet 1/1/6
device(config-if-1/1/6)# ip vrrp vrid 1
device(config-if-1/1/6-vrid-1)# advertise backup
```

Syntax: [no] **advertise backup**

VRRP and VRRP-E

Additional VRRP and VRRP-E parameter configuration

When you enable a Backup to send Hello messages, the Backup sends a Hello message to the Master every 60 seconds by default. You can change the interval to be up to 3600 seconds. To change the Hello message interval, enter the following commands.

```
device(config)# router vrrp
device(config)# interface ethernet 1/1/6
device(config-if-1/1/6)# ip vrrp vrid 1
device(config-if-1/1/6-vrid-1)# backup-hello-interval 180
```

Syntax: [no] **backup-hello-interval num**

The *num* variable specifies the message interval and can be from 60 through 3600 seconds. The default is 60 seconds.

The syntax is the same for VRRP v2 and IPv6 VRRP v3, and VRRP-E v2 and IPv6 VRRP-E v3.

Track port configuration

NOTE

Track port is not supported by IPv6 VRRPv3 owner.

You can configure the VRID on one interface to track the link state of another interface on the Layer 3 switch. This capability is quite useful for tracking the state of the exit interface for the path for which the VRID is providing redundancy.

To configure interface 1/1/6 on Router 1 to track interface 1/2/4, enter the following commands.

```
Router1(config)# interface ethernet 1/1/6
Router1(config-if-1/1/6)# ip vrrp vrid 1
Router1(config-if-1/1/6-vrid-1)# track-port ethernet 1/2/4
```

Syntax: **track-port ethernet [unitnum/slotnum/portnum | ve num]**

The syntax is the same for VRRP and VRRP-E.

Track priority configuration

NOTE

Track priority is not supported by IPv6 VRRP v3.

When you configure a VRID to track the link state of other interfaces, and one of the tracked interfaces goes down, the software changes the VRRP or VRRP-E priority of the VRID interface:

- For VRRP, the software changes the priority of the VRID to the track priority, which typically is lower than the VRID priority and lower than the VRID priorities configured on the Backups. For example, if the VRRP interface priority is 100 and a tracked interface with track priority 60 goes down, the software changes the VRRP interface priority to 60.
- For VRRP-E, the software reduces the VRID priority by the amount of the priority of the tracked interface that went down. For example, if the VRRP-E interface priority is 100 and a tracked interface with track priority 60 goes down, the software changes the VRRP-E interface priority to 40. If another tracked interface goes down, the software reduces the VRID priority again, by the amount of the tracked interface track priority.

The default track priority for an Owner for VRRP v2, IPv6 VRRP v3 and for IPv4 VRRP-E and IPv6 VRRP-E, the default track priority is 5. The default track priority for Backup routers is 1.

You enter the track priority value with the **owner** or **backup** command.

Syntax: **owner [track-priority value]**

Syntax: **backup [priority value] [track-priority value]**

The syntax is the same for VRRP and VRRP-E.

Backup preempt configuration

By default, a Backup that has a higher priority than another Backup that has become the Master can preempt the Master, and take over the role of Master. If you want to prevent this behavior, disable preemption.

Preemption applies only to Backups and takes effect only when the Master has failed and a Backup has assumed ownership of the VRID. The feature prevents a Backup with a higher priority from taking over as Master from another Backup that has a lower priority but has already become the Master of the VRID.

Preemption is especially useful for preventing flapping in situations where there are multiple Backups and a Backup with a lower priority than another Backup has assumed ownership, because the Backup with the higher priority was unavailable when ownership changed.

If you enable the non-preempt mode (thus disabling the preemption feature) on all the Backups, the Backup that becomes the Master following the disappearance of the Master continues to be the Master. The new Master is not preempted.

NOTE

In VRRP, regardless of the setting for the preempt parameter, the Owner always becomes the Master again when it comes back online.

To disable preemption on a Backup, enter commands such as the following.

```
device Router1(config)#interface ethernet 1/1/6
device Router1(config-if-1/1/6)#ip vrrp vrid 1
device Router1(config-if-1/1/6-vrid-1)#non-preempt-mode
```

Syntax: [no] non-preempt-mode

The syntax is the same for VRRP and VRRP-E.

Changing the timer scale

NOTE

Changing the timer scale is supported for IPv4 VRRP v2, IPv4 VRRP-E v2, and IPv6 VRRP-E v3. It is not supported for IPv6 VRRP v3.

To achieve sub-second failover times, you can shorten the duration of all scale timers for VSRP, VRRP, and VRRP-E by adjusting the timer scale. The **timerscale** is a value used by the software to calculate the timers. By default, the scale value is 1. If you increase the timer scale, each timer's value is divided by the scale value. Using the timer scale to adjust timer values enables you to easily change all the timers while preserving the ratios among their values.

TABLE 105 Time scale values

Timer	Timer scale	Timer value
Hello interval	1	1 second
	2	0.5 seconds
Dead interval	1	3 seconds
	2	1.5 seconds
Backup Hello interval	1	60 seconds
	2	30 seconds
Hold-down interval	1	2 seconds

TABLE 105 Time scale values (continued)

Timer	Timer scale	Timer value
	2	1 second

If you configure the device to receive its timer values from the Master, the Backup also receives the timer scale value from the Master.

To change the timer scale, enter a command such as the following at the global CONFIG level of the CLI.

```
device(config)# scale-timer 2
```

This command changes the scale to 2. All VSRP, VRRP, and VRRP-E timer values will be divided by 2.

Syntax: [no] **scale-timer** *num*

The *num* variable specifies the multiplier. You can specify a timer scale from 1 through 10. However, Brocade recommends the timer scale of 1 or 2 for VRRP and VRRP-E.

NOTE

Be cautious when configuring the **scale-timer** command in a VRRP or VRRP-E scaled environment. VSRP, VRRP, and VRRP-E are time-sensitive protocols and system behavior cannot be predicted when the timers are scaled.

VRRP-E slow start timer

In a VRRP-E configuration, if a Master router goes down, the Backup router with the highest priority takes over after expiration of the dead interval. When the original Master router comes back up again, it takes over from the Backup router (which became the Master router when the original Master router went down). By default, this transition from Backup back to Master takes place immediately. However, you can configure the VRRP-E slow start timer feature, which causes a specified amount of time to elapse between the time the Master is restored and when it takes over from the Backup. This interval allows time for OSPF convergence when the Master is restored.

To set the IPv4 VRRP-E slow start timer to 30 seconds, enter the following commands.

```
device(config)#router vrrp-extended
device(config-VRRP-E-router)#slow-start 30
```

To set the IPv6 VRRP-E slow start timer to 60 seconds, enter the following commands.

```
device(config)#ipv6 router vrrp-extended
device(config-ipv6-VRRP-E-router)#slow-start 60
```

Syntax: [no] **slow-start** *seconds*

The *seconds* variable specifies a value from 1 through 255.

If the Master subsequently comes back up again, the amount of time specified by the VRRP-E slow start timer elapses (in the IPv4 example, 30 seconds) before the Master takes over from the Backup.

The VRRP-E slow start timer is effective only if the VRRP-E Backup router detects another VRRP-E Master (Standby) router. It is not effective during the initial bootup. The slow start timer is effective on a Backup router if the priority of the Backup router is equal to the configured priority on the Backup state router.

NOTE

The VRRP-E slow start timer applies only to VRRP-E configurations. It does not apply to VRRP configurations.

VRRP-E Extension for Server Virtualization

VRRP-E is enhanced with the VRRP-E Extension for Server Virtualization feature so that the Ruckus device attempts to bypass the VRRP-E Master router and directly forward packets to their destinations through interfaces on the Backup router.

[Short-path forwarding configuration notes](#) on page 541 shows an example of VRRP-E Extension for Server Virtualization. As shown, the virtual servers are dynamically moved between Host Server 1 and Host Server 2. Each time the virtual server is activated, it can be on a different Host Server, and sometimes the traffic crosses the WAN two times before it reaches the client. For example, in the VRRP-E implementation (without VRRP-E Extension for Server Virtualization), traffic from Virtual server 1 to the client at 10.0.0.X was switched to the VRRP-E Master router, then routed back to the VRRP-E Backup router, and then routed to the client (the normal forwarding path).

Short-path forwarding limitation

- Short-path forwarding (SPF) applies to IPv4 on Brocade FSX 800, FSX 1600, and ICX 7750 switches only. SPF is not supported on Brocade FCX or ICX 6xxx switches.

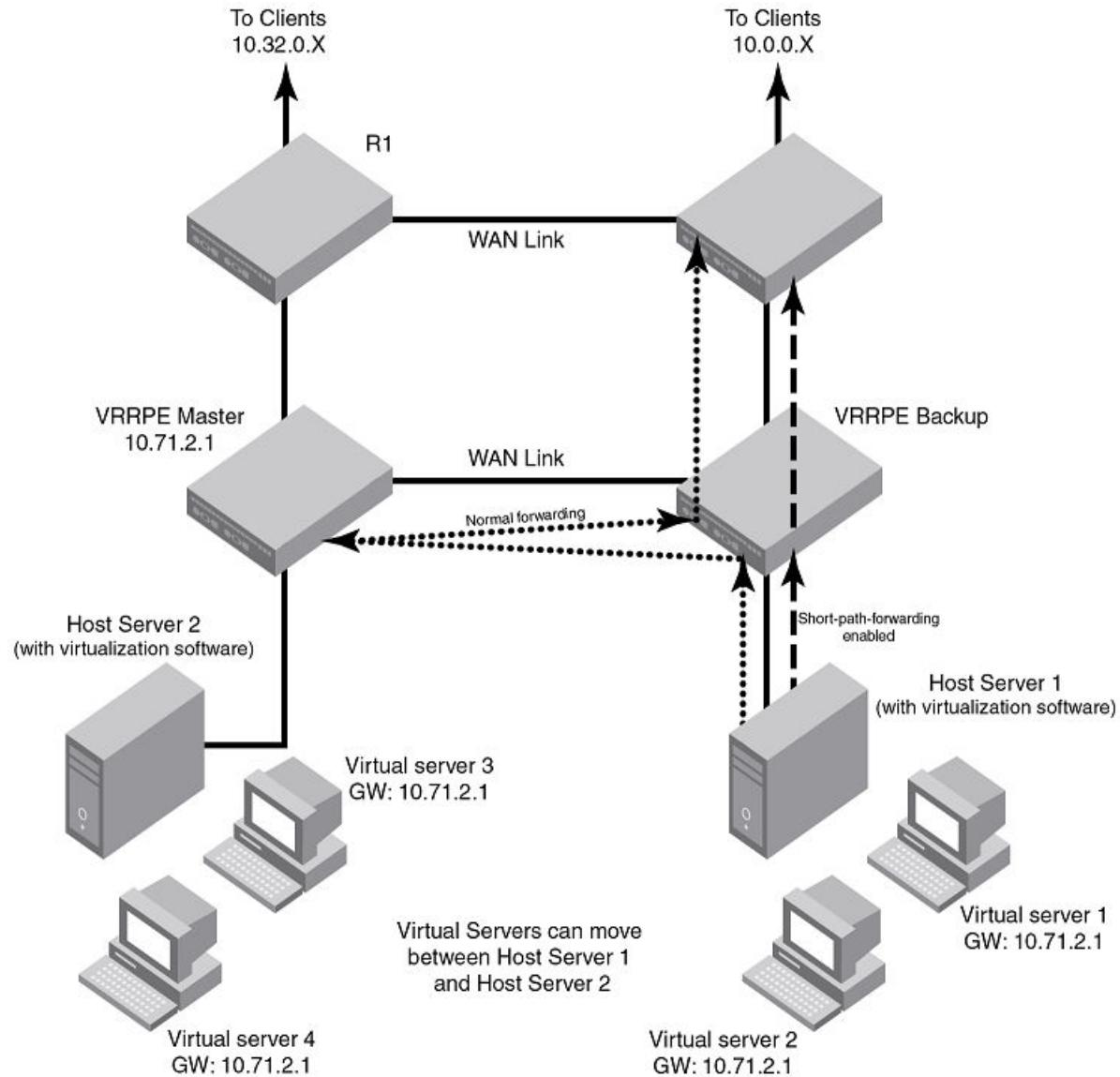
Short-path forwarding configuration notes

- The VRRP-E Master router and Backup router must have routes to all destinations. You should utilize dynamic routing protocols such as Open Shortest Path First (OSPF) on all routers; otherwise, you must configure the static routes.
- Although it is not required, it is recommended that interfaces on different routers with the same VRID have the same SPF configuration. This ensures that the SPF behavior is retained after a failover. Different VRIDs, however, can have different SPF configurations.

VRRP and VRRP-E

Additional VRRP and VRRP-E parameter configuration

FIGURE 37 VRRP-E Extension for short-path forwarding



VRRP-E Extension for short-path forwarding example

Under the VRRP-E VRID configuration level, there is an option to enable short-path forwarding. To enable **short-path forwarding**, enter the following commands.

```
device (config)# router vrrp-extended
device (config)# interface ve 10
device (config-vif-10)# ip-address 10.10.10.25/24
device (config-vif-10)# ip vrrp-extended vrid 10
device (config-vif-10-vrid-10)# backup priority 50
device (config-vif-10-vrid-10)# ip-address 10.10.10.254
device (config-vif-10-vrid-10)# short-path-forwarding
device (config-vif-10-vrid-10)# activate
```

Syntax: no short-path-forwarding [revert-priority value]

The **revert-priority** *value* parameter uses the priority value as the threshold to determine whether the short-path forwarding (SPF) behavior is effective. Typically, when short-path forwarding is enabled, the Backup router enforces SPF. For each port that goes down, the current priority of the VRRP-E router is lowered by the number specified in the **track-port** command. When the current priority is lower than the threshold, the SPF behavior is temporarily suspended and reverts back to the pre-SPF VRRP-E forwarding behavior. The value range is from 1 through 255.

Displaying short-path forwarding combinations

When short-path forwarding (SPF) is configured, the output of the following show commands include the SPF information:

- **show run**
- **show ip vrrp-e brief**
- **show ip vrrp-e vrid**

The following example displays information about VRID 1 when only short-path forwarding is configured.

```
device# show ip vrrp-e vrid 1
VRID 1
  Interface ethernet v100
  state backup
  administrative-status enabled
  priority 110
  current priority 90
  hello-interval 1000 msec
  dead-interval 0 msec
  current dead-interval 3500 msec
  preempt-mode true
  virtual ip address 10.1.1.3
  virtual mac address 0000.0089.7001
  advertise backup: disabled
  master router 10.1.1.1 expires in 00:00:02.6
  track-port 1/1/13(down)
  short-path-forwarding enabled
```

The following example displays information about VRID 1 when short-path forwarding and revert priority are configured.

```
device# show ip vrrp-e vrid 1
VRID 1
  Interface ethernet v100
  state backup
  administrative-status enabled
  priority 110
  current priority 90
  hello-interval 1000 msec
  dead-interval 0 msec
  current dead-interval 3500 msec
  preempt-mode true
  virtual ip address 10.1.1.3
  virtual mac address 0000.0089.7001
  advertise backup: disabled
  master router 10.1.1.1 expires in 00:00:02.7
  track-port 1/1/13(down)
  short-path-forwarding enabled revertible priority 80 not reverted
```

Suppressing default interface-level RA messages on an IPv6 VRRP or VRRP-E interface

You should have a valid IPv6 VRRP or VRRP-E configured on the interface.

VRRP and VRRP-E

Forcing a Master router to abdicate to a Backup router

By default, all IPv6-enabled interfaces send IPv6 Router Advertisement (RA) messages. If you configure an IPv6 VRRP/VRRP-E instance on an interface, the VRRP or VRRP-E instance also sends its IPv6 RA messages for the virtual IPv6 address on the same interface with the same source address. An IPv6 host cannot identify the valid IPv6 address for this router interface because of these two different IPv6 RA messages with the same source address from the same IPv6 router interface. To avoid this, you can disable the default interface-level IPv6 RA messages on an interface configured with IPv6 VRRP or VRRP-E.

To disable the default IPv6 RA messages and allow the interface to send only IPv6 VRRP or VRRP-E RA messages, use the **ipv6 nd skip-interface-ra** command in interface configuration mode.

The following example shows suppression of the default interface-level IPv6 RA messages on an Ethernet interface 1/1/7 that has IPv6 VRRP or VRRP-E configured on it.

