IP Configuration Guide, Cisco IOS XE Fuji 16.8.x (Catalyst 3650 Switches)

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Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

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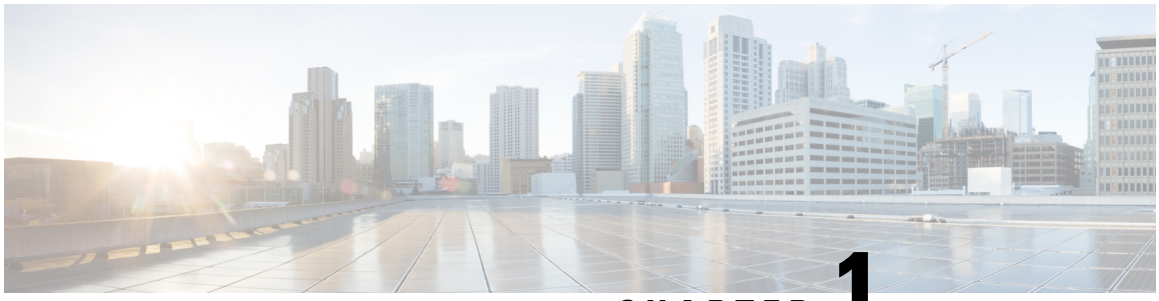


CHAPTER 1

Configuring HSRP

• Configuring HSRP , on page 1

Configuring HSRP

This chapter describes how to use Hot Standby Router Protocol (HSRP) to provide routing redundancy for routing IP traffic without being dependent on the availability of any single router.

You can also use a version of HSRP in Layer 2 mode to configure a redundant command switch to take over cluster management if the cluster command switch fails. This feature is not supported on the C9500-12Q, C9500-16X, C9500-24Q, C9500-40X models of the Cisco Catalyst 9500 Series Switches.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About Configuring HSRP

HSRP Overview

HSRP is Cisco's standard method of providing high network availability by providing first-hop redundancy for IP hosts on an IEEE 802 LAN configured with a default gateway IP address. HSRP routes IP traffic without relying on the availability of any single router. It enables a set of router interfaces to work together to present the appearance of a single virtual router or default gateway to the hosts on a LAN. When HSRP is configured on a network or segment, it provides a virtual Media Access Control (MAC) address and an IP address that is shared among a group of configured routers. HSRP allows two or more HSRP-configured routers to use the MAC address and IP network address of a virtual router. The virtual router does not exist; it represents the common target for routers that are configured to provide backup to each other. One of the routers is selected to be the active router and another to be the standby router, which assumes control of the group MAC address and IP address should the designated active router fail.

Note Routers in an HSRP group can be any router interface that supports HSRP, including routed ports and switch virtual interfaces (SVIs).

HSRP provides high network availability by providing redundancy for IP traffic from hosts on networks. In a group of router interfaces, the active router is the router of choice for routing packets; the standby router is the router that takes over the routing duties when an active router fails or when preset conditions are met.

HSRP is useful for hosts that do not support a router discovery protocol and cannot switch to a new router when their selected router reloads or loses power. When HSRP is configured on a network segment, it provides a virtual MAC address and an IP address that is shared among router interfaces in a group of router interfaces running HSRP. The router selected by the protocol to be the active router receives and routes packets destined for the group's MAC address. For n routers running HSRP, there are n +1 IP and MAC addresses assigned.

HSRP detects when the designated active router fails, and a selected standby router assumes control of the Hot Standby group's MAC and IP addresses. A new standby router is also selected at that time. Devices running HSRP send and receive multicast UDP-based hello packets to detect router failure and to designate active and standby routers. When HSRP is configured on an interface, Internet Control Message Protocol (ICMP) redirect messages are automatically enabled for the interface.

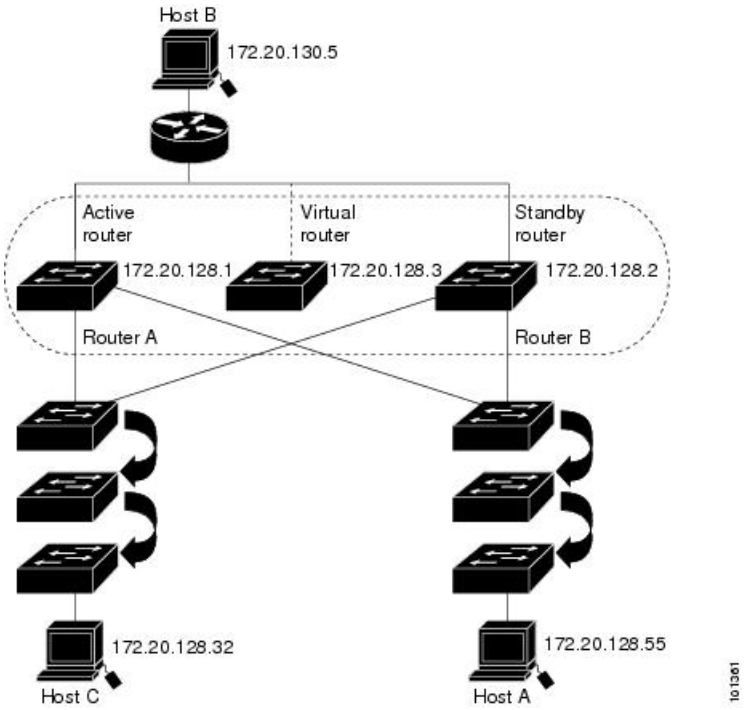
You can configure multiple Hot Standby groups among switches and switch stacks that are operating in Layer 3 to make more use of the redundant routers.

Note Catalyst 9500-H Series Switches do not support stacking.

To do so, specify a group number for each Hot Standby command group you configure for an interface. For example, you might configure an interface on switch 1 as an active router and one on switch 2 as a standby router and also configure another interface on switch 2 as an active router with another interface on switch 1 as its standby router.

The following figure shows a segment of a network configured for HSRP. Each router is configured with the MAC address and IP network address of the virtual router. Instead of configuring hosts on the network with the IP address of Router A, you configure them with the IP address of the virtual router as their default router. When Host C sends packets to Host B, it sends them to the MAC address of the virtual router. If for any reason, Router A stops transferring packets, Router B responds to the virtual IP address and virtual MAC address and becomes the active router, assuming the active router duties. Host C continues to use the IP address of the virtual router to address packets destined for Host B, which Router B now receives and sends to Host B. Until Router A resumes operation, HSRP allows Router B to provide uninterrupted service to users on Host C's segment that need to communicate with users on Host B's segment and also continues to perform its normal function of handling packets between the Host A segment and Host B.

Figure 1: Typical HSRP Configuration



HSRP Versions

Cisco IOS XE 3.3SE and later support these Hot Standby Router Protocol (HSRP) versions:

The switch supports these HSRP versions:

- HSRPv1- Version 1 of the HSRP, the default version of HSRP. It has these features:
  - The HSRP group number can be from 0 to 255.
  - HSRPv1 uses the multicast address 224.0.0.2 to send hello packets, which can conflict with Cisco Group Management Protocol (CGMP) leave processing. You cannot enable HSRPv1 and CGMP at the same time; they are mutually exclusive.
- HSRPv2- Version 2 of the HSRP has these features:
  - HSRPv2 uses the multicast address 224.0.0.102 to send hello packets. HSRPv2 and CGMP leave processing are no longer mutually exclusive, and both can be enabled at the same time.
  - HSRPv2 has a different packet format than HRSPv1.

A switch running HSRPv1 cannot identify the physical router that sent a hello packet because the source MAC address of the router is the virtual MAC address.

HSRPv2 has a different packet format than HSRPv1. A HSRPv2 packet uses the type-length-value (TLV) format and has a 6-byte identifier field with the MAC address of the physical router that sent the packet.

If an interface running HSRPv1 gets an HSRPv2 packet, the type field is ignored.