```
Brocade(config)# interface ethernet 1/1/7
Brocade(config-if-e1000-1/1/7)# ipv6 address 2002:AB3::2/64
Brocade(config-if-e1000-1/1/7)# ipv6 nd skip-interface-ra
```

Forcing a Master router to abdicate to a Backup router

NOTE

Forcing a Master router to abdicate to a Backup router is not supported for IPv6 VRRP, IPv4 VRRP-E, and IPv6 VRRP-E. It is only supported for IPv4 VRRP.

You can force a VRRP Master to abdicate (give away control) of a VRID to a Backup router by temporarily changing the Master priority to a value less than that of the Backup router.

The VRRP Owner always has priority 255. You can use this feature to temporarily change the Owner priority to a value from 1 through 254.

NOTE

When you change the VRRP Owner priority, the change takes effect only for the current power cycle. The change is not saved to the startup-config file when you save the configuration and is not retained across a reload or reboot. Following a reload or reboot, the VRRP Owner again has priority 255.

To change the Master priority, enter commands such as the following.

```
device(config)# interface ethernet 1/1/6
device(config-if-1/1/6)# ip vrrp vrid 1
device(config-if-1/1/6-vrid-1)# owner priority 99
```

Syntax: [no] owner priority num

The *num* variable specifies the new priority and can be a number from 1 through 254.

When the command is enabled, the software changes the priority of the Master to the specified priority. If the new priority is lower than at least one Backup priority for the same VRID, the Backup router takes over and becomes the new Master until the next software reload or system reset.

To verify the change, enter the following command from any level of the CLI.

```
device# show ip vrrp
Total number of VRRP routers defined: 1
Interface ethernet 1/1/6
auth-type simple text password
VRID 3
  state backup
  administrative-status enabled
```

```
version v3
mode non-owner(backup)
priority 110
current priority 110
hello-interval 1000 msec
dead-interval 0 msec
current dead-interval 3500 msec
preempt-mode true
ip-address 172.21.3.1
virtual mac address 0000-5E00-0103
advertise backup: enabled
next hello sent in 00:00:26.1
master router 172.21.3.1 expires in 00:00:02.7
track-port 1/4/1-1/4/4 (up)
```

This example shows that even though this Layer 3 switch is the Owner of the VRID ("mode owner"), the Layer 3 switch priority for the VRID is 110 and the state is now "backup" instead of "active". In addition, the administrative status is "enabled".

To change the Master priority back to the default Owner priority 255, enter **no** followed by the command you entered to change the priority. For example, to change the priority of a VRRP Owner back to 255 from 110, enter the following command.

```
device(config-if-1/1/6-vrid-1)# no owner priority 110
```

You cannot set the priority to 255 using the **owner priority** command.

Accept mode for backup VRRP devices

Accept mode allows a backup VRRP device to respond to ping, traceroute, and Telnet packets if the backup device becomes the master VRRP device.

For each VRRP virtual routing instance, there is one master device and all other devices are backups. Accept mode allows some network management functionality for backup VRRP devices, providing the ability to respond to ping, traceroute, and Telnet packets. By default, nonowner VRRP devices do not accept packets destined for the IPv4 or IPv6 VRID addresses. Troubleshooting network connections to the VRRP nonowner master device is difficult unless accept mode is enabled.

NOTE

The accept mode functionality enables a VRRP nonowner master device to respond to ping, Telnet, and traceroute packets, but the device will not respond to SSH packets. When the device acting as the master device is not the IP address owner (the device with the interface whose actual IP address is used as the virtual device's IP address), the master device accepts only the ARP packets sent to the virtual IP address. When accept mode is configured, the master device responds to ping, TELNET, and traceroute packets sent to the virtual IP address even when the master device is not the IP address owner.

Enabling accept mode on a backup VRRP device

Enabling accept mode allows a backup VRRP device to respond to ping, traceroute, and Telnet packets if the backup device becomes the master VRRP device.

This task is performed on any device that is designated as a backup VRRP device and the functionality is activated if the backup device becomes a master VRRP device. For each VRRP virtual routing instance there is one master device and all other devices are backups. Accept mode allows some network management functionality for backup VRRP devices with the ability to respond to ping, traceroute, and telnet packets. By default, non-owner VRRP devices do not accept packets destined for the IPv4 or IPv6 VRID addresses. Repeat this task for all devices that are to be designated as backup devices.

VRRP and VRRP-E

Accept mode for backup VRRP devices

NOTE

The accept mode functionality does not support ssh packets.

1. On the device designated as a backup VRRP device, from privileged EXEC mode, enter configuration mode by issuing the **configure terminal** command.

```
device# configure terminal
```

2. Globally enable the VRRP protocol.

```
device(config)# router vrrp
```

3. Configure the ethernet interface link.

```
device(config)# interface ethernet 1/1/5
```

4. Configure the IP address of the interface. All devices configured for the same virtual router ID (VRID) must be on the same subnet.

```
device(conf-if-e1000-1/1/5)# ip address 10.53.5.3/24
```

5. Assign this backup device to VRID 1, the same VRID as the VRRP owner device.

```
device(conf-if-e1000-1/1/5)# ip vrrp vrid 1
```

NOTE

You can assign a VRID number in the range of 1 through 255.

6. Designate this router as a backup VRRP device.

```
device(conf-if-e1000-1/1/5-vrid-1)# backup priority 110
```

While configuring a backup device, you can set a priority that is used when a master VRRP device goes offline. The backup device with the highest priority will assume the role of master device.

7. Enable accept mode for this device.

```
device(conf-if-e1000-1/1/5-vrid-1)# accept-mode
```

8. Exit out of configuration modes and return to privileged EXEC mode.

```
device(conf-if-e1000-1/1/5-vrid-1)# end
```

9. Verify that accept mode is enabled.

```
device# show ip vrrp vrid 1

Interface 1/1/5
-----
auth-type no authentication
VRID 1 (index 1)
  interface 1/1/5
  state master
  administrative-status enabled
  version v2
  mode non-owner (backup)
  virtual mac aaaa.bbbb.cccc (configured)
  priority 110
  current priority 110
  track-priority 2
  hello-interval 1 sec
  accept-mode enabled
.
.
.
```

The following example enables accept mode for a VRRP backup device.

```
device# configure terminal
device(config)# router vrrp
device(config)# interface ethernet 1/1/5
device(conf-if-e1000-1/1/5)# ip address 10.53.5.3/24
device(conf-if-e1000-1/1/5)# ip vrrp vrid 1
device(conf-if-e1000-1/1/5-vrid-1)# backup priority 110
device(conf-if-e1000-1/1/5-vrid-1)# accept-mode
```

Displaying VRRP and VRRP-E information

You can display the following information for VRRP or VRRP-E:

- Summary configuration and status information
- Detailed configuration and status information
- VRRP and VRRP-E statistics

Syntax for IPv4 and IPv6 VRRP:

Syntax: **show ip vrrp [brief | [stat | [statistics] [vrid num]] [ethernet unit/slotnum/portnum | ve num]]**

Syntax: **show ipv6 vrrp [brief | [stat | [statistics] [vrid num]] [ethernet unit/slotnum/portnum | ve num]]**

Syntax for IPv4 and IPv6 VRRP-E:

Syntax: **show ip vrrp-extended [brief | [stat | [statistics] [vrid num]] [ethernet unit/slotnum/portnum | ve num]]**

Syntax: **show ipv6 vrrp-extended [brief | [stat | [statistics] [vrid num]] [ethernet unit/slotnum/portnum | ve num]]**

The **brief** option displays the summary information. If you do not use this option, detailed information is displayed instead.

The **ethernet unit/slotnum/portnum** option displays VRRP or VRRP-E information only for the specified interface.

The **ve num** option specifies a virtual interface. If you use this option, the command displays VRRP or VRRP-E information only for the specified virtual interface.

The **stat** option displays statistics.

The **statistics** option displays a summary of key statistics.

VRRP and VRRP-E

Displaying VRRP and VRRP-E information

The **vrid num** option specifies the virtual router ID. Enter a value from 1 through 255.

Displaying summary information

To display summary information for a Layer 3 switch for VRRP, enter the **show ip vrrp brief** command at any level of the CLI.

```
device# show ip vrrp brief
Total number of VRRP routers defined: 1
Interface VRID CurPri P State Master addr Backup addr VIP
1/1/6      1      255      P Init    192.53.5.1      192.53.5.3          192.53.5.1
```

To display summary information for IPv6 VRRP, enter the **show ipv6 vrrp brief** command at any level of the CLI.

```
device# show ipv6 vrrp brief
Total number of VRRP routers defined: 1
Interface VRID CurPri P State
1/1/5      1      255      P Master
Master addr: Local
Backup addr: 2001:DB8::212:f2ff:fea8:3900
VIP        : 2001:DB8::1
```

To display summary information for IPv6 VRRP-E v3 , enter the **show ipv6 vrrp-extended brief** command at any level of the CLI.

```
device# show ipv6 vrrp-extended brief
Total number of VRRP-Extended routers defined: 3
Interface VRID CurPri P State Master addr
1/1/1      1      100     P Master Master addr: Local
                           Backup addr: 2001:DB8::212:f2ff:fea8:5b00
                           VIP      : 2001:DB8::100
1/1/2      2      150     P Master Master addr: Local
                           Backup addr: 2001:DB8::212:f2ff:fea8:5b00
                           VIP      : 2001:DB8::100
v51        100 100     P Master Master addr: Local
                           Backup addr: 2001:DB8::212:f2ff:fea8:5b00
                           VIP      : 2001:DB8::100
```

The table shows a description of the output for the **show ip vrrp brief** and **show ip vrrp-extended brief** commands.

TABLE 106 Output description for VRRP or VRRP-E summary information

Field	Description
Total number of VRRP (or VRRP-Extended) routers defined	The total number of VRIDs configured on this Layer 3 switch. NOTE The total applies only to the protocol the Layer 3 switch is running. For example, if the Layer 3 switch is running VRRP-E, the total applies only to VRRP-E routers.
Interface	The interface on which VRRP or VRRP-E is configured. If VRRP or VRRP-E is configured on multiple interfaces, information for each interface is listed separately.
VRID	The VRID configured on this interface. If multiple VRIDs are configured on the interface, information for each VRID is listed in a separate row.
CurPri	The current VRRP or VRRP-E priority of this Layer 3 switch for the VRID.
P	Whether the backup preempt mode is enabled. If the backup preempt mode is enabled, this field contains a "P". If the mode is disabled, this field is blank.
State	This Layer 3 switch VRRP or VRRP-E state for the VRID. The state can be one of the following: <ul style="list-style-type: none">• Init - The VRID is not enabled (activated). If the state remains Init after you activate the VRID, make sure that the VRID is

TABLE 106 Output description for VRRP or VRRP-E summary information (continued)

Field	Description
	<p>also configured on the other routers and that the routers can communicate with each other.</p> <p>NOTE If the state is Init and the mode is incomplete, make sure you have specified the IP address for the VRID.</p> <ul style="list-style-type: none"> • Backup - This Layer 3 switch is a Backup for the VRID. • Master - This Layer 3 switch is the Master for the VRID.
Master addr	IP address of the router interface that is currently Master for the VRID.
Backup addr	IP addresses of router interfaces that are currently Backups for the VRID.
VIP	The virtual IP address that is being backed up by the VRID.

Displaying detailed information

To display detailed VRRP or VRRP-E information, enter the **show ip vrrp** command at any level of the CLI.

```
device# show ip vrrp
Total number of VRRP routers defined: 1
Interface ethernet 1/1/3
auth-type simple text password
VRID 3
  state master
  administrative-status enabled
  version v3
  mode owner
  priority 255
  current priority 255
  track-priority 150
  hello-interval 1000 msec
  ip-address 172.21.3.1
  virtual mac address 0000-5E00-0103
  advertise backup: disabled
  next hello sent in 00:00:00.7
  backup router 172.21.3.2 expires in 00:02:41.3
  track-port 1/3/14 (up)
```

The following example is for a VRRP Backup.

```
device# show ip vrrp
Total number of VRRP routers defined: 1
Interface ethernet 1/1/4
auth-type simple text password
VRID 3
  state backup
  administrative-status enabled
  version v3
  mode non-owner (backup)
  priority 110
  current priority 110
  hello-interval 1000 msec
  dead-interval 0 msec
  current dead-interval 3500 msec
  preempt-mode true
  ip-address 172.21.3.1
  virtual mac address 0000-5E00-0103
  advertise backup: enabled
  next hello sent in 00:00:26.1
  master router 172.21.3.1 expires in 00:00:02.7
  track-port 1/4/1-1/4/4 (up)
```

VRRP and VRRP-E

Displaying VRRP and VRRP-E information

The following example is for an IPv6 VRRP Backup.

```
device# show ipv6 vrrp
Total number of VRRP routers defined: 26
Interface ethernet ve52
auth-type no authentication
VRID 52
state backup
administrative-status enabled
version v3
mode non-owner (backup)
priority 101
current priority 20
track-priority 20
hello-interval 100 msec
dead-interval 0 msec
current dead-interval 300 msec
preempt-mode true
ipv6-address 2001:DB8::52:3
virtual mac address 0000-5E00-0103
advertise backup: enabled
next hello sent in 00:00:36.5
master router 2001:DB8::768e:f8ff:fe33:8600 expires in 00:00:00.2
track-port 2/1/3-4/1/4 (down) v41 (up)
For Owner VRRP:
```

The following example is for a VRRP-E Master.

```
deviceshow ip vrrp-extended
Total number of VRRP-Extended routers defined: 50
Interface ethernet ve201
auth-type simple text password
VRID 201
state master
administrative-status enabled
priority 220
current priority 220
hello-interval 1000 msec
dead-interval 0 msec
current dead-interval 3100 msec
preempt-mode true
virtual ip address 10.201.201.5
virtual mac address 0000.00d7.82c9
advertise backup: enabled
next hello sent in 00:00:00.1
backup router 10.201.201.4 expires in 00:02:45.2
backup router 10.201.201.3 expires in 00:02:47.6
track-port 1/1/25-2/1/24 (up)
```

To display information for an IPv6 VRRP Owner, enter the **show ipv6 vrrp** command at any level of the CLI.