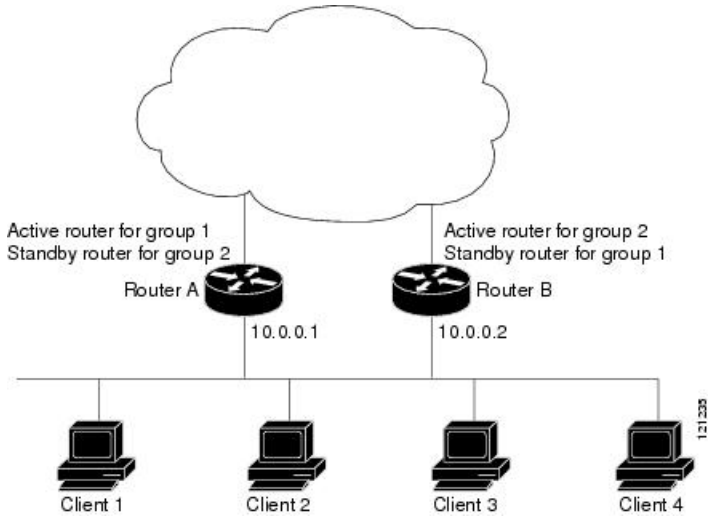
Multiple HSRP

The switch supports Multiple HSRP (MHSRP), an extension of HSRP that allows load sharing between two or more HSRP groups. You can configure MHSRP to achieve load-balancing and to use two or more standby groups (and paths) from a host network to a server network.

In the figure below, half the clients are configured for Router A, and half the clients are configured for Router B. Together, the configuration for Routers A and B establishes two HSRP groups. For group 1, Router A is the default active router because it has the assigned highest priority, and Router B is the standby router. For group 2, Router B is the default active router because it has the assigned highest priority, and Router A is the standby router. During normal operation, the two routers share the IP traffic load. When either router becomes unavailable, the other router becomes active and assumes the packet-transfer functions of the router that is unavailable.

Note For MHSRP, you need to enter the **standby preempt** interface configuration command on the HSRP interfaces so that if a router fails and then comes back up, preemption restores load sharing.

Figure 2: MHSRP Load Sharing



SSO HSRP

This feature is not supported on the C9500-12Q, C9500-16X, C9500-24Q, C9500-40X models of the Cisco Catalyst 9500 Series Switches. SSO HSRP alters the behavior of HSRP when a device with redundant Route Processors (RPs) is configured for stateful switchover (SSO) redundancy mode. When an RP is active and the other RP is standby, SSO enables the standby RP to take over if the active RP fails.

With this functionality, HSRP SSO information is synchronized to the standby RP, allowing traffic that is sent using the HSRP virtual IP address to be continuously forwarded during a switchover without a loss of data or a path change. Additionally, if both RPs fail on the active HSRP device, then the standby HSRP device takes over as the active HSRP device.

The feature is enabled by default when the redundancy mode of operation is set to SSO.

HSRP and Switch Stacks

HSRP hello messages are generated by the stack master. If an HSRP-active stack master fails, a flap in the HSRP active state might occur. This is because HSRP hello messages are not generated while a new stack master is elected and initialized, and the standby router might become active after the stack master fails.

Configuring HSRP for IPv6

Switches running the IP Services and IP Base feature set support the Hot Standby Router Protocol (HSRP) for IPv6. HSRP provides routing redundancy for routing IPv6 traffic not dependent on the availability of any single router. IPv6 hosts learn of available routers through IPv6 neighbor discovery router advertisement messages. These messages are multicast periodically or are solicited by hosts.

An HSRP IPv6 group has a virtual MAC address that is derived from the HSRP group number and a virtual IPv6 link-local address that is, by default, derived from the HSRP virtual MAC address.

Periodic messages are sent for the HSRP virtual IPv6 link-local address when the HSRP group is active. These messages stop after a final one is sent when the group leaves the active state.

Note When configuring HSRP for IPv6, you must enable HSRP version 2 (HSRPv2) on the interface.

How to Configure HSRP

Default HSRP Configuration

Table 1: Default HSRP Configuration

Feature	Default Setting
HSRP version	Version 1
HSRP groups	None configured
Standby group number	0
Standby MAC address	System assigned as: 0000.0c07.acXX, where XX is the HSRP group number
Standby priority	100
Standby delay	0 (no delay)
Standby track interface priority	10
Standby hello time	3 seconds
Standby holdtime	10 seconds

HSRP Configuration Guidelines

- HSRPv2 and HSRPv1 are mutually exclusive. HSRPv2 is not interoperable with HSRPv1 on an interface and the reverse.

- In the procedures, the specified interface must be one of these Layer 3 interfaces:
  - Routed port: A physical port configured as a Layer 3 port by entering the **no switchport** command in interface configuration mode.
  - SVI: A VLAN interface created by using the **interface vlan** *vlan_id* in global configuration mode, and by default a Layer 3 interface.
  - Etherchannel port channel in Layer 3 mode: A port-channel logical interface created by using the **interface port-channel** *port-channel-number* in global configuration mode, and binding the Ethernet interface into the channel group.
- All Layer 3 interfaces must have IP addresses assigned to them.

Note HSRP millisecond timers are not supported.

Enabling HSRP

The **standby ip** interface configuration command activates HSRP on the configured interface. If an IP address is specified, that address is used as the designated address for the Hot Standby group. If no IP address is specified, the address is learned through the standby function. You must configure at least one Layer 3 port on the LAN with the designated address. Configuring an IP address always overrides another designated address currently in use.

When the **standby ip** command is enabled on an interface and proxy ARP is enabled, if the interface's Hot Standby state is active, proxy ARP requests are answered using the Hot Standby group MAC address. If the interface is in a different state, proxy ARP responses are suppressed.

SUMMARY STEPS

1. **configure terminal**
2. **interface** *interface-id*
3. **standby version** { **1** | **2** }
4. **standby** [*group-number*] **ip** [*ip-address* [**secondary**]]
5. **end**
6. **show standby** [*interface-id* [*group*]]
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch(config)# configure terminal`	Enters global configuration mode.
Step 2	**interface** *interface-id* **Example:** `Switch(config)# interface gigabitethernet1/0/1`	Enters interface configuration mode, and enter the Layer 3 interface on which you want to enable HSRP.

	Command or Action	Purpose
Step 3	**standby version** { **1** | **2** } **Example:** `Switch(config-if)# standby version 1`	(Optional) Configures the HSRP version on the interface. • 1- Selects HSRPv1. • 2- Selects HSRPv2. If you do not enter this command or do not specify a keyword, the interface runs the default HSRP version, HSRP v1.
Step 4	**standby** [*group-number*] **ip** [*ip-address* [**secondary**]] **Example:** `Switch(config-if)# standby 1 ip`	Creates (or enable) the HSRP group using its number and virtual IP address. • (Optional) group-number- The group number on the interface for which HSRP is being enabled. The range is 0 to 255; the default is 0. If there is only one HSRP group, you do not need to enter a group number. • (Optional on all but one interface) ip-address- The virtual IP address of the hot standby router interface. You must enter the virtual IP address for at least one of the interfaces; it can be learned on the other interfaces. • (Optional) **secondary**- The IP address is a secondary hot standby router interface. If neither router is designated as a secondary or standby router and no priorities are set, the primary IP addresses are compared and the higher IP address is the active router, with the next highest as the standby router.
Step 5	**end** **Example:** `Switch(config-if)# end`	Returns to privileged EXEC mode
Step 6	**show standby** [*interface-id* [*group*]] **Example:** `Switch # show standby`	Verifies the configuration of the standby groups.
Step 7	**copy running-config startup-config** **Example:** `Switch# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configuring HSRP Priority

The **standby priority**, **standby preempt**, and **standby track** interface configuration commands are all used to set characteristics for finding active and standby routers and behavior regarding when a new active router takes over.

When configuring HSRP priority, follow these guidelines:

- Assigning a priority allows you to select the active and standby routers. If preemption is enabled, the router with the highest priority becomes the active router. If priorities are equal, the current active router does not change.
- The highest number (1 to 255) represents the highest priority (most likely to become the active router).
- When setting the priority, preempt, or both, you must specify at least one keyword (**priority**, **preempt**, or both)
- The priority of the device can change dynamically if an interface is configured with the **standby track** command and another interface on the router goes down.
- The **standby track** interface configuration command ties the router hot standby priority to the availability of its interfaces and is useful for tracking interfaces that are not configured for HSRP. When a tracked interface fails, the hot standby priority on the device on which tracking has been configured decreases by 10. If an interface is not tracked, its state changes do not affect the hot standby priority of the configured device. For each interface configured for hot standby, you can configure a separate list of interfaces to be tracked
- The **standby track** *interface-priority* interface configuration command specifies how much to decrement the hot standby priority when a tracked interface goes down. When the interface comes back up, the priority is incremented by the same amount.
- When multiple tracked interfaces are down and *interface-priority* values have been configured, the configured priority decrements are cumulative. If tracked interfaces that were not configured with priority values fail, the default decrement is 10, and it is noncumulative.
- When routing is first enabled for the interface, it does not have a complete routing table. If it is configured to preempt, it becomes the active router, even though it is unable to provide adequate routing services. To solve this problem, configure a delay time to allow the router to update its routing table.

Beginning in privileged EXEC mode, use one or more of these steps to configure HSRP priority characteristics on an interface:

SUMMARY STEPS

1. **configure terminal**
2. **interface** *interface-id*
3. **standby** [*group-number*] **priority***priority*
4. **standby** [*group-number*] **preempt** [**delay** [**minimum***seconds*] [**reload***seconds*] [**sync***seconds*]]
5. **standby** [*group-number*] **track** *type number* [*interface-priority*]
6. **end**
7. **show running-config**
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch # configure terminal`	Enters global configuration mode.
Step 2	**interface** *interface-id* **Example:** `Switch(config)# interface gigabitethernet1/0/1`	Enters interface configuration mode, and enter the HSRP interface on which you want to set priority.

	Command or Action	Purpose
Step 3	**standby** [*group-number*] **priority***priority* **Example:** `Switch(config-if)# standby 120 priority 50`	Sets a **priority** value used in choosing the active router. The range is 1 to 255; the default priority is 100. The highest number represents the highest priority. • (Optional) group-number—The group number to which the command applies. Use the **no** form of the command to restore the default values.
Step 4	**standby** [*group-number*] **preempt** [**delay** [**minimum***seconds*] [**reload***seconds*] [**sync***seconds*]] **Example:** `Switch(config-if)# standby 1 preempt delay 300`	Configures the router to **preempt**, which means that when the local router has a higher priority than the active router, it becomes the active router. • (Optional) group-number-The group number to which the command applies. • (Optional) **delay minimum**—Set to cause the local router to postpone taking over the active role for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). • (Optional) **delay reload**—Set to cause the local router to postpone taking over the active role after a reload for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over after a reload). • (Optional) **delay sync**—Set to cause the local router to postpone taking over the active role so that IP redundancy clients can reply (either with an ok or wait reply) for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). Use the **no** form of the command to restore the default values.
Step 5	**standby** [*group-number*] **track** *type number* [*interface-priority*] **Example:** `Switch(config-if)# standby track interface gigabitethernet1/1/1`	Configures an interface to track other interfaces so that if one of the other interfaces goes down, the device's Hot Standby priority is lowered. • (Optional) group-number- The group number to which the command applies. • type- Enter the interface type (combined with interface number) that is tracked. • number- Enter the interface number (combined with interface type) that is tracked. • (Optional) interface-priority- Enter the amount by which the hot standby priority for the router is decremented or incremented when the interface goes down or comes back up. The default value is 10.

	Command or Action	Purpose
Step 6	**end** **Example:** `Switch(config-if)# end`	Returns to privileged EXEC mode.
Step 7	**show running-config**	Verifies the configuration of the standby groups.
Step 8	**copy running-config startup-config**	(Optional) Saves your entries in the configuration file.

Configuring MHSRP

To enable MHSRP and load-balancing, you configure two routers as active routers for their groups, with virtual routers as standby routers as shown in the *MHSRP Load Sharing* figure in the Multiple HSRP section. You need to enter the **standby preempt** interface configuration command on each HSRP interface so that if a router fails and comes back up, the preemption occurs and restores load-balancing.

Router A is configured as the active router for group 1, and Router B is configured as the active router for group 2. The HSRP interface for Router A has an IP address of 10.0.0.1 with a group 1 standby priority of 110 (the default is 100). The HSRP interface for Router B has an IP address of 10.0.0.2 with a group 2 standby priority of 110.

Group 1 uses a virtual IP address of 10.0.0.3 and group 2 uses a virtual IP address of 10.0.0.4.

Configuring Router A

SUMMARY STEPS

1. **configure terminal**
2. **interface** *type number*
3. **no switchport**
4. **ip address** *ip-address mask*
5. **standby** [*group-number*] **ip** [*ip-address* [**secondary**]]
6. **standby** [*group-number*] **priority** *priority*
7. **standby** [*group-number*] **preempt** [**delay** [**minimum** *seconds*] [**reload** *seconds*] [**sync** *seconds*]]
8. **standby** [*group-number*] **ip** [*ip-address* [**secondary**]]
9. **standby** [*group-number*] **preempt** [**delay** [**minimum** *seconds*] [**reload** *seconds*] [**sync** *seconds*]]
10. **end**
11. **show running-config**
12. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch # configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**interface** *type number* **Example:** `Switch (config)# interface gigabitethernet1/0/1`	Configures an interface type and enters interface configuration mode.
Step 3	**no switchport** **Example:** `Switch (config)# no switchport`	Switches an interface that is in Layer 2 mode into Layer 3 mode for Layer 3 configuration.
Step 4	**ip address** *ip-address mask* **Example:** `Switch (config-if)# ip address 10.0.0.1 255.255.255.0`	Specifies an IP address for an interface.
Step 5	**standby** [*group-number*] **ip** [*ip-address* [**secondary**]] **Example:** `Switch (config-if)# standby 1 ip 10.0.0.3`	Creates the HSRP group using its number and virtual IP address. • (Optional) *group-number*- The group number on the interface for which HSRP is being enabled. The range is 0 to 255; the default is 0. If there is only one HSRP group, you do not need to enter a group number. • (Optional on all but one interface) *ip-address*- The virtual IP address of the hot standby router interface. You must enter the virtual IP address for at least one of the interfaces; it can be learned on the other interfaces. • (Optional) **secondary**- The IP address is a secondary hot standby router interface. If neither router is designated as a secondary or standby router and no priorities are set, the primary IP addresses are compared and the higher IP address is the active router, with the next highest as the standby router.
Step 6	**standby** [*group-number*] **priority** *priority* **Example:** `Switch(config-if)# standby 1 priority 110`	Sets a **priority** value used in choosing the active router. The range is 1 to 255; the default priority is 100. The highest number represents the highest priority. • (Optional) *group-number*—The group number to which the command applies. Use the **no** form of the command to restore the default values.
Step 7	**standby** [*group-number*] **preempt** [**delay** [**minimum** *seconds*] [**reload** *seconds*] [**sync** *seconds*]] **Example:** `Switch(config-if)# standby 1 preempt delay 300`	Configures the router to **preempt**, which means that when the local router has a higher priority than the active router, it becomes the active router. • (Optional) group-number-The group number to which the command applies. • (Optional) **delay minimum**—Set to cause the local router to postpone taking over the active role for the

	Command or Action	Purpose
		number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). • (Optional) **delay reload**—Set to cause the local router to postpone taking over the active role after a reload for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over after a reload). • (Optional) **delay sync**—Set to cause the local router to postpone taking over the active role so that IP redundancy clients can reply (either with an ok or wait reply) for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). Use the **no** form of the command to restore the default values.
Step 8	**standby** [*group-number*] **ip** [*ip-address* [**secondary**]] **Example:** `Switch (config-if)# standby 2 ip 10.0.0.4`	Creates the HSRP group using its number and virtual IP address. • (Optional) *group-number*- The group number on the interface for which HSRP is being enabled. The range is 0 to 255; the default is 0. If there is only one HSRP group, you do not need to enter a group number. • (Optional on all but one interface) *ip-address*- The virtual IP address of the hot standby router interface. You must enter the virtual IP address for at least one of the interfaces; it can be learned on the other interfaces. • (Optional) **secondary**- The IP address is a secondary hot standby router interface. If neither router is designated as a secondary or standby router and no priorities are set, the primary IP addresses are compared and the higher IP address is the active router, with the next highest as the standby router.
Step 9	**standby** [*group-number*] **preempt** [**delay** [**minimum** *seconds*] [**reload** *seconds*] [**sync** *seconds*]] **Example:** `Switch(config-if)# standby 2 preempt delay 300`	Configures the router to **preempt**, which means that when the local router has a higher priority than the active router, it becomes the active router. • (Optional) group-number-The group number to which the command applies. • (Optional) **delay minimum**—Set to cause the local router to postpone taking over the active role for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). • (Optional) **delay reload**—Set to cause the local router to postpone taking over the active role after a reload for the number of seconds shown. The range is 0 to