```
device#show ipv6 vrrp
Total number of VRRP routers defined: 25
Interface ethernet ve52
auth-type no authentication
VRID 52
state master
administrative-status enabled
version v3
mode owner
priority 255
current priority 255
track-priority 5
hello-interval 1000 msec
ipv6-address 2001:DB8::52:3
virtual mac address 0000-5E00-0103
advertise backup: disabled
next hello sent in 00:00:00.1
backup router 2001:DB8::224:38ff:fec8:5a40 expires in 00:02:03.1
```

The table shows a description of the output for the **show ip vrrp** and **show ip vrrp-extended** commands.

TABLE 107 Output description for VRRP-E detailed information

Field	Description
Total number of VRRP (or VRRP-Extended) routers defined	<p>The total number of VRIDs configured on this Layer 3 switch.</p> <p>NOTE The total applies only to the protocol the Layer 3 switch is running. For example, if the Layer 3 switch is running VRRP-E, the total applies only to VRRP-E routers.</p>
Interface parameters	
Interface	<p>The interface on which VRRP, VRRP v3, VRRP-E, or IPv6 VRRP-E is configured. If VRRP, VRRP v3, VRRP-E, or IPv6 VRRP-E is configured on multiple interfaces, information for each interface is listed separately.</p>
auth-type	The authentication type enabled on the interface.
VRID parameters	
VRID	<p>The VRID configured on this interface. If multiple VRIDs are configured on the interface, information for each VRID is listed separately.</p>
state	<p>This Layer 3 switch VRRP, VRRP v3, VRRP-E, or IPv6 VRRP-E state for the VRID. The state can be one of the following:</p> <ul style="list-style-type: none"> initialize - The VRID is not enabled (activated). If the state remains "initialize" after you activate the VRID, make sure that the VRID is also configured on the other routers and that the routers can communicate with each other. <p>NOTE If the state is "initialize" and the mode is incomplete, make sure you have specified the IP address for the VRID.</p> <ul style="list-style-type: none"> backup - This Layer 3 switch is a Backup for the VRID. master - This Layer 3 switch is the Master for the VRID.
administrative-status	<p>The administrative status of the VRID. The administrative status can be one of the following:</p> <ul style="list-style-type: none"> disabled - The VRID is configured on the interface but VRRP or VRRP-E has not been activated on the interface. enabled - VRRP, VRRP v3, VRRP-E, or IPv6 VRRP-E has been activated on the interface.
mode	<p>Indicates whether the Layer 3 switch is the Owner or a Backup for the VRID.</p> <p>NOTE If "incomplete" appears after the mode, configuration for this VRID is incomplete. For example, you might not have configured the virtual IP address that is being backed up by the VRID.</p> <p>NOTE This field applies only to VRRP or VRRP v3. All Layer 3 switches configured for VRRP-E are Backups.</p>
priority	<p>The device preferability for becoming the Master for the VRID. During negotiation, the router with the highest priority becomes the Master.</p> <p>If two or more devices are tied with the highest priority, the Backup interface with the highest IP address becomes the active router for the VRID.</p>

VRRP and VRRP-E

Displaying VRRP and VRRP-E information

TABLE 107 Output description for VRRP-E detailed information (continued)

Field	Description
current priority	<p>The current VRRP, VRRP v3, VRRP-E, or IPv6 VRRP-E priority of this Layer 3 switch for the VRID. The current priority can differ from the configured priority (refer to the priority field) for the following reason:</p> <p>The current priority can differ from the configured priority in the VRID if the VRID is configured with track ports and the link on a tracked interface has gone down.</p>
hello-interval	<p>The configured value for the Hello interval. This is the amount of time, in milliseconds, between Hello messages from the Master to the Backups for a given VRID.</p> <p>NOTE In some VRRP command outputs, Hello interval timers are displayed in seconds instead of milliseconds.</p>
dead interval	<p>The configured value for the dead interval. This is the amount of time, in milliseconds, that a Backup waits for a Hello message from the Master for the VRID before determining that the Master is no longer active.</p> <p>If the Master does not send a Hello message before the dead interval expires, the Backups negotiate (compare priorities) to select a new Master for the VRID.</p> <p>NOTE If the value is 0, then you have not configured this parameter.</p> <p>NOTE This field does not apply to VRRP Owners.</p> <p>NOTE All timer fields (Hello interval, dead interval, current dead interval, and so on) are displayed in milliseconds.</p>
current dead interval	<p>The current value of the dead interval. This value is equal to the value configured for the dead interval.</p> <p>If the value for the dead interval is not configured, then the current dead interval is equal to three times the Hello interval plus Skew time (where Skew time is equal to 256 minus priority divided by 256).</p> <p>NOTE This field does not apply to VRRP Owners.</p>
preempt mode	<p>Whether the backup preempt mode is enabled.</p> <p>NOTE This field does not apply to VRRP Owners.</p>
virtual ip address	The virtual IP addresses that this VRID is backing up. The address can be an IPv4 or IPv6 address.
virtual mac address	The virtual MAC addresses for the VRID. The MAC address can be an IPv4 or IPv6 address.
advertise backup	The IP addresses of Backups that have advertised themselves to this Layer 3 switch by sending Hello messages.

TABLE 107 Output description for VRRP-E detailed information (continued)

Field	Description
	<p>NOTE Hello messages from Backups are disabled by default. You must enable the Hello messages on the Backup for the Backup to advertise itself to the current Master.</p>
backup router ip-addr expires in time	<p>The IP addresses of Backups that have advertised themselves to this Master by sending Hello messages.</p> <p>The time value indicates how long before the Backup expires. A Backup expires if you disable the advertise backup option on the Backup or the Backup becomes unavailable. Otherwise, the Backup next Hello message arrives before the Backup expires. The Hello message resets the expiration timer.</p> <p>An expired Backup does not necessarily affect the Master. However, if you have not disabled the advertise backup option on the Backup, then the expiration may indicate a problem with the Backup.</p> <p>NOTE This field applies only when Hello messages are enabled on the Backups (using the advertise backup option).</p>
next hello sent in time	<p>How long until the Backup sends its next Hello message.</p> <p>NOTE This field applies only when this Layer 3 switch is the Master and the Backup is configured to send Hello messages (the advertise backup option is enabled).</p>
master router ip-addr expires in time	<p>The IP address of the Master and the amount of time until the Master dead interval expires. If the Backup does not receive a Hello message from the Master by the time the interval expires, either the IP address listed for the Master will change to the IP address of the new Master, or this Layer 3 switch itself will become the Master.</p> <p>NOTE This field applies only when this Layer 3 switch is a Backup.</p>
track port	<p>The interfaces that the VRID interface is tracking. If the link for a tracked interface goes down, the VRRP, VRRP v3, VRRP-E, or IPv6 VRRP-E priority of the VRID interface is changed, causing the devices to renegotiate for Master.</p> <p>NOTE This field is displayed only if track interfaces are configured for this VRID.</p>

Displaying detailed information for an individual VRID

You can display information about the settings configured for a specified VRRP Virtual Router ID (VRID). To display information about VRID 1, enter the **show ip vrrp vrid** command.

```
device#show ip vrrp vrid 2
VRID 2
  Interface ethernet v2
  state master
  administrative-status enabled
  version v2
  mode non-owner(backup)
```

VRRP and VRRP-E

Displaying VRRP and VRRP-E information

```
priority 100
current priority 100
hello-interval 1000 msec
dead-interval 0 msec
current dead-interval 3600 msec
preempt-mode true
ip-address 10.1.1.5
virtual mac address 0000.0000.0102
advertise backup: disabled
next hello sent in 00:00:01.0
```

To display information about the settings configured for a specified IPv6 VRRP VRID, enter the **show ipv6 vrrp vrid** command.

```
device#show ipv6 vrrp vrid 1
VRID 1
  Interface ethernet 5
    state backup
    administrative-status enabled
    version v3
    mode non-owner(backup)
    priority 100
    current priority 100
    hello-interval 1000 msec
    dead-interval 0 msec
    current dead-interval 3000 msec
    preempt-mode true
    ip-address Layer 3 switch a7a7::1
    virtual mac address 0000.0000.0201
    advertise backup: enabled
    next hello sent in 00:00:38.0
    track-port 1/1/5(up)
    master router fe80::212:f2ff:fea8:5b00 timer expires in 00:00:02.6
```

The table shows a description of the output for the **show ip vrrp vrid** command.

TABLE 108 show ip vrrp vrid output description

Field	Description
VRID	The specified VRID.
Interface	The interface on which VRRP is configured.
State	<p>The Layer 3 switch VRRP state for the VRID. The state can be one of the following:</p> <ul style="list-style-type: none">Init - The VRID is not enabled (activated). If the state remains Init after you activate the VRID, make sure that the VRID is also configured on the other routers and that the routers can communicate with each other. <p>NOTE If the state is Init and the mode is incomplete, make sure you have specified the IP address for the VRID.</p> <ul style="list-style-type: none">Backup - This Layer 3 switch is a Backup for the VRID.Master - This Layer 3 switch is the Master for the VRID.
priority	The configured VRRP priority of this Layer 3 switch for the VRID.
current priority	The current VRRP priority of this Layer 3 switch for the VRID.
track priority	The new VRRP priority that the router receives for this VRID if the interface goes down.
hello interval	How often the Master router sends Hello messages to the Backups.
dead interval	The amount of time a Backup waits for a Hello message from the Master before determining that the Master is dead.
current dead interval	The current value of the dead interval. This value is equal to the value configured for the dead interval.

TABLE 108 show ip vrrp vrid output description (continued)

Field	Description
	If the value for the dead interval is not configured, then the current dead interval is equal to three times the Hello interval plus Skew time (where Skew time is equal to 256 minus priority divided by 256). NOTE This field does not apply to VRRP Owners.
preempt mode	Whether the backup preempt mode is enabled. If the backup preempt mode is enabled, this field contains "true". If the mode is disabled, this field contains "false".
advertise backup	Whether Backup routers send Hello messages to the Master.

Displaying statistics

You can view VRRP and VRRP-E detailed or summary statistics.

Displaying detailed statistics

Use the **stat** keyword to display detailed statistics.

The following example displays the output of the **show ip vrrp stat ve** command:

```
device# show ip vrrp stat ve 105
Interface ethernet v105
rxed vrrp header error count = 0
rxed vrrp auth error count = 0
rxed vrrp auth passwd mismatch error count = 0
rxed vrrp vrid not found error count = 52
VRID 55
rxed arp packet drop count = 0
rxed ip packet drop count = 0
rxed vrrp port mismatch count = 0
rxed vrrp number of ip address mismatch count = 0
rxed vrrp ip address mismatch count = 0
rxed vrrp hello interval mismatch count = 0
rxed vrrp priority zero from master count = 0
rxed vrrp higher priority count = 0
transitioned to master state count = 1
transitioned to backup state count = 1
total number of vrrp packets received = 4
backup advertisements received = 1
total number of vrrp packets sent = 25
backup advertisements sent = 1
VRID 105
rxed arp packet drop count = 0
rxed ip packet drop count = 0
rxed vrrp port mismatch count = 0
rxed vrrp number of ip address mismatch count = 0
rxed vrrp ip address mismatch count = 0
rxed vrrp hello interval mismatch count = 0
rxed vrrp priority zero from master count = 0
rxed vrrp higher priority count = 1
transitioned to master state count = 1
transitioned to backup state count = 2
total number of vrrp packets received = 455
backup advertisements received = 0
total number of vrrp packets sent = 105
backup advertisements sent = 10
```

VRRP and VRRP-E

Displaying VRRP and VRRP-E information

The following example displays the output of the **show ipv6 vrrp-extended stat ve** command:

```
device# show ipv6 vrrp-extended stat ve 30
Interface ethernet v30
rxed vrrp header error count = 0
rxed vrrp auth error count = 0
rxed vrrp auth passwd mismatch error count = 0
rxed vrrp vrid not found error count = 0
VRID 11
rxed arp packet drop count = 0
rxed ip packet drop count = 0
rxed vrrp port mismatch count = 0
rxed vrrp ip address mismatch count = 0
rxed vrrp hello interval mismatch count = 0
rxed vrrp priority zero from master count = 0
rxed vrrp higher priority count = 0
transitioned to master state count = 2
transitioned to backup state count = 2
total number of vrrp-extended packets received = 0
backup advertisements received = 0
total number of vrrp-extended packets sent = 61
backup advertisements sent = 0
```

TABLE 109 Output field descriptions

Field	Description
Interface statistics	
Interface	The interface on which VRRP or VRRP-E is configured. If VRRP or VRRP-E is configured on more than one interface, the display lists the statistics separately for each interface.
rxed vrrp header error count	The number of VRRP or VRRP-E packets received by the interface that had a header error.
rxed vrrp auth error count	The number of VRRP or VRRP-E packets received by the interface that had an authentication error.
rxed vrrp auth passwd mismatch error count	The number of VRRP or VRRP-E packets received by the interface that had a password value that does not match the password used by the interface for authentication.
rxed vrrp vrid not found error count	The number of VRRP or VRRP-E packets received by the interface that contained a VRID that is not configured on this interface.
VRID statistics	
rxed arp packet drop count	The number of ARP packets addressed to the VRID that were dropped.
rxed ip packet drop count	The number of IP packets addressed to the VRID that were dropped.
rxed vrrp port mismatch count	The number of packets received that did not match the configuration for the receiving interface.
rxed vrrp ip address mismatch count	The number of packets received that did not match the configured IP addresses.
rxed vrrp hello interval mismatch count	The number of packets received that did not match the configured Hello interval.
rxed vrrp priority zero from master count	Indicates that the current Master has resigned.
rxed vrrp higher priority count	The number of VRRP or VRRP-E packets received by the interface that had a higher backup priority for the VRID than this Layer 3 switch backup priority for the VRID.
transitioned to master state count	The number of times this Layer 3 switch has changed from the backup state to the master state for the VRID.
transitioned to backup state count	The number of times this Layer 3 switch has changed from the master state to the backup state for the VRID.
total number of vrrp packets received	The number of VRRP or VRRP-E advertisement packets received for a VRID on a specific interface.

TABLE 109 Output field descriptions (continued)

Field	Description
backup advertisements received	The number of VRRP backup advertisement packets received for a VRID on a specific interface.
total number of vrrp packets sent	The number of VRRP or VRRP-E advertisement packets sent by this router for a VRID on a specific interface.
backup advertisements sent	The number of VRRP backup advertisement packets sent by this router for a VRID on a specific interface.

Displaying summary of key statistics

To display VRRP or VRRP-E statistics for each VRID configured on an interface, use the **statistics** keyword. The output will be similar for VRRP and VRRP-E (IPv4 and IPv6); the output fields are the same.

The following example displays the output of the **show ip vrrp statistics** command:

```
device# show ip vrrp statistics
Total number of VRRP routers defined: 23
          RX master adv   TX master adv   RX backup adv   TX backup adv   VR Errors   Port Errors
v211      VR211        0            93542       1559           0            0            0
v212      VR212        0            93542       1559           0            0            0
v213      VR213        1            93543       1559           0            0            0
v214      VR214        0            93542       1559           0            0            0
v215      VR215        0            93542       1559           0            0            0
v225      VR225        0            93542       1559           0            0            0
v226      VR226        0            46772       1559           0            0            0
v227      VR227        0            93542       1559           0            0            0
v228      VR228        0            93542       1559           0            0            0
v229      VR229        1            93543       1559           0            0            0
v311      (output truncated)
```

To display a summary of the VRRP-E statistics on a device, enter the following command at any level of the CLI:

```
device# show ip vrrp-extended statistics
Total number of VRRP-Extended routers defined: 2
          RX master adv   TX master adv   RX backup adv   TX backup
adv          VR Errors   Port Errors
v20
VR 20        0            801           8            9            12            0
v30
VR101       150          104           0            14           0            0
```

To display a summary of the IPv6 VRRP v3 statistics on a device, enter the following command at any level of the CLI:

```
device# show ipv6 vrrp statistics
Total number of ipv6 VRRP routers defined: 1
          RX master adv   TX master adv   RX backup adv   TX backup
adv          VR Errors   Port Errors
v200
VR200       0            15            16           10           0            0
```

VRRP and VRRP-E

Displaying VRRP and VRRP-E information

To display a summary of the IPv6 VRRP-E v3 statistics on a device, enter the following command at any level of the CLI:

```
device# show ipv6 vrrp-extended statistics
Total number of ipv6 VRRP-Extended routers defined: 2
      RX master adv          TX master adv          RX backup adv          TX backup
adv           VR Errors       Port Errors
v30
VR 11           984            502             17              9               0
VR 31           845            249             10              1               0
```

TABLE 110 Output field descriptions

Field	Description
RX master adv	The number of VRRP or VRRP-E advertisement packets received for a VRID on a specific interface. This is the same as the "total number of vrrp/vrrp-extended packets received" output of the stat option.
TX master adv	The number of VRRP or VRRP-E advertisement packets sent by this router for a VRID on a specific interface. This is the same as the "total number of vrrp/vrrp-extended packets sent" output of the stat option.
RX backup adv	The number of VRRP backup advertisement packets received for a VRID on a specific interface. This is the same as the "backup advertisements received" output of the stat option.
TX backup adv	The number of VRRP backup advertisement packets sent by this router for a VRID on a specific interface. This is the same as the "backup advertisements sent" output of the stat option.
VR Errors	This is the sum of these values: <ul style="list-style-type: none">• rxed arp packet drop count• rxed ip packet drop count• rxed vrrp port mismatch count• rxed vrrp number of ip address mismatch count• rxed vrrp ip address mismatch count• rxed vrrp hello interval mismatch count
Port Errors	This is the sum of these values: <ul style="list-style-type: none">• rxed vrrp header error count• rxed vrrp auth error count• rxed vrrp auth passwd mismatch error count• rxed vrrp vrid not found error count

Clearing VRRP or VRRP-E statistics

To clear VRRP or VRRP-E statistics, enter the **clear ip vrrp-stat** command at the Privileged EXEC level or any configuration level of the CLI.

```
device#clear ip vrrp-stat
```

Syntax: **clear ip vrrp-stat**

To clear IPv6 VRRP v3 or IPv6 VRRP-E v3 statistics, enter the following command at the Privileged EXEC level or any configuration level of the CLI.

```
device#clear ipv6 vrrp-stat
```

Syntax: **clear ipv6 vrrp-stat**

Configuration examples

The following sections contain the CLI commands for implementing VRRP and VRRP-E configurations.

VRRP example

To implement the VRRP configuration shown in "VRRP Overview," use the following method.

Configuring Switch 1

To configure VRRP Switch 1, enter the following commands.