	Command or Action	Purpose
		3600 seconds (1 hour); the default is 0 (no delay before taking over after a reload). • (Optional) **delay sync**—Set to cause the local router to postpone taking over the active role so that IP redundancy clients can reply (either with an ok or wait reply) for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). Use the **no** form of the command to restore the default values.
Step 10	**end** **Example:** `Switch(config-if)# end`	Returns to privileged EXEC mode.
Step 11	**show running-config**	Verifies the configuration of the standby groups.
Step 12	**copy running-config startup-config**	(Optional) Saves your entries in the configuration file.

Configuring Router B

SUMMARY STEPS

1. **configure terminal**
2. **interface** *type number*
3. **no switchport**
4. **ip address** *ip-address mask*
5. **standby** [*group-number*] **ip** [*ip-address* [**secondary**]]
6. **standby** [*group-number*] **priority** *priority*
7. **standby** [*group-number*] **preempt** [**delay** [**minimum** *seconds*] [**reload** *seconds*] [**sync** *seconds*]]
8. **standby** [*group-number*] **ip** [*ip-address* [**secondary**]]
9. **standby** [*group-number*] **preempt** [**delay** [**minimum** *seconds*] [**reload** *seconds*] [**sync** *seconds*]]
10. **end**
11. **show running-config**
12. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch # configure terminal`	Enters global configuration mode.
Step 2	**interface** *type number* **Example:** `Switch (config)# interface gigabitethernet1/0/1`	Configures an interface type and enters interface configuration mode.

	Command or Action	Purpose
Step 3	**no switchport** **Example:** `Switch (config)# no switchport`	Switches an interface that is in Layer 2 mode into Layer 3 mode for Layer 3 configuration.
Step 4	**ip address** *ip-address mask* **Example:** `Switch (config-if)# 10.0.0.2 255.255.255.0`	Specifies an IP address for an interface.
Step 5	**standby** [*group-number*] **ip** [*ip-address* [**secondary**]] **Example:** `Switch (config-if)# standby 1 ip 10.0.0.3`	Creates the HSRP group using its number and virtual IP address. • (Optional) *group-number*- The group number on the interface for which HSRP is being enabled. The range is 0 to 255; the default is 0. If there is only one HSRP group, you do not need to enter a group number. • (Optional on all but one interface) *ip-address*- The virtual IP address of the hot standby router interface. You must enter the virtual IP address for at least one of the interfaces; it can be learned on the other interfaces. • (Optional) **secondary**- The IP address is a secondary hot standby router interface. If neither router is designated as a secondary or standby router and no priorities are set, the primary IP addresses are compared and the higher IP address is the active router, with the next highest as the standby router.
Step 6	**standby** [*group-number*] **priority** *priority* **Example:** `Switch(config-if)# standby 2 priority 110`	Sets a **priority** value used in choosing the active router. The range is 1 to 255; the default priority is 100. The highest number represents the highest priority. • (Optional) *group-number*—The group number to which the command applies. Use the **no** form of the command to restore the default values.
Step 7	**standby** [*group-number*] **preempt** [**delay** [**minimum** *seconds*] [**reload** *seconds*] [**sync** *seconds*]] **Example:** `Switch(config-if)# standby 1 preempt delay 300`	Configures the router to **preempt**, which means that when the local router has a higher priority than the active router, it becomes the active router. • (Optional) group-number-The group number to which the command applies. • (Optional) **delay minimum**—Set to cause the local router to postpone taking over the active role for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). • (Optional) **delay reload**—Set to cause the local router to postpone taking over the active role after a reload

	Command or Action	Purpose
		for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over after a reload). • (Optional) **delay sync**—Set to cause the local router to postpone taking over the active role so that IP redundancy clients can reply (either with an ok or wait reply) for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). Use the **no** form of the command to restore the default values.
Step 8	**standby** [*group-number*] **ip** [*ip-address* [**secondary**]] **Example:** `Switch (config-if)# standby 2 ip 10.0.0.4`	Creates the HSRP group using its number and virtual IP address. • (Optional) *group-number*- The group number on the interface for which HSRP is being enabled. The range is 0 to 255; the default is 0. If there is only one HSRP group, you do not need to enter a group number. • (Optional on all but one interface) *ip-address*- The virtual IP address of the hot standby router interface. You must enter the virtual IP address for at least one of the interfaces; it can be learned on the other interfaces. • (Optional) **secondary**- The IP address is a secondary hot standby router interface. If neither router is designated as a secondary or standby router and no priorities are set, the primary IP addresses are compared and the higher IP address is the active router, with the next highest as the standby router.
Step 9	**standby** [*group-number*] **preempt** [**delay** [**minimum** *seconds*] [**reload** *seconds*] [**sync** *seconds*]] **Example:** `Switch(config-if)# standby 2 preempt delay 300`	Configures the router to **preempt**, which means that when the local router has a higher priority than the active router, it becomes the active router. • (Optional) group-number-The group number to which the command applies. • (Optional) **delay minimum**—Set to cause the local router to postpone taking over the active role for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). • (Optional) **delay reload**—Set to cause the local router to postpone taking over the active role after a reload for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over after a reload). • (Optional) **delay sync**—Set to cause the local router to postpone taking over the active role so that IP redundancy clients can reply (either with an ok or

	Command or Action	Purpose
		wait reply) for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). Use the **no** form of the command to restore the default values.
Step 10	**end** **Example:** `Switch(config-if)# end`	Returns to privileged EXEC mode.
Step 11	**show running-config**	Verifies the configuration of the standby groups.
Step 12	**copy running-config startup-config**	(Optional) Saves your entries in the configuration file.

Configuring HSRP Authentication and Timers

You can optionally configure an HSRP authentication string or change the hello-time interval and holdtime.

When configuring these attributes, follow these guidelines:

- The authentication string is sent unencrypted in all HSRP messages. You must configure the same authentication string on all routers and access servers on a cable to ensure interoperation. Authentication mismatch prevents a device from learning the designated Hot Standby IP address and timer values from other routers configured with HSRP.
- Routers or access servers on which standby timer values are not configured can learn timer values from the active or standby router. The timers configured on an active router always override any other timer settings.
- All routers in a Hot Standby group should use the same timer values. Normally, the *holdtime* is greater than or equal to 3 times the *hellotime*.

Beginning in privileged EXEC mode, use one or more of these steps to configure HSRP authentication and timers on an interface:

SUMMARY STEPS

1. **configure terminal**
2. **interface** *interface-id*
3. **standby** [*group-number*] **authentication** *string*
4. **standby** [*group-number*] **timers** *hellotime holdtime*
5. **end**
6. **show running-config**
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch # configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**interface** *interface-id* **Example:** `Switch(config) # interface gigabitethernet1/0/1`	Enters interface configuration mode, and enter the HSRP interface on which you want to set priority.
Step 3	**standby** [*group-number*] **authentication** *string* **Example:** `Switch(config-if) # standby 1 authentication word`	(Optional) **authentication** *string*—Enter a string to be carried in all HSRP messages. The authentication string can be up to eight characters in length; the default string is **cisco**. (Optional) *group-number*—The group number to which the command applies.
Step 4	**standby** [*group-number*] **timers** *hellotime holdtime* **Example:** `Switch(config-if) # standby 1 timers 5 15`	(Optional) Configure the time between hello packets and the time before other routers declare the active router to be down. • *group-number*—The group number to which the command applies. • *hellotime* —Set to cause the local router to postpone taking over the active role for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over). • *holdtime*—Set to cause the local router to postpone taking over the active role after a reload for the number of seconds shown. The range is 0 to 3600 seconds (1 hour); the default is 0 (no delay before taking over after a reload).
Step 5	**end** **Example:** `Switch(config-if) # end`	Returns to privileged EXEC mode.
Step 6	**show running-config**	Verifies the configuration of the standby groups.
Step 7	**copy running-config startup-config**	(Optional) Saves your entries in the configuration file.

Enabling HSRP Support for ICMP Redirect Messages

ICMP redirect messages are automatically enabled on interfaces configured with HSRP. ICMP is a network layer Internet protocol that provides message packets to report errors and other information relevant to IP processing. ICMP provides diagnostic functions, such as sending and directing error packets to the host. This feature filters outgoing ICMP redirect messages through HSRP, in which the next hop IP address might be changed to an HSRP virtual IP address. For more information, see the Cisco IOS IP Configuration Guide, Release 12.4.

Configuring HSRP Groups and Clustering

This feature is not supported on the C9500-12Q, C9500-16X, C9500-24Q, C9500-40X models of the Cisco Catalyst 9500 Series Switches. When a device is participating in an HSRP standby routing and clustering is enabled, you can use the same standby group for command switch redundancy and HSRP redundancy. Use

the **cluster standby-group** *HSRP-group-name* [**routing-redundancy**] global configuration command to enable the same HSRP standby group to be used for command switch and routing redundancy. If you create a cluster with the same HSRP standby group name without entering the **routing-redundancy** keyword, HSRP standby routing is disabled for the group.

Verifying HSRP

Verifying HSRP Configurations

From privileged EXEC mode, use this command to display HSRP settings:

show standby [*interface-id* [*group*]] [**brief**] [**detail**]

You can display HSRP information for the whole switch, for a specific interface, for an HSRP group, or for an HSRP group on an interface. You can also specify whether to display a concise overview of HSRP information or detailed HSRP information. The default display is **detail**. If there are a large number of HSRP groups, using the **show standby** command without qualifiers can result in an unwieldy display.

Example

```
Switch #show standby
VLAN1 - Group 1
Local state is Standby, priority 105, may preempt
Hellotime 3 holdtime 10
Next hello sent in 00:00:02.182
Hot standby IP address is 172.20.128.3 configured
Active router is 172.20.128.1 expires in 00:00:09
Standby router is local
Standby virtual mac address is 0000.0c07.ac01
Name is bbb

VLAN1 - Group 100
Local state is Standby, priority 105, may preempt
Hellotime 3 holdtime 10
Next hello sent in 00:00:02.262
Hot standby IP address is 172.20.138.51 configured
Active router is 172.20.128.1 expires in 00:00:09
Active router is local
Standby router is unknown expired
Standby virtual mac address is 0000.0c07.ac64
Name is test
```

Configuration Examples for Configuring HSRP

Enabling HSRP: Example

This example shows how to activate HSRP for group 1 on an interface. The IP address used by the hot standby group is learned by using HSRP.

Note This procedure is the minimum number of steps required to enable HSRP. Other configurations are optional.

```
Switch # configure terminal
Switch(config) # interface gigabitethernet1/0/1
Switch(config-if)# no switchport
Switch(config-if)# standby 1 ip
Switch(config-if)# end
Switch # show standby
```

Configuring HSRP Priority: Example

This example activates a port, sets an IP address and a priority of 120 (higher than the default value), and waits for 300 seconds (5 minutes) before attempting to become the active router:

```
Switch # configure terminal
Switch(config) # interface gigabitethernet1/0/1
Switch(config-if)# no switchport
Switch(config-if)# standby ip 172.20.128.3
Switch(config-if)# standby priority 120 preempt delay 300
Switch(config-if)# end
Switch # show standby
```

Configuring MHSRP: Example

This example shows how to enable the MHSRP configuration shown in the figure *MHSRP Load Sharing*

Router A Configuration

```
Switch # configure terminal
Switch(config) # interface gigabitethernet1/0/1
Switch(config-if)# no switchport
Switch(config-if)# ip address 10.0.0.1 255.255.255.0
Switch(config-if)# standby ip 10.0.0.3
Switch(config-if)# standby 1 priority 110
Switch(config-if)#  standby 1 preempt
Switch(config-if)# standby 2 ip 10.0.0.4
Switch(config-if)#  standby 2 preempt
Switch(config-if)# end
```

Router B Configuration

```
Switch # configure terminal
Switch(config) # interface gigabitethernet1/0/1
Switch(config-if)# no switchport
Switch(config-if)# ip address 10.0.0.2 255.255.255.0
Switch(config-if)# standby ip 10.0.0.3
Switch(config-if)#  standby 1 preempt
Switch(config-if)# standby 2 ip 10.0.0.4
Switch(config-if)# standby 2 priority 110
Switch(config-if)#  standby 2 preempt
Switch(config-if)# end
```

Configuring HSRP Authentication and Timer: Example

This example shows how to configure word as the authentication string required to allow Hot Standby routers in group 1 to interoperate:

```
Switch # configure terminal
Switch(config) # interface gigabitethernet1/0/1
Switch(config-if)# no switchport
Switch(config-if)# standby 1 authentication word
Switch(config-if)# end
```

This example shows how to set the timers on standby group 1 with the time between hello packets at 5 seconds and the time after which a router is considered down to be 15 seconds:

```
Switch # configure terminal
Switch(config) # interface gigabitethernet1/0/1
Switch(config-if)# no switchport
Switch(config-if)# standby 1 ip
Switch(config-if)# standby 1 timers 5 15
Switch(config-if)# end
```

Configuring HSRP Groups and Clustering: Example

This example shows how to bind standby group my_hsrp to the cluster and enable the same HSRP group to be used for command switch redundancy and router redundancy. The command can only be executed on the cluster command switch. If the standby group name or number does not exist, or if the switch is a cluster member switch, an error message appears.

```
Switch # configure terminal
Switch(config) # cluster standby-group my_hsrp routing-redundancy
Switch(config-if)# end
```

Additional References for Configuring HSRP

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases

Standards and RFCs

Standard/RFC	Title
RFC 2281	Cisco Hot Standby Router Protocol

MIBs

MIB	MIBs Link
All the supported MIBs for this release.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

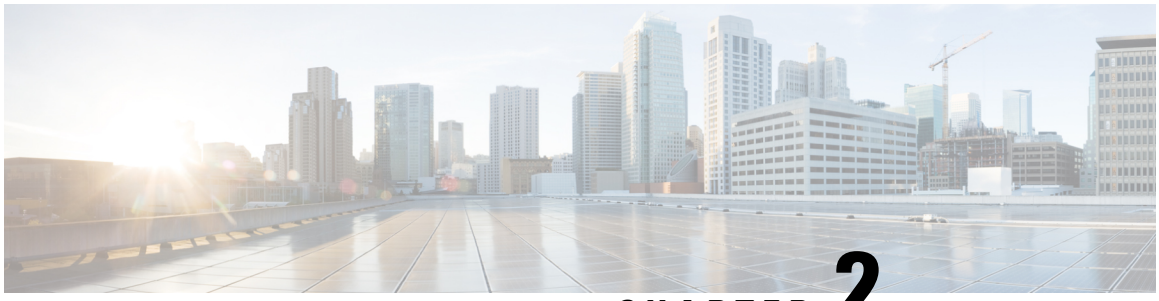
Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

Feature Information for Configuring HSRP

Table 2: Feature Information for Configuring HSRP

Release	Feature Information
Cisco IOS XE 3.3SE	This feature was introduced.