```
Switch1(config)# router vrrp
Switch1(config)# interface ethernet 1/1/6
Switch1(config-if-1/1/6)# ip address 192.53.5.1
Switch1(config-if-1/1/6)# ip vrrp vrid 1
Switch1(config-if-1/1/6-vrid-1)# owner track-priority 20
Switch1(config-if-1/1/6-vrid-1)# track-port ethernet 1/2/4
Switch1(config-if-1/1/6-vrid-1)# ip-address 192.53.5.1
Switch1(config-if-1/1/6-vrid-1)# activate
```

NOTE

When you configure the Master (Owner), the address you enter with the **ip-address** command must already be configured on the interface.

Configuring Switch 2

To configure Switch 2 in "VRRP Overview" after enabling VRRP, enter the following commands.

```
Switch2(config)#router vrrp
Switch2(config)#interface ethernet 1/1/5
Switch2(config-if-1/1/5)#ip address 192.53.5.3
Switch2(config-if-1/1/5)#ip vrrp vrid 1
Switch2(config-if-1/1/5-vrid-1)#backup priority 100 track-priority 19
Switch2(config-if-1/1/5-vrid-1)#track-port ethernet 1/3/2
Switch2(config-if-1/1/5-vrid-1)#ip-address 192.53.5.1
Switch2(config-if-1/1/5-vrid-1)#activate
```

The **backup** command specifies that this router is a VRRP Backup for virtual router VRID1. The IP address entered with the **ip-address** command is the same IP address as the one entered when configuring Switch 1. In this case, the IP address cannot also exist on Switch 2, but the interface on which you are configuring the VRID Backup must have an IP address in the same subnet. By entering the same IP address as the one associated with this VRID on the Owner, you are configuring the Backup to back up the address, but you are not duplicating the address.

NOTE

When you configure a Backup router, the router interface on which you are configuring the VRID must have a real IP address that is in the same subnet as the address associated with the VRID by the Owner. However, the address cannot be the same.

The **priority** parameter establishes the router VRRP priority in relation to the other VRRP routers in this virtual router. The **track-priority** parameter specifies the new VRRP priority that the router receives for this VRID if the interface goes down.

The **activate** command activates the VRID configuration on this interface. The interface does not provide backup service for the virtual IP address until you activate the VRRP configuration. Alternatively, you can use the **enable** command. The **activate** and **enable** commands do the same thing.

Syntax: **router vrrp**

VRRP and VRRP-E

Configuration examples

Syntax: ip vrrp vridvrid

Syntax: owner [track-priorityvalue]

Syntax: backup [priorityvalue][track-priorityvalue]

Syntax: track-port ethernet [unitnum/slotnum/portnum | ve num]

Syntax: ip-address ip-addr

Syntax: activate

VRRP-E example

To implement the VRRP-E configuration shown in "VRRP-E Overview," use the following CLI method.

Configuring Switch 1

To configure VRRP Switch 1 in "VRRP-E Overview," enter the following commands.

```
Switch1(config)#router vrrp-extended
Switch1(config)#interface ethernet 1/1/6
Switch1(config-if-1/1/6)#ip address 192.53.5.2/24
Switch1(config-if-1/1/6)#ip vrrp-extended vrid 1
Switch1(config-if-1/1/6-vrid-1)#backup priority 110 track-priority 20
Switch1(config-if-1/1/6-vrid-1)#track-port ethernet 1/2/4
Switch1(config-if-1/1/6-vrid-1)#ip-address 192.53.5.254
Switch1(config-if-1/1/6-vrid-1)#activate
VRRP Router 1 for this interface is activating
Switch1(config-if-1/1/6-vrid-1)#exit
Switch1(config)#interface ethernet 1/1/6
Switch1(config-if-1/1/6)#ip vrrp-extended vrid 2
Switch1(config-if-1/1/6-vrid-1)#backup priority 100 track-priority 20
Switch1(config-if-1/1/6-vrid-1)#track-port ethernet 1/2/4
Switch1(config-if-1/1/6-vrid-1)#ip-address 192.53.5.253
Switch1(config-if-1/1/6-vrid-1)#activate
VRRP Router 2 for this interface is activating
```

NOTE

The address you enter with the **ip-address** command cannot be the same as a physical IP address configured on the interface.

Configuring Switch 2

To configure Switch 2, enter the following commands.

```
Switch2(config)#router vrrp-extended
Switch2(config)#interface ethernet 1/5/1
Switch2(config-if-1/5/1)#ip address 192.53.5.3/24
Switch2(config-if-1/5/1)#ip vrrp-extended vrid 1
Switch2(config-if-1/5/1-vrid-1)#backup priority 100 track-priority 20
Switch2(config-if-1/5/1-vrid-1)#track-port ethernet 1/3/2
Switch2(config-if-1/5/1-vrid-1)#ip-address 192.53.5.254
Switch2(config-if-1/5/1-vrid-1)#activate
VRRP Router 1 for this interface is activating
Switch2(config-if-1/5/1-vrid-1)#exit
Switch2(config)#interface ethernet 1/5/1
Switch2(config-if-1/5/1)#ip vrrp-extended vrid 2
Switch2(config-if-1/5/1-vrid-1)#backup priority 110 track-priority 20
Switch2(config-if-1/5/1-vrid-1)#track-port ethernet 1/2/4
Switch2(config-if-1/5/1-vrid-1)#ip-address 192.53.5.253
Switch2(config-if-1/5/1-vrid-1)#activate
VRRP Router 2 for this interface is activating
```

The **backup** command specifies that this router is a VRRP-E Backup for virtual router VRID1. The IP address entered with the **ip-address** command is the same IP address as the one entered when configuring Switch 1. In this case, the IP address cannot also exist on Switch 2, but the interface on which you are configuring the VRID Backup must have an IP address in the same subnet. By entering the same IP address as the one associated with this VRID on the Owner, you are configuring the Backup to back up the address, but you are not duplicating the address.

NOTE

When you configure a Backup router, the router interface on which you are configuring the VRID must have a real IP address that is in the same subnet as the address associated with the VRID by the Owner. However, the address cannot be the same.

The **priority** parameter establishes the router VRRP-E priority in relation to the other VRRP-E routers in this virtual router. The **track-priority** parameter specifies the new VRRP-E priority that the router receives for this VRID if the interface goes down.

The **activate** command activates the VRID configuration on this interface. The interface does not provide backup service for the virtual IP address until you activate the VRRP-E configuration. Alternatively, you can use the **enable** command. The **activate** and **enable** commands do the same thing.

Syntax: **router vrrp-extended**

Syntax: **ip vrrp-extended vrid vrid**

Syntax: **backup [priority value] [track-priority value]**

Syntax: **track-port ethernet [unitnum/slotnum/portnum | ve num]**

Syntax: **ip-address ip-addr**

Syntax: **activate**

Multi-VRF

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Multi-VRF overview

Virtual Routing and Forwarding (VRF) allows routers to maintain multiple routing tables and forwarding tables on the same router. A Multi-VRF router can run multiple instances of routing protocols with a neighboring router with overlapping address spaces configured on different VRF instances.

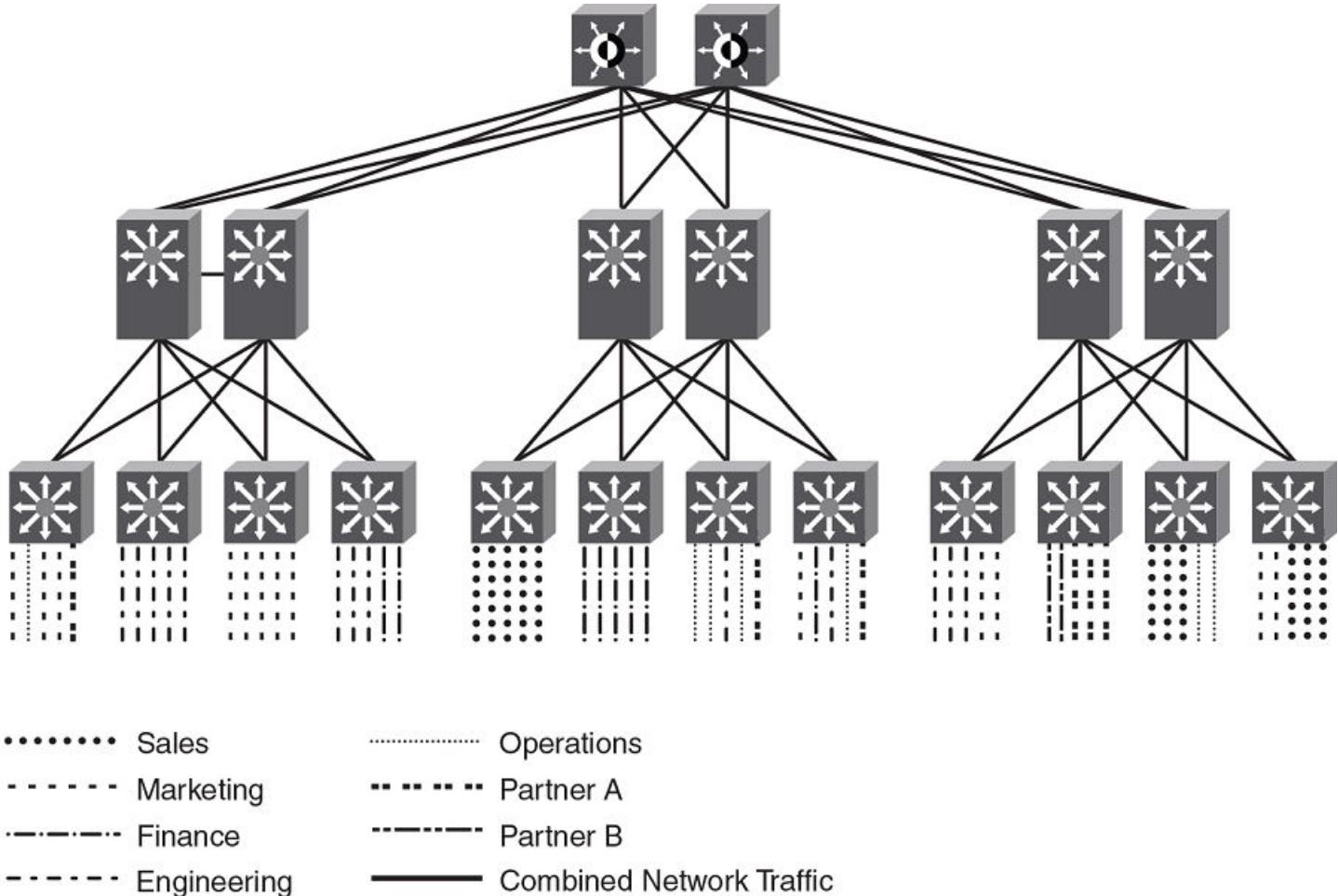
Some vendors also use the terms Multi-VRF CE or VRF-Lite for this technology. VRF-Lite provides a reliable mechanism for a network administrator to maintain multiple virtual routers on the same device. The goal of providing isolation among different VPN instances is accomplished without the overhead of heavyweight protocols (such as MPLS) used in secure VPN technologies. Overlapping address spaces can be maintained among the different VPN instances.

Central to VRF-Lite is the ability to maintain multiple VRF tables on the same Provider Edge (PE) Router. VRF-Lite uses multiple instances of a routing protocol such as OSPF or BGP to exchange route information for a VPN among peer PE routers. The VRF-Lite capable PE router maps an input customer interface to a unique VPN instance. The router maintains a different VRF table for each VPN instance on that PE router. Multiple input interfaces may also be associated with the same VRF on the router, if they connect to sites belonging to the same VPN. This input interface can be a physical interface or a virtual Ethernet interface on a port.

In Multi-VRF deployments:

- Two VRF-capable routers must be directly connected at Layer 3, deploying BGP, OSPF, RIP, or static routes.
- Each VRF maintains unique routing and forwarding tables.
- Each VRF can be assigned one or more Layer 3 interfaces on a router to be part of the VRF.
- Each VRF can be configured with IPv4 address family, IPv6 address family, or both.
- A packet's VRF instance is determined based on the VRF index of the interface on which the packet is received.
- Separate routing protocol instances are required for each VRF instance.
- Overlapping address spaces can be configured on different VRF instances.

Multi-VRF deployments provide the flexibility to maintain multiple virtual routers, which are segregated for each VRF instance. The following illustrates a generic, high-level topology where different enterprise functions are assigned unique VRF instances.

FIGURE 38 Example high-level Multi-VRF topology

A Multi-VRF instance can be configured on any of the following:

- Platforms that support untagged physical ports - Applies only to FastIron SX series chassis-based systems, the Brocade ICX 7750, and the Brocade ICX 7450; untagged physical ports are not supported on the Brocade ICX 6610, ICX 6650, and FCX series. It is recommended that these ports be configured "route-only" to prevent the leaking of switching traffic if two interfaces in the same VLAN are configured with different VRFs.
- Virtual interfaces
- Loopback interfaces
- Tunnel interfaces - The tunnel can belong to any user-defined VRF, but the tunnel source and tunnel destination are restricted to the default VRF.

A Multi-VRF instance **cannot** be configured on any of the following:

- Physical interfaces
- Management interfaces

To configure Multi-VRF, perform the following steps:

- Configure VRF-related system-max values.
- Configure VRF instances.

- Configure a Route Distinguisher (RD) for new VRF instances.
- Configure an IPv4 or IPv6 Address Family (AF) for new VRF instances.
- Configure routing protocols for new Multi-VRF instances.
- Assign VRF instances to Layer 3 interfaces.

FastIron considerations for Multi-VRF

When a VRF is configured, a warning message specifies that any configuration existing on the interface is deleted.

VRF-related system-max values

The default FastIron configuration does not allow space for VRF routing tables. As a result, you must modify VRF-related system-max values before configuring a VRF instance. The following table lists commands that configure system-max values at the global level.

TABLE 111 Commands for configuring system-max values

Command	Description
ip-vrf	Configures maximum VRF instances supported by the software.
ip-route	Configures maximum IPv4 routes, used to initialize hardware during system init.
ip6-route	Configures maximum IPv6 routes, used to initialize hardware during system init.
ip-route-default-vrf	Configures maximum IPv4 routes to be allocated for the default VRF instance.
ip6-route-default-vrf	Configures maximum IPv6 routes to be allocated for the default VRF instance.
ip-route-vrf	Configures default maximum IPv4 routes to be allocated per user-defined VRF.
ip6-route-vrf	Configures default maximum IPv6 routes to be allocated per user-defined VRF.

This example includes two VRF instances for IPv4 and two VRF instances for IPv6. For the IPv4 partition, the default value for IPv4 TCAM allocation (12,000 on a Brocade ICX 6610) is decreased to 10,000. IPv6 TCAM allocation can then be increased from the default value of 908 to 1408. Both IPv4 and IPv6 VRF instances are planned to allocate 500 routes each.

The following table lists the default and maximum system-max values related to VRF for the FastIron configuration example, on a Brocade ICX 6610.

TABLE 112 Default and maximum system-max values related to Multi-VRF

System Parameter	Default	Maximum
ip-route	12000	15168
ip6-route	908	2884
ip-vrf	16	16
ip-route-default-vrf	12000	15168
ip6-route-default-vrf	908	2884
ip-route-vrf	1024	15168
ip6-route-vrf	100	2884

Multi-VRF

Multi-VRF overview

The following table lists the configuration limits for the **system-max** command.

TABLE 113 Configuration limits for system-max

Configuration	FSX			FCX / ICX 6610/7450			ICX 6650			ICX 7750		
	Min	Default	Max	Min	Default	Max	Min	Default	Max	Min	Default	Max
ip-vrf	16	128	128	4	16	16	4	16	16	4	16	16
ip-vrf (for 2nd generation line card)	0	4	4	x	x	x	4	4	4	128	128	128
ip-route (system-max IPv4 routes that all VRFs in total can support)	4096	262144	524288	4096	12000	15168	2048	5120	7168	98304	98304	131072
ip6-route (system-max IPv6 routes that all VRFs in total can support)	2048	32768	65536	68	908	2884	68	580	1348	5120	5120	7168
ip-route-default-vrf (system-max IPv4 routes configuration for default-VRF)	1024	262144	524288	1024	12000	15168	1024	5120	7168	256	65536	131072
ip-route-vrf (default system-max IPv4 routes per non-default-VRF instances)	1024	65536	524288	128	1024	15168	128	1024	7168	64	4096	131072
ip6-route-default-vrf (system-max IPv6 routes configuration for default-VRF)	1024	32768	65536	64	908	2884	64	580	1348	64	2048	7168
ip6-route-vrf (default system-max IPv6 routes per non-default-VRF instances, for 3rd generation line cards)	256	8192	65536	64	100	2884	64	100	1348	16	1024	7168

The following examples illustrate the **system-max** values to support two VRF instances for IPv4 and two instances for IPv6.

- To allocate 2 x 500 routes for IPv4 user-VRF, $(10000 - (500+500) = 9000$ routes):