CHAPTER 2

Configuring NHRP

• Configuring NHRP, on page 23

Configuring NHRP

The Next Hop Resolution Protocol (NHRP) is an Address Resolution Protocol (ARP)-like protocol that dynamically maps a nonbroadcast multiaccess (NBMA) network, instead of manually configuring all the tunnel end points. With NHRP, systems attached to an NBMA network can dynamically learn the NBMA (physical) address of the other systems that are part of that network, allowing these systems to directly communicate. This protocol provides an ARP-like solution which allows stations' data-link addresses to be dynamically determined

NHRP is a client and server protocol where the hub is the Next Hop Server (NHS) and the spokes are the Next Hop Clients (NHCs). The hub maintains an NHRP database of the public interface addresses of each spoke. Each spoke registers its non-NBMA (real) address when it boots and queries the NHRP database for addresses of the destination spokes to build direct tunnels.

This module explains how to configure NHRP with generic routing encapsulation (GRE). In Cisco IOS XE Denali 16.3.1, the NHRP supports only spoke configurations.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About Configuring NHRP

NHRP and NBMA Network Interaction

Most WAN networks are a collection of point-to-point links. Virtual tunnel networks (for example Generic Routing Encapsulation [GRE] tunnels) are also a collection of point-to-point links. To effectively scale the connectivity of these point-to-point links, they are usually grouped into a single or multilayer hub-and-spoke

network. Multipoint interfaces (for example, GRE tunnel interfaces) can be used to reduce the configuration on a hub router in such a network. This resulting network is a NBMA network.

Because there are multiple tunnel endpoints that are reachable through a single multipoint interface, there needs to be a mapping from the logical tunnel endpoint IP address to the physical tunnel endpoint IP address, to forward packets out of the tunnel interfaces over this NBMA network. This mapping could be statically configured, but it is preferable if the mapping can be discovered or learned dynamically.

NHRP is an ARP-like protocol that alleviates these NBMA network problems. With NHRP, systems attached to an NBMA network dynamically learn the NBMA address of other systems that are part of the network, allowing these systems to directly communicate without requiring traffic to use an intermediate hop.

Routers, access servers, and hosts can use NHRP to discover the addresses of other routers and hosts connected to an NBMA network. Partially-meshed NBMA networks typically have multiple logical networks behind the NBMA network. In such configurations, packets traversing the NBMA network might have to make several hops over the NBMA network before arriving at the exit router (the router nearest the destination network).

NHRP Registration helps support these NBMA networks:

- NHRP Registration—NHRP allows Next Hop Clients (NHCs) to dynamically register with Next Hop Servers (NHSs). This registration function allows the NHCs to join the NBMA network without configuration changes on the NHSs, especially in cases where the NHC has a dynamic physical IP address or is behind a Network Address Translation (NAT) router that dynamically changes the physical IP address. In these cases, it would be impossible to preconfigure the logical (VPN IP address) to physical (NBMA IP) mapping for the NHC on the NHS.

Dynamically Built Hub-and-Spoke Networks

With NHRP, the NBMA network is initially laid out as a hub-and-spoke network that can have multiple hierarchical layers of NHCs as spokes and NHSs as hubs. The NHCs are configured with static mapping information to reach their NHSs and will connect to their NHS and send an NHRP registration to the NHS. This configuration allows the NHS to dynamically learn the mapping information for the spoke, reducing the configuration needed on the hub and allowing the spoke to obtain a dynamic NBMA (physical) IP address.

How to Configure NHRP

Enabling NHRP on an Interface

Perform this task to enable NHRP for an interface on a switch. In general, all NHRP stations within a logical NBMA network should be configured with the same network identifier.

The NHRP network ID is used to define the NHRP domain for an NHRP interface and differentiate between multiple NHRP domains or networks, when two or more NHRP domains (GRE tunnel interfaces) are available on the same NHRP node (switch). The NHRP network ID helps keep two NHRP networks (clouds) separate when both are configured on the same switch.

The NHRP network ID is a local-only parameter. It is significant only to the local switch and is not transmitted in NHRP packets to other NHRP nodes. For this reason the actual value of the NHRP network ID configured on a switch need not match the same NHRP network ID on another switch where both of these switches are in the same NHRP domain. As NHRP packets arrive on a GRE interface, they are assigned to the local NHRP domain in the NHRP network ID that is configured on that interface.

We recommend that the same NHRP network ID be used on the GRE interfaces on all switches that are in the same NHRP network. It is then easier to track which GRE interfaces are members of which NHRP network.

NHRP domains (network IDs) can be unique on each GRE tunnel interface on a switch. NHRP domains can span across GRE tunnel interfaces on a route. In this case the effect of using the same NHRP network ID on the GRE tunnel interfaces is to merge the two GRE interfaces into a single NHRP network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address network-mask*
5. **ip nhrp network-id** *number*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Switch> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Switch(config)# interface tunnel 100`	Configures an interface and enters interface configuration mode.
Step 4	**ip address** *ip-address network-mask* **Example:** `Switch(config-if)# ip address 10.0.0.1 255.255.255.0`	Enables IP and gives the interface an IP address.
Step 5	**ip nhrp network-id** *number* **Example:** `Switch(config-if)# ip nhrp network-id 1`	Enables NHRP on the interface.
Step 6	**end** **Example:** `Switch(config)# end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring a GRE Tunnel for Multipoint Operation

Perform this task to configure a GRE tunnel for multipoint (NMBA) operation.

A tunnel network of multipoint tunnel interfaces can be considered of as an NBMA network. When multiple GRE tunnels are configured on the same switch, they must either have unique tunnel ID keys or unique tunnel source addresses.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address*
5. **ip mtu** *bytes*
6. **ip pim sparse-dense-mode**
7. **ip nhrp map** *ip-address nbma-address*
8. **ip nhrp map multicast** *nbma-address*
9. **ip nhrp network-id** *number*
10. **ip nhrp nhs** *nhs-address*
11. **tunnel source vlan** *interface-number*
12. **tunnel destination** *ip-address*
13. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Switch> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Switch(config)# interface tunnel 100`	Configures an interface and enters interface configuration mode.
Step 4	**ip address** *ip-address* **Example:** `Switch(config-if)# ip address 172.16.1.1 255.255.255.0`	Configures an IP address for the interface.

	Command or Action	Purpose
Step 5	**ip mtu** *bytes* **Example:** `Switch(config-if)# ip mtu 1400`	Sets the maximum transmission unit (MTU) size of IP packets sent on an interface.
Step 6	**ip pim sparse-dense-mode** **Example:** `Switch(config-if)# ip pim sparse-dense-mode`	Enables Protocol Independent Multicast (PIM) on an interface and treats the interface in either sparse mode or dense mode of operation, depending on which mode the multicast group operates in.
Step 7	**ip nhrp map** *ip-address nbma-address* **Example:** `Switch(config-if)# ip nhrp map 172.16.1.2 10.10.10.2`	Statically configures the IP-to-nonbroadcast multiaccess (NBMA) address mapping of IP destinations connected to an NBMA network. • *ip-address*—IP address of the destinations reachable through the NBMA network. This address is mapped to the NBMA address. • *nbma-address*—NBMA address that is directly reachable through the NBMA network. The address format varies depending on the medium used. For example, ATM has a Network Service Access Point (NSAP) address, Ethernet has a MAC address, and Switched Multimegabit Data Service (SMDS) has an E.164 address. This address is mapped to the IP address.
Step 8	**ip nhrp map multicast** *nbma-address* **Example:** `Switch(config-if)# ip nhrp map multicast 10.10.10.2`	Configures nonbroadcast multiaccess (NBMA) addresses used as destinations for broadcast or multicast packets to be sent over a tunnel network.
Step 9	**ip nhrp network-id** *number* **Example:** `Switch(config-if)# ip nhrp network-id 1`	Enable the Next Hop Resolution Protocol (NHRP) on an interface. • *number*—Globally unique, 32-bit network ID from a nonbroadcast multiaccess (NBMA) network. The range is from 1 to 4294967295.
Step 10	**ip nhrp nhs** *nhs-address* **Example:** `Switch(config-if)# ip nhrp nhs 172.16.1.2`	Specifies the address of one or more NHRP servers. • *nhs-address*—Address of the next-hop server being specified.
Step 11	**tunnel source vlan** *interface-number* **Example:** `Switch(config-if)# tunnel source vlan 1`	Sets the source address for a tunnel interface