```
device(config)# system-max ip-route-default-vrf 9000
Total max configured ipv4 routes are 12000
  - Max ipv4 routes configured for default VRF are 9000
  - Max ipv4 routes available for all non-default VRFs are 3000
Warning: Please revalidate these values to be valid for your configuration.
Reload required. Please write memory and then reload or power cycle.
device#
```

- To modify the IPv4 partition after modifying the **ip-route-default-vrf** value:

```
device(config)# system-max ip-route 10000
ip-route and ip6-route values changed.
ip-route: 10000
ip6-route: 1408
Warning: Please reconfigure system-max for ip-route-default-vrf and ip-route-vrf (if required).
Reload required. Please write memory and then reload or power cycle.
device#
```

This step also modifies the **ip6-route system-max** parameter and is intended only for the ICX 6610, the ICX 6650, and the FCX series (not the ICX 7450, or ICX 7750).

- To allocate 500 routes for IPv4 user-VRF:

```
device(config)# system-max ip-route-vrf 500
Reload required. Please write memory and then reload or power cycle.
device#
```

- To allocate 2 x 500 routes for IPv6 user-VRF ($1408 - (500+500) = 408$):

```
device(config)# system-max ip6-route-default-vrf 408
Total max configured ipv6 routes are 1408
  - Max ipv6 routes configured for default VRF are 408
  - Max ipv6 routes available for all non-default VRFs are 1000
Warning: Please revalidate these values to be valid for your configuration.
Reload required. Please write memory and then reload or power cycle.
device#
```

- To allocate 500 routes for IPv6 user-VRF:

```
device# system-max ip6-route-vrf 500
Reload required. Please write memory and then reload or power cycle.
device# end
```

- To save the configuration changes:

```
device# write memory
Write startup-config done.
device# Flash Memory Write (8192 bytes per dot) .
Flash to Flash Done.
```

- After the system reloads, the system-max configuration appears as an active configuration.

```
!
system-max ip-route 10000
system-max ip6-route 1408
system-max ip-route-default-vrf 9000
system-max ip6-route-default-vrf 408
system-max ip-route-vrf 500
system-max ip6-route-vrf 500
!
```

Additional features to support Multi-VRF

In addition to basic features, you can configure dynamic ARP inspection, DHCP snooping, and IP Source Guard to support Multi-VRF.

Static ARP

Static ARP entries help ensure Layer 2 to Layer 3 mappings. This removes some network overhead in the form of ARP requests and replies and can be helpful in managing Multi-VRF networks where devices must communicate on a regular basis. The interface associated with an ARP entry determines which VRF the ARP entry belongs to. However, the additional management involved in adding and maintaining static ARP cache entries must also be taken into account.

An ARP entry is defined by the following parameters:

- IP address
- MAC address
- Type
- Interface

The **arp** command is used to configure static ARP entries on a nondefault VRF interface. (An ARP index is not required before a static ARP is configured.) The **arp** command is available in the address-family mode for a particular VRF.

NOTE

The **arp** command is backward compatible from FastIron release 08.0.00a, which uses a new command format. In releases prior to FastIron release 08.0.00a, static ARP needed an index. For FastIron 08.0.00a and later releases, FastIron accepts the use of indexes as well as the new command without the index.

Proxy ARP

Proxy ARP allows a Layer 3 switch to answer ARP requests from devices on one subnet on behalf of devices in another network. Proxy ARP is configured globally and can be further configured per interface. Interface-level configuration overrides the global configuration.

With the **proxy-arp** command configured, a router does not respond to ARP requests for IP addresses in the same subnet as the incoming ports. The **local-proxy-arp** command permits the router to respond to ARP requests for IP addresses within the same subnet and to forward all traffic between hosts in the subnet. The **local-proxy-arp** command is an interface-level configuration that has no VRF-related impact.

ARP rate limiting

ARP rate limiting is configured globally and applies to all VRFs.

ARP age can be configured globally and on a Layer 3 interface. An ARP age timer configured on a Layer 3 interface overrides the global configuration for ARP aging. The aging timer ensures that the ARP cache does not retain learned entries that are no longer valid.

Dynamic ARP inspection

Dynamic ARP Inspection (DAI) enables the Brocade device to intercept and examine all ARP request and response packets in a subnet and to discard packets with invalid IP-to-MAC address bindings. DAI can prevent common man-in-the-middle (MiM) attacks such as ARP cache poisoning and can prevent the misconfiguration of client IP addresses. DAI allows only valid ARP requests and responses to be forwarded, and supports Multi-VRFs with overlapping address spaces. For more information on DAI, refer to the *FastIron Ethernet Switch Security Configuration Guide*.

DHCP snooping

Dynamic Host Configuration Protocol (DHCP) snooping enables a Brocade device to filter untrusted DHCP IPv4 or IPv6 packets in a subnet. DHCP snooping can ward off MiM attacks, such as a malicious user posing as a DHCP server sending false DHCP server reply packets with the intention of misdirecting other users. DHCP snooping can also stop unauthorized DHCP servers and prevent errors resulting from the user misconfiguration of DHCP servers. DHCP snooping supports Multi-VRFs. For more information on configuring DHCP IPv4 or IPv6 snooping to support a Multi-VRF instance, refer to the *FastIron Ethernet Switch Security Configuration Guide*.

IP Source Guard

You can use IP Source Guard (IPSG) together with DAI on untrusted ports. The Brocade implementation of the IP Source Guard feature supports configuration on a port, on specific VLAN memberships on a port (for Layer 2 devices only), and on specific ports on a virtual Ethernet (VE) interface (for Layer 3 devices only). For more information on IPSG, refer to the *FastIron Ethernet Switch Security Configuration Guide*.

Configuring Multi-VRF

Configuring VRF system-max values

Use this example procedure to modify the default system-max values to accommodate Multi-VRF.

The default **system-max** value must be configured because the device does not have routing table space for user VRFs.

Do the following to configure system-max values on a Brocade ICX 7450.

In this example, two user VRFs are configured with 512 maximum routes on each VRF. The *ip-route-default-vrf* and *ip-route-vrf* values must be modified. The **write memory** and **reload** commands are required after the modification.

Once the device has rebooted after the reload, enter the **show default values** command to display the **system-max** settings.

1. Verify the default values.

```
device(config)# show default values
sys log buffers:50          mac age time:300 sec      telnet sessions:5
ip arp age:10 min          bootp relay max hops:4    ip ttl:64 hops
ip addr per intf:24
:
:
System Parameters      Default   Maximum   Current   Configured
ip-arp                 4000     64000     4000     4000
ip-static-arp           512      6000      512      512
pim-mcache              1024     4096      1024     1024
:
:
ip-route                12000    15168     12000    12000
ip-static-route          64       2048      64       64
:
:
ip-vrf                  16       16        16        16
ip-route-default-vrf    12000    15168     12000    12000
ip6-route-default-vrf   908      2884      908      908
ip-route-vrf             1024     15168     1024     1024
ip6-route-vrf            100      2884      100      100
device(config)#

```

2. Change the maximum number of routes, save the configuration, and reload the device.

```
device(config)# system-max ip-route-default-vrf 10000
Total max configured ipv4 routes are 12000
  - Max ipv4 routes configured for default VRF are 10000
  - Max ipv4 routes available for all non-default VRFs are 2000
Warning: Please revalidate these values to be valid for your configuration.
Reload required. Please write memory and then reload or power cycle.
device(config)#
device(config)# system-max ip-route-vrf 512
Reload required. Please write memory and then reload or power cycle.
device(config)#
device(config)# exit
device# write memory
Write startup-config done.
device# Flash Memory Write (8192 bytes per dot) .
Flash to Flash Done.
device# reload
Are you sure? (enter 'y' or 'n'): Rebooting(0)...
Y
*
$
FCX Boot Code Version 7.3.03 (grz07303)
Enter 'a' to stop at memory test
Enter 'b' to stop at boot monitor

```

Multi-VRF

Configuring Multi-VRF

3. Confirm the modified values.

```
device(config)# show default values
sys log buffers:50          mac age time:300 sec      telnet sessions:5
ip arp age:10 min          bootp relay max hops:4    ip ttl:64 hops
ip addr per intf:24
:
:
System Parameters      Default   Maximum   Current   Configured
ip-arp                 4000     64000     4000     4000
ip-static-arp           512      6000      512      512
pim-mcache              1024     4096      1024     1024
:
:
ip-route                12000    15168     12000    12000
ip-static-route          64       2048      64       64
:
:
ip-vrf                  16       16        16        16
ip-route-default-vrf    12000    15168     10000    10000
ip6-route-default-vr    908      2884      908      908
ip-route-vrf             1024     15168     512      512
ip6-route-vrf            100      2884      100      100
device(config) #
```

Creating VLANs as links on a tagged port for security

Where Multi-VRF is used, for example, in an enterprise data center, trusted servers or devices should be allowed to communicate directly, and untrusted ones should not be allowed to communicate directly at all. This optional task configures tagged Layer 3 interfaces to support secure VRF instances.

1. In global configuration mode, create a VLAN.

```
device(config)# vlan 10
device(config-vlan-10) #
```

2. Use the **tagged** command to identify the interface as secure.

```
device(config-vlan-10) # tagged e 1/1/1
```

3. Repeat the previous step on the corresponding interface on the peer device.

Configuring a VRF instance

Do the following to configure a VRF instance.

A device can be configured with more than one VRF instance. You should define each VRF instance before assigning the VRF to a Layer 3 interface. The range of the instance name is from 1 through 255 alphanumeric characters. Each VRF instance is identified by a unique Route Distinguisher (RD), which is prepended to the address being advertised. Because the RD provides overlapping client address space with a unique identifier, the same IP address can be used for different VRFs without conflict. The RD can be an AS number, followed by a colon (:) and a unique arbitrary number as shown below. Alternatively, it can be a local IP address followed by a colon (:) and a unique arbitrary number, as in "1.1.1.1:100." An optional router ID can also be assigned.

Use the **address-family** command in VRF configuration mode to specify an IPv4 or IPv6 address family. For a specific address family you can also configure static route, static ARP, IGMP, and multicast for IPv4, and static route, IPv6 neighbor, and multicast for IPv6.

ATTENTION

Using the **overwrite** option while downloading a configuration from a TFTP server to the running-config will lead to the loss of all VRF configurations when a VRF is configured on a routing interface.

1. (Optional) Assign a Route Distinguisher (RD).

```
device(config-vrf-corporate)# rd 11:11
```

2. (Optional) Assign a router ID.

```
device(config-vrf-corporate)# ip router-id 1.1.1.1
```

3. Use the **address-family unicast (VRF)** command to configure an address family on the VRF and exit. This example uses IPv4.

```
device(config-vrf-corporate)# address-family ipv4 unicast
device(config-vrf-corporate-ipv4)# exit
```

4. Verify the configuration.

```
device(config-vrf-corporate)# do show vrf
Total number of VRFs configured: 2
Status Codes - A:active, D:pending deletion, I:inactive
Name          Default RD      vrf|v4|v6 Routes Interfaces
corporate     11:11           A | A| I      0
guest         10:10           A | A| I      0
Total number of IPv4 unicast route for all non-default VRF is 0
Total number of IPv6 unicast route for all non-default VRF is 0
```

Starting a routing process for a VRF

You must enable a routing protocol for each VRF instance. This example uses OSPF.

1. In global configuration mode, enable OSPF for the VRF instance "corporate."

```
device(config)# router ospf vrf corporate
```

2. Configure the VRF to use OSPF Area 0.

```
device(config-ospf-router-vrf-corporate)# area 0
```

3. (Optional) Configure the VRF to ensure that essential OSPF neighbor state changes are logged, especially in the case of errors.

```
device(config-ospf-router-vrf-corporate)# log adjacency
```

Assigning a Layer 3 interface to a VRF

The following example illustrates how a virtual Ethernet (VE) interface is assigned to a VRF, and how IP addresses and the OSPF protocol are configured.

ATTENTION

After you configure a VRF instance on the device, you must assign one or more Layer 3 interfaces (physical or virtual Ethernet) to the VRF. When you do this, all existing IP addresses are deleted; this action also triggers cache deletion, route deletion, and associated cleanup. After you assign an interface to the VRF, you must reconfigure the IP address and interface properties.

1. Enter global configuration mode.

```
device# configure terminal
```

2. In global configuration mode, enter the **interface ve** command to create a VE interface.

```
device(config)# interface ve 10
```

3. In VE configuration mode, enable forwarding for the VRF "guest".

```
device(config-vif-10)# vrf forwarding guest
Warning: All IPv4 and IPv6 addresses (including link-local) on this interface have been removed
have been removed
```

4. Configure an IPv4 address and mask on the VE interface.

```
device(config-vif-10)# ip address 192.168.1.254/24
```

5. Enable OSPF Area 0.

```
device(config-vif-10)# ip ospf area 0
```

6. Configure the interface as passive.

```
device(config-vif-10)# ip ospf passive
device(config-vif-10)# exit
```

7. Exit the configuration.

```
device(config-vif-10)# exit
```

Assigning a loopback interface to a VRF

Do the following to assign a loopback interface to a nondefault VRF.

Because a loopback interface is always available as long as the device is available, it allows routing protocol sessions to stay up even if the outbound interface is down. Assigning a loopback interface to a VRF is similar to assigning any interface. A loopback interface that is not assigned to a nondefault VRF belongs to the default VRF.

1. Enter global configuration mode.

```
device# configure terminal
```

2. In global configuration mode, enter interface subtype configuration mode and assign a loopback interface.

```
device(config)# interface loopback 1
```

3. Use the **vrf forwarding** command to assign the interface to the VRF "customer-1" in this example.

```
device(config-lbif-1)# vrf forwarding customer-1
```

4. Assign an IPv4 address and mask to the loopback interface.

```
device(config-lbif-1)# ip address 10.0.0.1/24
```

Verifying a Multi-VRF configuration

The following examples illustrate the use of a variety of show commands that are useful in verifying Multi-VRF configurations.

To verify all configured VRFs in summary mode, enter the **show vrf** command, as in the following example.

```
device# show vrf
Total number of VRFs configured: 2
Status Codes - A:active, D:pending deletion, I:inactive
Name Default RD vrf|v4|v6 Routes Interfaces
green 1:1 A | A| A 12 ve111 ve211 ve311*
red 10:12 A | A| A 4 ve1117 port-id tn1*
Total number of IPv4 unicast route for all non-default VRF is 8
Total number of IPv6 unicast route for all non-default VRF is 8
```

To verify a specific VRF in detail mode, enter the **show vrf detail vrf-name** command, as in the following example.

```
device# show vrf green
VRF green, default RD 1:1, Table ID 1
IP Router-Id: 1.1.1.1
Interfaces: ve111 ve211 ve311 ve1116 ve2115
Address Family IPv4
Max Routes: 5500
Number of Unicast Routes: 6
Address Family IPv6
Max Routes: 400
Number of Unicast Routes: 6
```

To verify all configured VRFs in detail mode, enter the **show vrf detail** command, as in the following example.