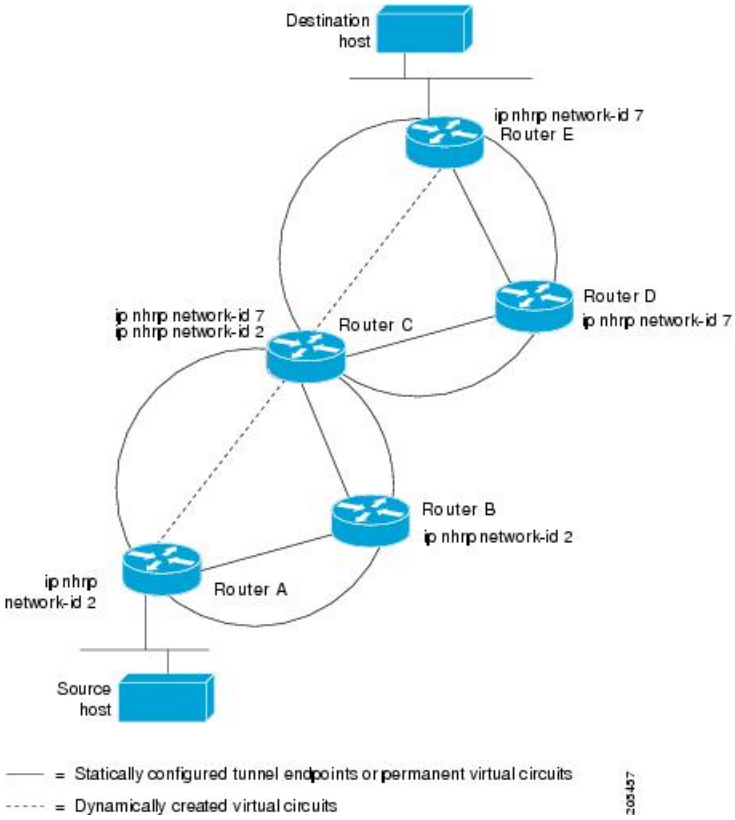
	Command or Action	Purpose
Step 12	**tunnel destination** *ip-address* **Example:** `Switch(config-if)# tunnel destination 10.10.10.2`	Sets the destination address for a tunnel interface.
Step 13	**end** **Example:** `Switch(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuration Examples for NHRP

Physical Network Designs for Logical NBMA Examples

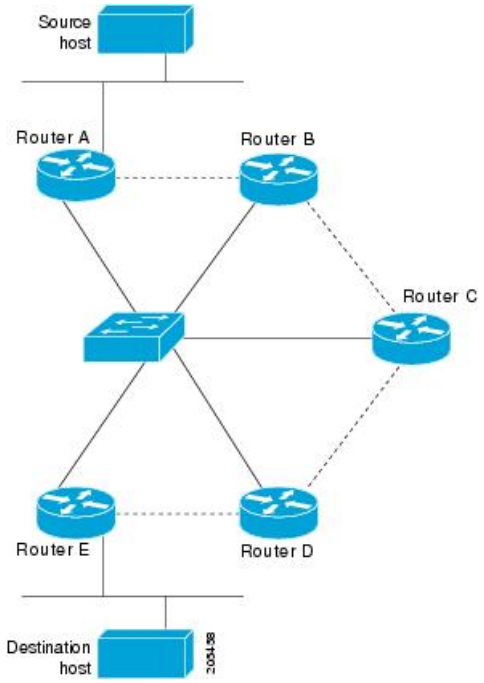
A logical NBMA network is considered the group of interfaces and hosts participating in NHRP and having the same network identifier. The figure below illustrates two logical NBMA networks (shown as circles) configured over a single physical NBMA network. Router A can communicate with routers B and C because they share the same network identifier (2). Router C can also communicate with routers D and E because they share network identifier 7. After address resolution is complete, router A can send IP packets to router C in one hop, and router C can send them to router E in one hop, as shown by the dotted lines.

Figure 3: Two Logical NBMA Networks over One Physical NBMA Network



The physical configuration of the five routers in the figure above might actually be that shown in the figure below. The source host is connected to router A and the destination host is connected to router E. The same switch serves all five routers, making one physical NBMA network.

Figure 4: Physical Configuration of a Sample NBMA Network



Refer again to the first figure above. Initially, before NHRP has resolved any NBMA addresses, IP packets from the source host to the destination host travel through all five routers connected to the switch before reaching the destination. When router A first forwards the IP packet toward the destination host, router A also generates an NHRP request for the IP address of the destination host. The request is forwarded to router C, whereupon a reply is generated. Router C replies because it is the egress router between the two logical NBMA networks.

Similarly, router C generates an NHRP request of its own, to which router E replies. In this example, subsequent IP traffic between the source and the destination still requires two hops to traverse the NBMA network, because the IP traffic must be forwarded between the two logical NBMA networks. Only one hop would be required if the NBMA network were not logically divided.

Example: GRE Tunnel for Multipoint Operation

With multipoint tunnels, a single tunnel interface may be connected to multiple neighboring switches. Unlike point-to-point tunnels, a tunnel destination need not be configured. In fact, if configured, the tunnel destination must correspond to an IP multicast address.

In the following example, switches A and B share an Ethernet segment. Minimal connectivity over the multipoint tunnel network is configured, thus creating a network that can be treated as a partially meshed NBMA network. Due to the static NHRP map entries, switch A knows how to reach switch B and vice versa.

The following example shows how to configure a GRE multipoint tunnel:

Switch A Configuration

```
Switch(config)# interface tunnel 100 !Tunnel interface configured for PIM traffic
Switch(config-if)# no ip redirects
Switch(config-if)# ip address 192.168.24.1 255.255.255.252
Switch(config-if)# ip mtu 1400
```

```
Switch(config-if)# ip pim sparse-dense-mode
Switch(config-if)# ip nhrp map 192.168.24.3 172.16.0.1 !NHRP may optionally be configured
to dynamically discover tunnel end points.
Switch(config-if)# ip nhrp map multicast 172.16.0.1
Switch(config-if)# ip nhrp network-id 1
Switch(config-if)# ip nhrp nhs 192.168.24.3
Switch(config-if)# tunnel source vlan 1
Switch(config-if)# tunnel destination 172.16.0.1
Switch(config-if)# end
```

Switch B Configuration

```
Switch(config)# interface tunnel 100
Switch(config-if)# no ip redirects
Switch(config-if)# ip address 192.168.24.2 255.255.255.252
Switch(config-if)# ip mtu 1400
Switch(config-if)# ip pim sparse-dense-mode
Switch(config-if)# ip nhrp map 192.168.24.4 10.10.0.3
Switch(config-if)# ip nhrp map multicast 10.10.10.3
Switch(config-if)# ip nhrp network-id 1
Switch(config-if)# ip nhrp nhs 192.168.24.4
Switch(config-if)# tunnel source vlan 1
Switch(config-if)# tunnel destination 10.10.10.3
Switch(config-if)# end
```

Additional References for Configuring NHRP

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases

RFCs

RFC	Title
RFC 2332	*NBMA Next Hop Resolution Protocol (NHRP)*

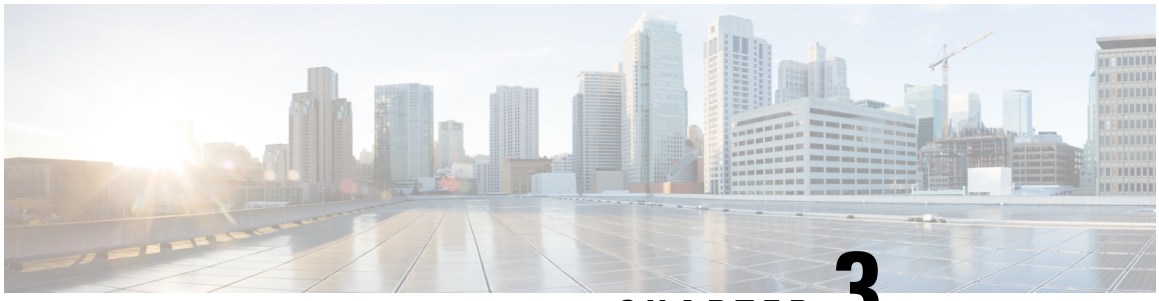
Technical Assistance

Description	Link
The Cisco Technical Support & Documentation website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, tools, and technical documentation. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Feature Information for Configuring NHRP

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.