```
device# show vrf detail
Total number of VRFs configured: 2
VRF green, default RD 1:1, Table ID 1
IP Router-Id: 1.1.1.1
Interfaces: Use "show vrf green" to see the list of interfaces
Address Family IPv4
Max Routes: 5500
Number of Unicast Routes: 6
Address Family IPv6
Max Routes: 400
Number of Unicast Routes: 6
VRF red, default RD 10:12, Table ID 2
IP Router-Id: 1.1.17.1
Interfaces:
Use "show vrf red" to see the list of interfaces
Address Family IPv4
Max Routes: 300
Number of Unicast Routes: 2
Address Family IPv6
Max Routes: 70
Number of Unicast Routes: 2
Total number of IPv4 unicast route for all non-default VRF is 8
Total number of IPv6 unicast route for all non-default VRF is 8
```

Multi-VRF

Configuring Multi-VRF

The following commands display additional information about a specific application, protocol configuration, or protocol state for both the default VRF and user-defined VRFs.

TABLE 114 Useful show commands

Default VRF	User-defined VRF
show ip route	show ip route vrf <i>vrf-name</i>
show ip ospf neighbor	show ip ospf vrf <i>vrf-name</i> neighbor
show ip bgp summary	show ip bgp vrf <i>vrf-name</i> summary

Removing a VRF configuration

The following examples illustrate a variety of ways by which you can remove a VRF configuration: deleting a VRF instance from a port, deleting an address family from a VRF, and deleting the VRF globally.

To delete a VRF instance from a specific port, use the **no** form of the **vrf** command. This removes all Layer 3 interface bindings from the VRF, and returns the interface to default VRF mode. All IP addresses and protocol configuration on this Layer 3 interface are removed.

```
device(config-if-e1000-1/7/1)# no vrf forwarding1
All existing IP and IPv6 address will be removed from port 1/7/1
The port will be returned to default VRF
```

To delete an IPv4 or IPv6 address family from a VRF instance, use the **no** form of the **address-family** command. All configuration related to the address family on all ports of the VRF are removed. Routes allocated to the address family are returned to the global pool.

```
device(config-vrf-customer1)# no address-family ipv4
device(config-vrf-customer1)#

```

To delete a VRF instance globally, use the **no** form of the **vrf** command. All IPv4 or IPv6 addresses are removed from all interfaces.

```
device(config)# no vrf customer1
Warning: All IPv4 and IPv6 addresses (including link-local) from all interfaces in VRF customer1 have been removed
```

Configuring static ARP for Multi-VRF

The interface associated with an ARP entry determines to which VRF the ARP entry belongs.

An ARP entry is defined by the following parameters:

- IP address
- MAC address
- Type
- Interface

1. The following example illustrates how to configure static ARP on default VRFs on an Ethernet interface.

```
device(config)# arp 192.168.1.100 0000.2344.2441 eth 1/7/1
```

- The following example illustrates how to configure static ARP on nondefault VRFs.

NOTE

The **arp** command can be used to configure static-ARP entries on a nondefault VRF interface. The VRF command does not require an ARP index before a static-ARP is configured. The **arp** command is available in the address-family mode for a particular VRF.

The **arp** command is backward compatible from FastIron release 08.0.00a, which uses a new command format. In releases prior to FastIron release 08.0.00a, static-ARP needed an index. For FastIron 08.0.00a and later releases, FastIron accepts the use of indexes as well as the new command without the index.

```
device(config)#
device(config)# vrf customer-1
device(config-vrf-customer-1)# address-family ipv4
device(config-vrf-customer-1-ipv4)# arp 1.1.1.1 0004.8044.5566 ethernet 1/7/8
device(config-vrf-customer-1-ipv4)# exit-address-family
device(config-vrf-customer-1)# exit-vrf
device(config)#
```

Configuring additional ARP features for Multi-VRF

This section discusses options for configuring proxy ARP and ARP rate limiting.

Proxy ARP allows a Layer 3 switch to answer ARP requests from devices on one subnet on behalf of devices in another network. Proxy ARP is configured globally and can be further configured per interface. Interface-level configuration overrides the global configuration.

With the **proxy-arp** command configured, a router does not respond to ARP requests for IP addresses in the same subnet as the incoming ports. The **local-proxy-arp** command permits the router to respond to ARP requests for IP addresses within the same subnet and to forward all traffic between hosts in the subnet. The **local-proxy-arp** command is an interface-level configuration that has no VRF-related impact.

ARP rate limiting is configured globally and applies to all VRFs.

ARP age can be configured globally and on a Layer 3 interface. An ARP age timer configured on a Layer 3 interface overrides the global configuration for ARP aging. The aging timer ensures that the ARP cache does not retain learned entries that are no longer valid.

To configure proxy ARP globally:

```
device(config)# proxy-arp
```

To configure proxy ARP on a Layer 3 Ethernet interface:

```
device(config)# int e1000 1/7/1
device(config-if-e1000-1/7/1)# local-proxy-arp
```

To configure ARP rate limiting globally:

```
device(config)# rate-limit-arp
```

To configure ARP rate limiting on a Layer 3 Ethernet interface for an aging timeout of 20 minutes:

```
device(config)# int e1000 1/7/1
device(config-if-e1000-1/7/1)# ip arp-age 20
```


Multi-Chassis Trunking

- Layer 3 behavior with MCT.....577

Layer 3 behavior with MCT

The following table lists the type of Layer 3 support available with MCT.

TABLE 115 Layer 3 Feature Support with MCT

Feature	Sub-feature	Session VLAN VE	Member VLAN VE	Design Philosophy
ip	access-group ^a	Yes	Yes	Only features that are relevant for MCT management are supported on session VLAN VE.
	address	Yes	Yes	
	arp-age	Yes	Yes	
	bgp	No	Yes	
	bootp-gateway	Yes	Yes	
	directed-broadcast	Yes	Yes	
	encapsulation	Yes	Yes	
	follow	No	No	
	helper-address	Yes	Yes	
	icmp	Yes	Yes	
	igmp	No	No	
	irdp	No	Yes	
	local-proxy-arp	No	Yes	
	metric	No	Yes	
	mtu	Yes	Yes	
	multicast-boundary	No	No	
	ospf	No	Yes	
	pim	No	No	
	pim-sparse	No	Yes	
	policy	No	Yes	
	proxy-arp	No	Yes	
	redirect	No	Yes	
	rip	No	Yes	
	tcp	Yes	Yes	
	tunnel	No	Yes	
	use-acl-on-arp	Yes	Yes	
	vrrp	No	Yes	
	vrrp-extended	No	Yes	

TABLE 115 Layer 3 Feature Support with MCT (continued)

Feature	Sub-feature	Session VLAN VE	Member VLAN VE	Design Philosophy
ipv6		No	No	IPv6 is not supported for MCT management. IPv6 is not supported on member VLAN VE.

a.) *ICL: The ICL port is added as default whenever a CCEP is in OIF. The data traffic received from the ICL port is filtered out by a dynamically programmed egress filter on the CCEPs.

Layer 3 unicast forwarding over MCT

A simple MCT topology addresses resiliency and efficient load balancing in Layer 2 network topologies. Layer 3 technologies can run in an MCT environment too. This allows various Layer 3 technologies to function while leveraging the benefits at the Layer 2 level. The following sections describe the details of Layer 3 behavior in an MCT environment.

ARP Resolution

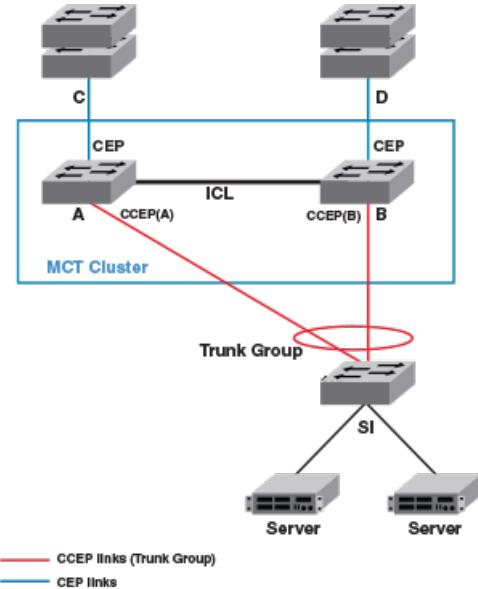
ARP resolution for the MCT client is required at the MCT cluster to forward traffic from a CEP to the CCEP. This ARP packet would normally be learned over the CCEP port. However, if the client's MAC address is not already known on the CCEP, its ARP could be temporarily learned over the ICL. When the MAC Database Update Protocol (MDUP) message from the cluster peer device moves the client MAC address from the ICL to the CCEP, ARP is also moved to the CCEP. During this transient time, no client ARP should be programmed over the ICL for a long period of time unless the local CCEP port is down.

During this transient time, the Layer 3 traffic gets forwarded toward the MCT peer. While the ICX 7750, as an MCT peer, can successfully forward this traffic to the client, SX 800 and SX 1600 devices will experience loss of traffic during this time.

If the MCT client triggers an ARP request, it would do so for its Layer 3 next hop IP address, which generally resides on the MCT cluster devices. This address could be the default gateway on the MCT client or it could be learned through dynamic routing. If VRRP or VRRP-E is deployed on the MCT cluster devices, this IP address can be the virtual IP address.

Due to the inherent nature of LAG on the MCT client, this ARP request can reach an MCT device directly (over the CCEP) or through the MCT peer (over the ICL). In either case, the ARP response is sent out on the port where the client's MAC address is learned. If the MAC address is already learned on the MCT device at the time of receiving the ARP request, it would be over the CCEP under normal working conditions (local CCEP is in the up state). If the client's MAC address was not already learnt when the ARP request is received, the client's ARP could be temporarily learned over the ICL (and is moved to the CCEP when the MDUP message from the peer is received) and the ARP response could be sent over the ICL. The cluster peer then switches the ARP response further towards the MCT client.

FIGURE 39 Configuration for Layer 3 unicast



Layer 3 traffic forwarding towards MCT clients

Traffic destined to the MCT clients follows normal IP routing. By default, the best route should not involve the ICL link. Only when the local CCEP is down is traffic rerouted to pass over the ICL.

Layer 3 traffic forwarding from MCT clients

For Layer 3 forwarding to work on MCT devices, a dynamic trunk must be configured on the MCT client. Routes should be statically configured or dynamically learned on the MCT cluster devices.

The client routes the traffic towards its next hop, which can be either one of the MCT devices. If ECMP is deployed on the client, each MCT device can be a possible next hop. In such a deployment, the traffic can be load balanced at a Layer 3 level over the next two hops. Because a LAG is deployed at the client, this traffic is further subjected to load balancing at the Layer 2 level over the physical ports in the LAG. Thus, the traffic being sent out with the next hop as one of the MCT devices can either reach it directly or through the cluster peer (where it gets Layer 2 switched towards the intended next hop).

Therefore, almost 50 percent of traffic being forwarded from MCT clients (and as much as 100 percent traffic in the worst case) can pass through the ICL. This fact should be considered when designing the ICL capacity in the network.

VRRP or VRRP-E over an MCT-enabled network

To interface a Layer 2 MCT deployment with a Layer 3 network and add redundancy at the Layer 3 level, MCT can be configured with Virtual Router Redundancy Protocol (VRRP). The standard VRRP mode is master-backup, and all traffic is forwarded through the master. In VRRP-E server virtualization, multiple VRRP standby devices are supported, and each device can be configured to route to an upstream Layer 3 network. This provides efficient deployment for both Layer 2 and Layer 3 networks.

The MCT device acting as a backup router will Layer 2 switch all packets destined to VRRP/ VRRP-E virtual MAC address to the VRRP/VRRP-E master router for routing. The VRRP/VRRP-E backup learns the virtual MAC address while processing the VRRP hello message from the VRRP master. Both data traffic and VRRP/VRRP-E control traffic travel through the ICL unless the short-path forwarding feature is enabled (VRRP-E only).

VRRP/VRRP-E and VRRP-E2 SPF should be enabled, if required. If VRRP is deployed or VRRP-E is deployed without the short path forwarding feature on the VRRP-E backup, it is likely that almost fifty percent of CCEP to CEP traffic (and as much as a hundred percent of traffic in the worst case) can pass through the ICL from the backup to the master device. This fact should be considered when designing ICL capacity in the network.

When one MCT device acts as a VRRP/VRRP-E master and the peer device is the VRRP/VRRP-E backup, the following behavior is observed:

- Frames sent to the VRRP/VRRP-E virtual MAC address are Layer 2-switched to the VRRP/VRRP-E master device for routing. The VRRP-E MAC address is learned by the other MCT device that acts as backup router.
- Both data traffic and VRRP-E control traffic received by the VRRP backup from an MCT client must travel through the ICL, unless the short-path forwarding feature is enabled.

When both MCT devices act as the VRRP or VRRP-E backup, the following traffic behavior is observed:

- Frames sent to the VRRP/VRRP-E virtual MAC address are Layer 2 forwarded to the VRRP/VRRP-E master router for routing.
- The VRRP-E MAC address is learned by both MCT devices acting as backup routers.
- Both data traffic and VRRP-E control traffic travel through the links connecting them to the VRRP/VRRP-E master.

VRRP-E short-path forwarding and revertible option

At the VRRP-E VRID configuration level, use the following command to enable short-path forwarding.

```
device(config-if-e1000-vrid-2)# short-path-forwarding revert-priority 60
```

Syntax: [no] short-path-forwarding [revert-priority value]

The **revert-priority** value in the **short-path-forwarding** command works in conjunction with the **track-port** command to control forwarding behavior.

The **track-port** command monitors the status of the outgoing port on the backup. Command behavior can cause short-path forwarding to be disabled temporarily. This happens because as one or more ports tracked by the **track-port** command go down, the current priority of the VRRP-E is lowered by a specific amount configured in the **track-port** command for each port. Once the current-priority of the VRRP-E is lower than the threshold value configured as the **revert-priority** value, short-path forwarding is temporarily suspended because the VRRP-E reverts back to its default forwarding behavior.

To counter this behavior, use the **revert-priority** value in the **short-path-forwarding** command as a control threshold. Short-path forwarding resumes as soon as the VRRP-E priority becomes higher than the **revert priority** threshold. The VRRP-E priority increases by the value configured for the **track port** command as each of the ports tracked by the command becomes active again.

OSPF and BGP over an MCT-enabled network

OSPF and BGP adjacencies can be established over the MCT member VLANs between any combinations of network elements in the MCT topology.

The combinations that can be established are:

- Devices connected to MCT cluster over CEP ports
- Devices connected to MCT cluster over non-MCT ports
- MCT cluster devices
- MCT clients

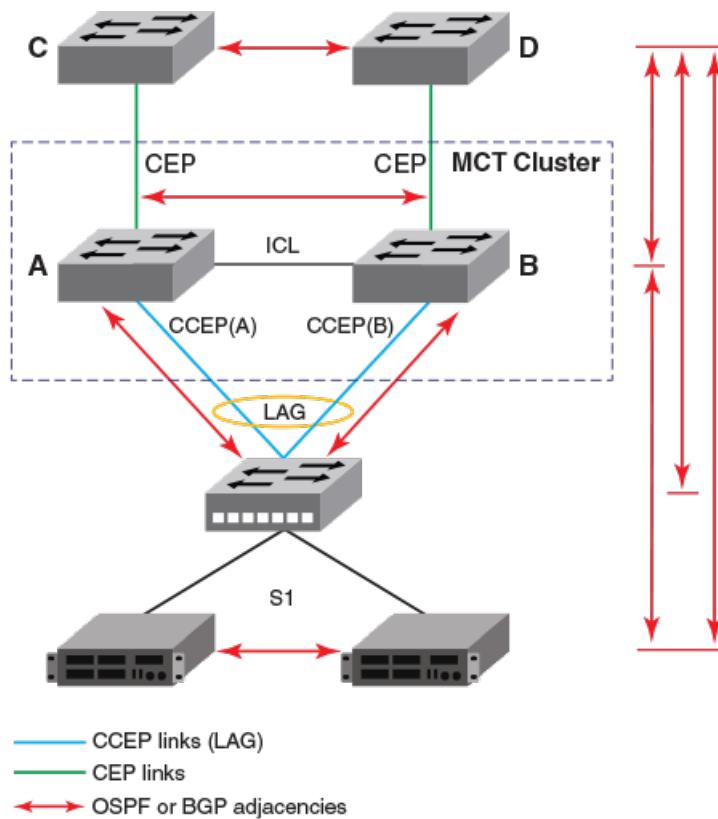
- Devices behind MCT clients

In such a deployment, the MCT clients and the devices behind them form separate protocol adjacencies with each MCT cluster device. These multiple L3 next hops can be utilized by deploying ECMP on the MCT client device.

NOTE

The MCT failover will not be a hitless one for layer 3 traffic since each MCT cluster device forms an independent adjacency. When one of the MCT devices goes down, a layer 3 re-convergence is required and traffic loss is expected during this time.

FIGURE 40 OSPF and BGP configuration in an MCT-enabled network



Layer 3 with MCT configuration considerations

The following configurations apply to layer 3 behavior with MCT.

- Not all layer 3 features on MCT management interface are supported. If a VLAN is already configured with these Layer 3 features, it cannot be made the session VLAN. To see the list of unsupported features on MCT management interface, refer to [Layer 3 behavior with MCT](#) on page 577.
- IPv6 configurations are not supported on VEs of session or member VLANs.
- Route-only ports cannot be used as CCEP or ICL ports.
- Global route-only configuration and MCT cluster configuration are mutually exclusive.
- Using MCT management interface IPs for a tunnel source is not supported.
- Configuring static and policy-based routes using MCT management interface is not supported.

- Configurations to redistribute connected routes will not advertise IP addresses on an MCT management interface.
- IP addresses on the MCT management interface should not be used for BGP peers on neighboring devices.
- IP addresses on the MCT management interface should not be used for static configurations on neighboring devices.
- For MCT devices configured with VRRP or VRRP-E, track-port features can be enabled to track the link status to the core devices on the VRRP master, so the VRRP or VRRP-E failover can be triggered and on the VRRP backup, so as to disable short path forwarding when it loses its relevance.
- VRRP or VRRP-E shouldn't be used along with OSPF or BGP on the same MCT member VE.

NOTE

To prevent unintended traffic forwarding by the CPU, Brocade recommends disabling ICMP redirect globally when VRRP or VRRP-E is configured.

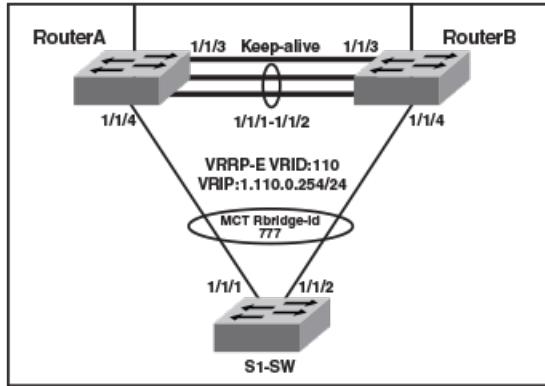
MCT configuration examples

The examples in this section show the topology and configuration for a single-level MCT deployment, VRRP/VRRP-E over MCT, OSPF over MCT and BGP over MCT.

MCT configuration for a single-level MCT deployment

The following figure shows a sample configuration for a single-level MCT. The associated configuration follows.

FIGURE 41 Sample Configuration for a single-level MCT



Router A - MCT configuration

This example presents the MCT configuration for Router A cluster device.

```
!
lag lag_routerA static id 55
  ports ethernet 1/1/1 to 1/1/2
  primary-port 1/1/1
  deploy
!
  port-name "ICL-To_routerB_eth1/1/1" ethernet 1/1/1
  port-name "ICL-To_routerB_eth1/1/2" ethernet 1/1/2
!
vlan 110 name Member-vlan by port
  tagged ethernet 1/1/1 ethe 1/1/2 to 1/1/4
```

```

router-interface ve 110
!
vlan 1000 name ICL-Session-vlan by port
tagged ethernet 1/1/1 to 1/1/2
router-interface ve 1000
!
vlan 1001 name MCT-Keep-Alive by port
tagged ethernet 1/1/3
!
interface ve 1000
ip address 10.0.0.254 255.255.255.252
!
cluster FI-MCT 1750
rbridge-id 801
session-vlan 1000
keep-alive-vlan 1001
icl FI_SWR-MCT ethernet 1/1/1
peer 10.0.0.253 rbridge-id 800 icl FI_SWR-MCT
deploy
client S1-SW
rbridge-id 777
client-interface ethernet 1/1/4
deploy
!
interface ve 110
port-name S1-SW
ip address 10.110.0.253 255.255.255.0
!

```

Router B- MCT configuration

This example presents the MCT configuration for the RouterB cluster device.

```

lag lag_routerb static id 55
ports ethernet 1/1/1 to 1/1/2
primary-port 1/1/1
deploy
!
vlan 110 name Member-vlan by port
tagged ethernet 1/1/1 ethernet 1/1/2 to 1/1/4
router-interface ve 110
!
vlan 1000 name ICL-Session-vlan by port
tagged ethernet 1/1/1 to 1/1/2
router-interface ve 1000
!
vlan 1001 name MCT-Keep-Alive by port
tagged ethernet 1/1/3
!
interface ve 1000
ip address 10.0.0.253 255.255.255.252
!
cluster FI-MCT 1750
rbridge-id 800
session-vlan 1000
keep-alive-vlan 1001
icl FI_SWR-MCT ethernet 1/1/1
peer 10.0.0.254 rbridge-id 801 icl FI_SWR-MCT
deploy
client S1-SW
rbridge-id 777
client-interface ethernet 1/1/4
deploy
!
interface ve 110
port-name S1-SW
ip address 10.110.0.252 255.255.255.0
!
```

S1-SW configuration

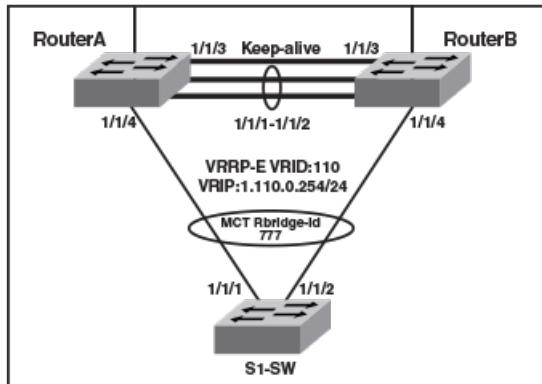
This example presents the configuration for the S1-SW device.

```
!
lag lag_s1_sw static id 60
ports ethe 1/1/1 to 1/1/2
primary-port 1/1/1
deploy
!
vlan 110 by port
tagged ethe 1/1/1 to 1/1/2
router-interface ve 110
!
interface ve 110
ip address 10.110.0.1 255.255.255.0
!
```

MCT configuration with VRRP-E

The following figure shows a sample MCT configuration with VRRP-E. The associated configuration follows. The configuration for VRRP is similar.

FIGURE 42 Sample MCT configuration with VRRP-E



Router A - VRRP-E configuration

This example presents the VRRP-E configuration for the Router A cluster device.

```
!
router vrrp-extended
!
interface ve 110
port-name S1-SW
ip address 10.110.0.253 255.255.255.0
ip vrrp-extended vrid 110
backup
ip-address 10.110.0.254
short-path-forwarding
enable
!
```

Router B - VRRP-E configuration

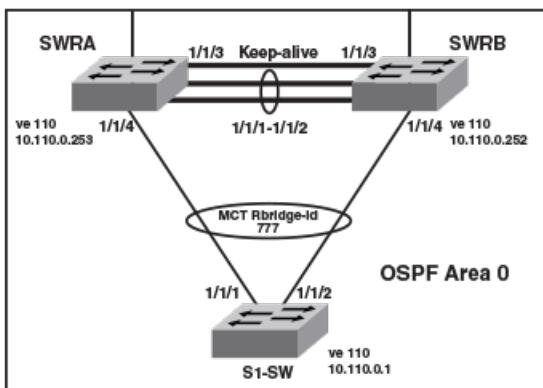
This example presents the VRRP-E configuration for the RouterB cluster device.

```
!
router vrrp-extended
!
interface ve 110
port-name S1-SW
ip address 10.110.0.252 255.255.255.0
ip vrrp-extended vrid 110
  backup
    ip-address 10.110.0.254
    short-path-forwarding
    enable
!
!
```

MCT Configuration with OSPF

The following examples describe sample MCT configurations with OSPF.

FIGURE 43 MCT Configuration with OSPF



SWRA - OSPF configuration

This example presents the OSPF configuration for the SWRA cluster device.

```
!
router ospf
area 0
!
interface ve 110
ip address 10.110.0.253 255.255.255.0
ip ospf area 0
!
```

SWRB - OSPF configuration

This example presents the OSPF configuration for the SWRB cluster device.

```
!
router ospf
area 0
!
interface ve 110
ip address 10.110.0.252 255.255.255.0
ip ospf area 0
!
```

S1-SW configuration

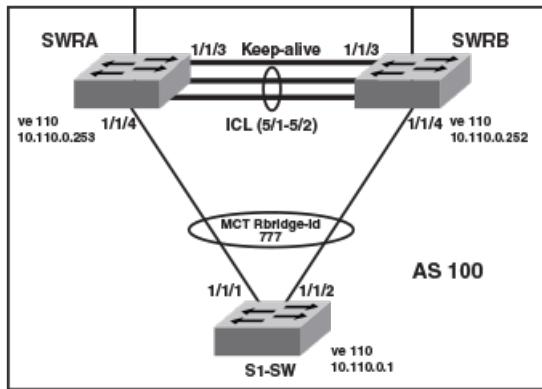
This example presents the configuration for the S1-SW device.

```
!
lag lag_s1_sw static id 60
ports ethernet 1/1/1 to 1/1/2
primary-port 1/1/1
deploy
!
vlan 110 by port
tagged ethernet 1/1/1 to 1/1/2
router-interface ve 110
!
router ospf
area 0
!
interface ve 110
ip address 10.110.0.1 255.255.255.0
ip ospf area 0
!
```

MCT Configuration with BGP

The following examples describe sample MCT configurations with BGP.

FIGURE 44 MCT Configuration with BGP



SWRA - BGP configuration

This example presents the BGP configuration for the SWRA cluster device.

```
!
interface ve 110
ip address 10.110.0.253 255.255.255.0
!
router bgp
local-as 100
neighbor 10.110.0.252 remote-as 100
neighbor 10.110.0.1 remote-as 100
!
```

SWRB - BGP configuration

This example presents the BGP configuration for the SWRB cluster device.

```
!
interface ve 110
ip address 10.110.0.252 255.255.255.0
!
router bgp
local-as 100
neighbor 10.110.0.253 remote-as 100
neighbor 10.110.0.1 remote-as 100
!
```

S1-SW configuration

This example presents the configuration for the S1-SW device.

```
!
lag lag_s1_sw static id 60
ports ethernet 1/1/1 to 1/1/2
primary-port 1/1/1
deploy
!
vlan 110 by port
tagged ethernet 1/1/1 to 1/1/2
router-interface ve 110
!
interface ve 110
ip address 10.110.0.1 255.255.255.0
!
router bgp
local-as 100
neighbor 10.110.0.253 remote-as 100
neighbor 10.110.0.252 remote-as 100
!
```

PIM over MCT intermediate router functionality

MCT peers support intermediate router functionality by accepting PIM neighbors on specific interfaces, thus routing multicast traffic as fully functional PIM devices acting as upstream and downstream routers.

MCT peers support multicast routing (PIM) on Cluster Client Edge Port (CCEP) and Inter-Chassis Link (ICL) interfaces.

PIM states between MCT peers are synchronized by sending the control packets natively over ICL. The nature of the MCT LAG requires this. Packets from the MCT client on the CCEP ports are received by only one of the MCT peers. Hence the control packets that are received natively on the CCEP ports are sent over ICL to synchronize the states. The Join or Prune and Asserts are synchronized to maintain the Outgoing Interface (OIF) state for the CCEP ports on both peers. For CCEP OIFs created by PIM joins, only one of the MCT peers forwards the traffic and the other peer drops the traffic.

These are the general rules followed for the control packet handling algorithm.

- Control packets originated from MCT peers will be flooded on MCT VLAN. Exceptions are Assert packets and Join packets triggered only for ICL OIFs.
- Control packets received on any port of MCT VLAN are flooded on MCT VLAN.
- Control packets received on ICL are flooded in a controlled manner on MCT VLAN based on remote CCEP status, that is, based on whether they are up or down.

Control and data packets received on an ICL port are processed by searching the source MAC of the packet in the MAC table to determine the packet ingress port as follows:

- If the source MAC is learned on CCEP port, the packet ingress port will be a CCEP port.

- If it is not, the packet ingress port will be an ICL port.

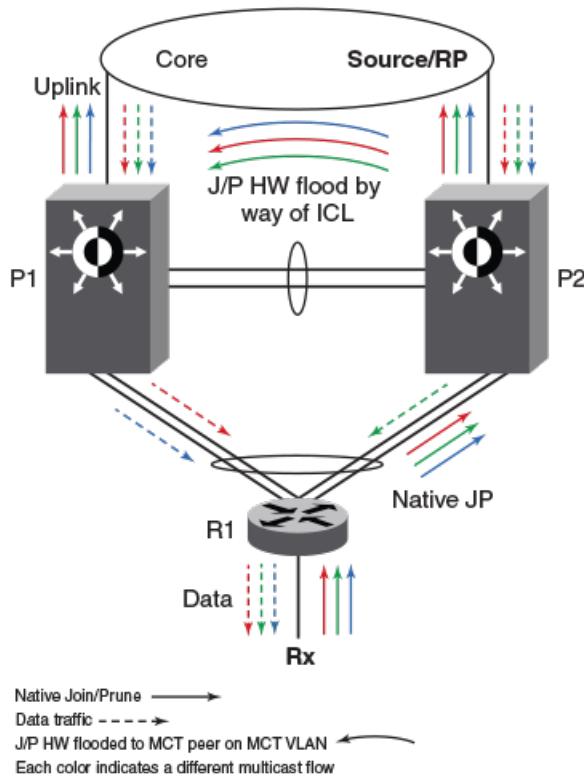
In the following figures, P1 and P2 are MCT peers and R1 is the MCT client. P1, P2 and R1 are configured with PIM on the MCT VE interface. MCT peers act as PIM intermediate routers with respect to R1.

MCT peer as intermediate Upstream router

P1 and P2 are the MCT peers and are acting as upstream routers for R1. R1 is the last-hop router (LHR).

P1, P2, and R1 are configured with PIM on the MCT virtual Ethernet (VE) interface. RP and source is in the core and the connectivity to the core is via an uplink.

FIGURE 45 MCT peer as immediate Upstream router



Hello exchange and neighbor state:

- In MCT topology, the CCEP links going out of P1 and P2 to R1 are treated as a single LAG at R1. That means when R1 sends multicast packets (either control or data packets), they reach only one of the peers. These control packets (hellos, joins, prunes, and others) received by one peer are flooded on the MCT VLAN including the ICL port to the other peer.
- Hellos sent by R1 could reach either P1 or P2 due to the above nature of MCT LAG.
- Hellos that reach P2 are sent to P1 natively over ICL. That means P1 learns about R1 (by searching the source-MAC of the hello packet in its MAC table) and it treats the hello as if it was received on its CCEP interface. Thus both P1 and P2 learn about the PIM neighbors across the CCEP links and create neighbor state for R1.
- Hellos originated from P1 and P2 are flooded on the MCT VLAN i.e. on ICL, CEP, local CCEP ports. This enables R1 to learn that both the MCT peers are PIM neighbors and also enables P1 and P2 to learn about each other as PIM neighbors on an ICL link and create neighbor state, for each other.

Join or prune exchange and mcache state:

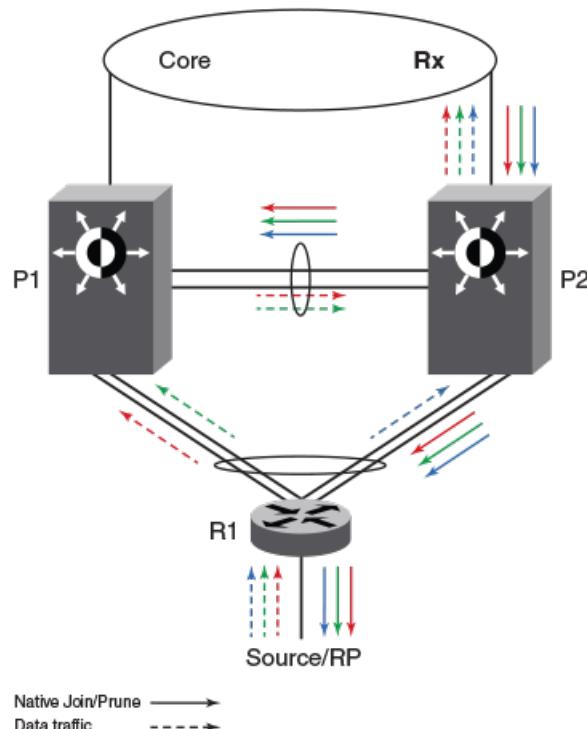
- As receivers are connected to R1, R1 creates \ast, G state and sends a join state towards RP and sends it on the MCT LAG. This join, like any other packet, is received by only one of the MCT peers.
- Suppose P2 receives the \ast, G join natively. This join is processed or consumed and is also flooded to P1 over ICL.
- P1 processes the join received over ICL as if it is received on CCEP.
- Both P1 and P2 create \ast, G state with CCEP as OIF.
- Both the peers send the \ast, G join towards RP and both the peers pull the traffic.
- When the traffic arrives, the S, G state is created on both the peers but only one of them forwards based on the software hashing algorithm.

MCT peer as intermediate Downstream router

P1 and P2 are the MCT peers and are acting as downstream routers for R1. R1 is the intermediate router.

P1, P2 and R1 are configured with PIM on the MCT VE interface. RP and source are beyond R1.

FIGURE 46 MCT peer as immediate downstream router



Hello exchange and neighbor state:

It acts and works as the upstream router.

Join or prune exchange and mcache state:

- The \ast, G joins come from the core to P2.
- P2 creates \ast, G state with uplink as OIF by consuming the join state.

- P2 due to its *,G state originates a join towards RP. This join is flooded on the MCT VLAN and R1 creates *,G state.
- P1 on receiving this join natively via ICL creates *,G state and adds ICL as OIF. Note that as a special case P1 will not include the *,G in the join it generates towards RP as in this case the IIF is CCEP and ICL is the only OIF and the remote CCEP is up. This is to avoid P1 pulling traffic from P2 unnecessarily on the ICL link because of P1 sending joins flooded on the VLAN and in turn P2 adds ICL as an OIF.
- R1 sends the join toward RP and pulls the traffic. Because the OIF at R1 is LAG, traffic pulled by R1 will be load-shared among the member links.
- Thus traffic for S,G will reach only one of the MCT peers. Assuming the traffic reaches P2, (S,G) state will be created on P2 and P2 will be forwarding the traffic.
- Assuming the traffic reaches P1 the traffic will be forwarded via ICL to P2 and P2 will forward it to its OIFs which is the link connecting to the core.

Load sharing of multicast traffic by MCT-cluster on CCEP links

MCT peers load-share multicast traffic on both the local and the remote CCEP links when both are available.

Loads are only shared, and may or may not be balanced, across the CCEP links. An MCT peer selects a stream for forwarding based on a software hash function that uses the source and group addresses. That means you can have one MCT peer forwarding more multicast streams than another.

The load is assigned without regard to the capacity of the CCEP links, so the feature works best when both CCEP links have the same capacity and the source and group addresses are evenly distributed. That situation avoids the timing synchronization between the MCT peer routers, which would be very hard to achieve.

The sharing is done at a stream, not packet, level ,using the following software hash algorithm:

$((\text{source address} + \text{group address}) \& 0x00000001) ^ (\text{local_bridge_id} > \text{remote_bridge_id})$

If result is 1, local CCEP forwards the traffic; if result is 0, remote CCEP forwards the traffic

Fast convergence of multicast traffic

The multicast routing on MCT feature provides sub-second convergence of traffic in the event of CCEP or MCT peer failures and recoveries.

When a CCEP or MCT peer fails, multicast traffic that used to go through the failed CCEP link or node switches to the surviving CCEP link in approximately one second or less.

Sub-second convergence requires both MCT peers to maintain state for, and pull down, traffic for all multicast flows from the core, regardless of whether the chassis is forwarding this stream out of the local CCEP. This means that streams forwarded by the remote CCEP are pulled down to the local MCT peer but dropped in the absence of other receivers on the local router, thus potentially wasting the bandwidth inside the core on uplink. This is deemed a fair tradeoff because otherwise the MCT peer that takes over the job of forwarding a stream when the remote CCEP or peer fails, must establish a new multicast path through the core, which can potentially black out the stream for many seconds

Requirements for multicast MCT

OSPF must be supported on MCT member VLAN virtual Ethernet (VE) interfaces, that is, on CCEP, CEP, and ICL links.

Limitations

These are the limitations for MCT peers to support intermediate router functionality. These limitations are due to load-sharing and fast convergence trade-offs.

- PIM-DM is not supported.
- Few packets may be lost during convergence interval or forwarding duplication may happen.
- MCT client will do flow based load-sharing, not per packet load-sharing.
- Traffic loss or duplication will happen when Keep-Alive VLAN, Cluster Communication Protocol (CCP) ,or ICL between MCT peers are not up.
- Multicast routing configurations on session VLAN is not supported and restricted in configuration.
- The load will only be shared, and may or may not be balanced across the CCEPs.
- During the convergence interval, a few packets may be lost. In the case of recoveries, some packets may end up being forwarded by both cluster routers during interval.
- Both the MCT peers maintain state and pull down traffic for all multicast flows from the core, whether the chassis is forwarding this stream to the local CCEP or not. This could potentially waste the bandwidth inside the core and on uplink.
- You can configure both MCT peers to do either PIM routing or multicast snooping in MCT VLANs. However, configuring one MCT peer to do PIM routing and the other to do multicast snooping in the same MCT VLAN is not supported.
- PIM neighbor on CEP in an MCT VLAN is not supported if the MCT cluster is running PIM on the same MCT VLAN.
- First-hop routing (FHR) and "Last-hop routing (LHR) are not supported on MCT clusters on MCT VLAN interfaces.
- Rendezvous points (RP) are not supported on MCT clusters.
- MSDP and Anycast-RP are not supported on MCT clusters.
- This feature is not supported on non default VRFs.
- IPv6 multicast routing on MCT is not supported on MCT clusters.

Configuring multicast routing over MCT

Follow these steps to configure multicast routing over MCT.

1. Configure an MCT cluster.
2. Configure an MCT member VLAN.
3. Configure multicast routing (PIM) over MCT member VE.

Multi-Chassis Trunking

Layer 3 behavior with MCT

This example shows the configuration of an MCT cluster, MCT member VLAN with router interface (VE), PIM configuration over MCT member VE on MCT Peer 1.

```
cluster cs 10
rbridge-id 1000
session-vlan 4
keep-alive-vlan 5
icl MCT ethernet 1/1/1
peer 5.5.5.100 rbridge-id 4000 icl MCT
deploy
client client-100
rbridge-id 100
client-interface ethernet 1/1/11
deploy
!
!
!
!
!
!
end

vlan 10 name member-vlan by port
tagged ethe 1/1/1 ethe 1/1/11 ethe 1/1/25
router-interface ve 10
spanning-tree 802-1w
spanning-tree 802-1w ethe 1/1/11 disable
!
!

interface ve 10
ip address 10.10.10.100 255.255.255.0
ip pim-sparse
ip ospf area 0
```

This example shows the configuration of an MCT cluster, MCT member VLAN with router interface (VE), PIM configuration over MCT member VE on MCT Peer 2.

```
cluster cs 10
rbridge-id 4000
session-vlan 4
keep-alive-vlan 5
icl MCT ethernet 2/1/1
peer 5.5.5.10 rbridge-id 1000 icl MCT
deploy
client client-100
rbridge-id 100
client-interface ethernet 2/1/11
deploy
!
!
!
!
!
!
end

vlan 10 name member-vlan by port
tagged ethe 2/1/1 ethe 2/1/11 ethe 2/1/27
router-interface ve 10
spanning-tree 802-1w
spanning-tree 802-1w ethe 2/1/11 disable
!

interface ve 10
ip address 10.10.10.1 255.255.255.0
ip pim-sparse
ip ospf area 0
```


Unicast Reverse Path Forwarding

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Unicast Reverse Path Forwarding

The unicast Reverse Path Forwarding check is used to avoid source IP-based spoofing and a malformed source IP address.

A number of common types of denial-of-service (DoS) attacks, including Smurf and Tribe Flood Network (TFN), can take advantage of forged or rapidly changing source IP addresses to allow attackers to thwart efforts to locate or filter the attacks. Reverse Path Forwarding (RPF) is designed to prevent such an attacker from spoofing a source IP address by checking that the source IP address specified for a packet is received from a network to which the device has access. Packets with invalid source IP addresses are not forwarded. RPF is supported for IPv4 and IPv6 packets. Differences in RPF support between IPv4 and IPv6 are noted within this section where necessary. RFC3704, Ingress Filtering for Multihomed Networks, covers various aspects of the Source IP address being spoofed in a traffic being forwarded.

FastIron devices support two unicast Reverse Path Forwarding (uRPF) modes according to RFC 3704:

- Strict mode: In this mode, all incoming packets are tested against the forwarding information base (FIB). If the incoming interface is not the best reverse path, the packet check fails. Failed packets are discarded by default. Source IP (SIP) lookup and the SIP's next hop layer interface information is used in this mode. This mode has options to include default route check or exclude default route check.
- Loose mode: In this mode, each incoming packet's source address is tested against the forwarding information base. As long as there is a match for the source IP address in the forwarding information base, the traffic is allowed. Next hop interface information is not used in this mode. The packet is dropped only if the source address is not reachable through any interface on that router. This mode has options of including the default route check or excluding the default route check. Including the default route check is the default configuration mode. Use the **rpf-mode strict** command for this mode. To exclude the default route check, you must include the option to **urpf-exclude-default** after entering the command **rpf-mode strict** explicitly.

Configuration considerations for uRPF

The following configuration considerations apply to unicast Reverse Path Forwarding (uRPF) on supported Brocade devices.

The following are general considerations for uRPF:

- uRPF works on the layer 3 interface level (layer 3 physical interface or layer 3 VE interface).
- uRPF is VRF-aware.
- If a VLAN has multiple ports, the uRPF check will not identify packets coming in from different ports within the same VLAN, since a VLAN is considered as having a single Layer 3 interface.
- uRPF can be configured along with PBR, routing protocol configurations, and multicast configurations.
- uRPF is not supported on tunnel interfaces.

Unicast Reverse Path Forwarding

Unicast Reverse Path Forwarding feasibility

- Tunnel keep-alive packets will be dropped in the hardware if uRPF is configured.
- uRPF should not be configured on devices where group-VE, tunnel keep-alive packets, or OpenFlow is configured.
- Counters or logging information is unavailable for uRPF hits.
- After enabling reverse path check, you must reload the device for uRPF to be programmed.
- Tunnel over user VRF should not be configured on a device on which uRPF is enabled.

ICX 6610 considerations

- ICX 6610 devices support only strict mode configuration.
- You can enable uRPF only in global configuration mode on ICX 6610 devices.
- You cannot enable uRPF mode at the interface level on ICX 6610 devices.
- uRPF is supported only in a homogeneous ICX 6610 stack.
- uRPF is enabled on selective prefixes on ICX 6610 devices.
- IPv4 routes which have a single path or ECMP path next hop learned on VE interfaces are only uRPF-enabled.
- IPv4 unicast routed packets are supported on ICX 6610 devices for uRPF check.
- You cannot enable RPF mode at the interface level on ICX 6610 devices.
- Prefixes learned over IPv4 and IPv6 tunnel are not subjected to uRPF check on ICX 6610 devices.
- Scaling numbers on the device remain intact after configuring uRPF.

ICX 7750 considerations

- ICX 7750 devices support global mode and interface configuration mode.
- Per-interface level configuration is available on VE interfaces and physical ports only.
- IPv4 and IPv6 unicast routed packets are subjected to uRPF check on ICX 7750 devices.
- Scaling numbers are reduced by half for the following system values when uRPF is enabled: ip-route, ip6-route, ip-route-default-vrf, ip6-route-default-vrf, ip-route-vrf, ip6-route-vrf.
- uRPF and MCT should not be configured together.
- If for a route the number ECMP path is more than 8, the hardware automatically chooses to use loose mode check, despite the configuration on the incoming interface.
- If the interface is not uRPF enabled the traffic is not subjected to uRPF check.
- If the interface is uRPF enabled both IPv4 and IPv6 traffic will be subjected to uRPF check.

Unicast Reverse Path Forwarding feasibility

The following table provides support information about uRPF.

TABLE 116 unicast Reverse Path Forwarding Feasibility

Device	Configurable mode	ECMP route supported	Default route lookup control	Non-Tunneled		Tunneled	
				IPv4	IPv6	IPv4	IPv6
ICX 6610	Strict mode (Global configuration)	Yes	N/A	Yes	No	No	No

TABLE 116 unicast Reverse Path Forwarding Feasibility (continued)

Device	Configurable mode	ECMP route supported	Default route lookup control	Non-Tunneled		Tunneled	
ICX 7750	Strict mode (Interface configuration)	Yes	Yes	Yes	Yes	No	No
	Loose mode (Interface configuration)	NA	Yes	Yes	Yes	No	No

NOTE

For the Strict mode (interface configuration), if the number of ECMP paths for a route is more than 8, then the hardware will apply loose mode check for the SIP check, even if the interface is configured as strict mode.

System-max changes and uRPF

The following tables describe the system-max values with and without uRPF configured on the device. Note that the values with uRPF configuration after reload are reduced by half.

TABLE 117 ICX 7750 system-max values without uRPF configuration

System parameter	Default	Maximum	Current	Configured
ip-route	98304	131072	98304	98304
ip6-route	5120	7168	5120	5120
ip-route-default-vrf	65536	131072	65536	65536
ip6-route-default-vrf	2048	7168	2048	2048
ip-route-vrf	4096	131072	4096	4096
ip6-route-vrf	1024	7168	1024	1024

TABLE 118 ICX 7750 system-max values with uRPF configuration after reload

System parameter	Default	Maximum	Current	Configured
ip-route	49152	65536	49152	49152
ip6-route	2560	3584	2560	2560
ip-route-default-vrf	32768	65536	32768	32768
ip6-route-default-vrf	1024	3584	1024	1024
ip-route-vrf	2048	65536	2048	2048
ip6-route-vrf	512	3584	512	512

TABLE 119 ICX 7250 system-max values without uRPF configuration

System parameter	Default	Maximum	Current	Configured
ip-route	12000	12000	12000	12000
ip6-route	730	2048	730	730

Unicast Reverse Path Forwarding

Enabling unicast Reverse Path Forwarding

TABLE 120 ICX 7250 system-max values with uRPF configuration after reload

System parameter	Default	Maximum	Current	Configured
ip-route	6000	6000	6000	6000
ip6-route	365	1024	365	365

TABLE 121 ICX 7450 system-max values without uRPF configuration

System parameter	Default	Maximum	Current	Configured
ip-route	12000	15168	12000	12000
ip6-route	5120	5120	5120	5120
ip-route-default-vrf	12000	15168	12000	12000
ip6-route-default-vrf	5120	5120	5120	5120
ip-route-vrf	1024	15168	1024	1024
ip6-route-vrf	100	5120	100	100

TABLE 122 ICX 7450 system-max values with uRPF configuration after reload

System parameter	Default	Maximum	Current	Configured
ip-route	6000	7584	6000	6000
ip6-route	2584	3572	2584	2584
ip-route-default-vrf	6000	7584	6000	6000
ip6-route-default-vrf	2560	2560	2560	2560
ip-route-vrf	512	7584	512	512
ip6-route-vrf	50	2560	50	50

Enabling unicast Reverse Path Forwarding

Unicast Reverse Path Forwarding can be enabled in different modes.

The strict mode is enabled when you enable uRPF on ICX 6610 devices. The prefixes learned over the VE interfaces that do not have tunnel-termination specified as a next hop are enabled. On ICX 7750 devices, the uRPF check enables the interface level CLI and hardware settings. You should reload the device after enabling reverse path check for this configuration to be captured in the system settings.

NOTE

Refer to the *FastIron Command Reference* for a complete list of supported commands.

1. Enter global configuration mode.
2. Enter the **reverse-path-check** command.

The following example enables uRPF at the global level.

```
device(config)# reverse-path-check
```

Configuring unicast Reverse Path Forwarding modes

Configure the various unicast reverse path forwarding modes on a layer 3 VE or physical interface.

You must enable unicast reverse path forwarding globally before you enable the required forwarding modes.

1. Enter interface configuration mode.
2. Enter the **rpf-mode** command followed by the required mode (**strict** or **loose**) you want to configure on the device. You can optionally use the exclude default route (urpf-exclude-default) check on the physical interface.

The following example shows the uRPF strict mode enabled.

```
device# interface ethernet 1/1/9
device(interface ethernet 1/1/9)# rpf-mode strict
```



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