CHAPTER 3

VRRPv3 Protocol Support

- VRRPv3 Protocol Support, on page 33

VRRPv3 Protocol Support

Virtual Router Redundancy Protocol (VRRP) enables a group of devices to form a single virtual device to provide redundancy. The LAN clients can then be configured with the virtual device as their default gateway. The virtual device, representing a group of devices, is also known as a VRRP group. The VRRP version 3 (v3) Protocol Support feature provides the capability to support IPv4 and IPv6 addresses while VRRP version 2 (v2) only supports IPv4 addresses. This module explains concepts related to VRRPv3 and describes how to create and customize a VRRP group in a network. Benefits of using VRRPv3 Protocol Support include the following:

- Interoperability in multi-vendor environments.
- VRRPv3 supports usage of IPv4 and IPv6 addresses while VRRPv2 only supports IPv4 addresses
- Improved scalability through the use of VRRS Pathways.

Note In this module, VRRP and VRRPv3 are used interchangeably.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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Restrictions for VRRPv3 Protocol Support

- VRRPv3 is not intended as a replacement for existing dynamic protocols. VRRPv3 is designed for use over multi-access, multicast, or broadcast capable Ethernet LANs.
- VRRPv3 is supported on Ethernet, Fast Ethernet, Bridge Group Virtual Interface (BVI), and Gigabit Ethernet interfaces, and on Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs), VRF-aware MPLS VPNs, and VLANs.
- Because of the forwarding delay that is associated with the initialization of a BVI interface, you must not configure the VRRPv3 advertise timer to a value lesser than the forwarding delay on the BVI interface. If you configure the VRRPv3 advertise timer to a value equal to or greater than the forwarding delay on the BVI interface, the setting prevents a VRRP device on a recently initialized BVI interface from unconditionally taking over the master role. Use the **bridge forward-time** command to set the forwarding delay on the BVI interface. Use the **vrrp timers advertise** command to set the VRRP advertisement timer.
- VRRPv3 does not support Stateful Switchover (SSO).
- Full network redundancy can only be achieved if VRRP operates over the same network path as the VRRS Pathway redundant interfaces. For full redundancy, the following restrictions apply:
  - VRRS pathways should not share a different physical interface as the parent VRRP group or be configured on a sub-interface having a different physical interface as the parent VRRP group.
  - VRRS pathways should not be configured on Switch Virtual Interface (SVI) interfaces as long as the associated VLAN does not share the same trunk as the VLAN on which the parent VRRP group is configured.

Information About VRRPv3 Protocol Support

VRRPv3 Benefits

Support for IPv4 and IPv6

VRRPv3 supports IPv4 and IPv6 address families while VRRPv2 only supports IPv4 addresses.

Note When VRRPv3 is in use, VRRPv2 is unavailable. For VRRPv3 to be configurable, the **fhrp version vrrp v3** command must be used in global configuration mode

Redundancy

VRRP enables you to configure multiple devices as the default gateway device, which reduces the possibility of a single point of failure in a network.

Load Sharing

You can configure VRRP in such a way that traffic to and from LAN clients can be shared by multiple devices, thereby sharing the traffic load more equitably between available devices.

Multiple Virtual Devices

VRRP supports up to 255 virtual devices (VRRP groups) on a device physical interface, subject to restrictions in scaling. Multiple virtual device support enables you to implement redundancy and load sharing in your LAN topology. In scaled environments, VRRS Pathways should be used in combination with VRRP control groups.

Multiple IP Addresses

The virtual device can manage multiple IP addresses, including secondary IP addresses. Therefore, if you have multiple subnets configured on an Ethernet interface, you can configure VRRP on each subnet.

Note To utilize secondary IP addresses in a VRRP group, a primary address must be configured on the same group.

Preemption

The redundancy scheme of VRRP enables you to preempt a virtual device backup that has taken over for a failing virtual device master with a higher priority virtual device backup that has become available.

Note Preemption of a lower priority master device is enabled with an optional delay.

Advertisement Protocol

VRRP uses a dedicated Internet Assigned Numbers Authority (IANA) standard multicast address for VRRP advertisements. For IPv4, the multicast address is 224.0.0.18. For IPv6, the multicast address is FF02:0:0:0:0:0:0:12. This addressing scheme minimizes the number of devices that must service the multicasts and allows test equipment to accurately identify VRRP packets on a segment. The IANA has assigned VRRP the IP protocol number 112.

VRRP Device Priority and Preemption

An important aspect of the VRRP redundancy scheme is VRRP device priority. Priority determines the role that each VRRP device plays and what happens if the virtual device master fails.

If a VRRP device owns the IP address of the virtual device and the IP address of the physical interface, this device will function as a virtual device master.

Priority also determines if a VRRP device functions as a virtual device backup and the order of ascendancy to becoming a virtual device master if the virtual device master fails. You can configure the priority of each virtual device backup with a value of 1 through 254 using the **priority** command (use the **vrrp address-family** command to enter the VRRP configuration mode and access the **priority** option).

For example, if device A, the virtual device master in a LAN topology, fails, an election process takes place to determine if virtual device backups B or C should take over. If devices B and C are configured with the priorities of 101 and 100, respectively, device B is elected to become virtual device master because it has the higher priority. If devices B and C are both configured with the priority of 100, the virtual device backup with the higher IP address is elected to become the virtual device master.

By default, a preemptive scheme is enabled whereby a higher priority virtual device backup that becomes available takes over from the virtual device backup that was elected to become virtual device master. You

can disable this preemptive scheme using the **no preempt** command (use the **vrrp address-family** command to enter the VRRP configuration mode, and enter the **no preempt** command). If preemption is disabled, the virtual device backup that is elected to become virtual device master remains the master until the original virtual device master recovers and becomes master again.

Note Preemption of a lower priority master device is enabled with an optional delay.

VRRP Advertisements

The virtual device master sends VRRP advertisements to other VRRP devices in the same group. The advertisements communicate the priority and state of the virtual device master. The VRRP advertisements are encapsulated into either IPv4 or IPv6 packets (based on the VRRP group configuration) and sent to the appropriate multicast address assigned to the VRRP group. For IPv4, the multicast address is 224.0.0.18. For IPv6, the multicast address is FF02:0:0:0:0:0:0:12. The advertisements are sent every second by default and the interval is configurable.

Cisco devices allow you to configure millisecond timers, which is a change from VRRPv2. You need to manually configure the millisecond timer values on both the primary and the backup devices. The master advertisement value displayed in the **show vrrp** command output on the backup devices is always 1 second because the packets on the backup devices do not accept millisecond values.

You must use millisecond timers where absolutely necessary and with careful consideration and testing. Millisecond values work only under favorable circumstances. The use of the millisecond timer values is compatible with third party vendors, as long as they also support VRRPv3. You can specify a timer value between 100 milliseconds and 40000 milliseconds.

Information About VRRPv3 Protocol Support

VRRPv3 Benefits

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VRRPv3 supports IPv4 and IPv6 address families while VRRPv2 only supports IPv4 addresses.

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You must use millisecond timers where absolutely necessary and with careful consideration and testing. Millisecond values work only under favorable circumstances. The use of the millisecond timer values is compatible with third party vendors, as long as they also support VRRPv3. You can specify a timer value between 100 milliseconds and 40000 milliseconds.

How to Configure VRRPv3 Protocol Support

Creating and Customizing a VRRP Group

To create a VRRP group, perform the following task. Steps 6 to 14 denote customizing options for the group, and they are optional:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **fhrp version vrrp v3**
4. **interface** *type number*
5. **vrrp** *group-id* **address-family** {**ipv4** | **ipv6**}
6. **address** *ip-address* [**primary** | **secondary**]
7. **description** *group-description*
8. **match-address**
9. **preempt delay minimum** *seconds*
10. **priority** *priority-level*
11. **timers advertise** *interval*
12. **vrrpv2**
13. **vrrs leader** *vrrs-leader-name*

14. **shutdown**
15. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**fhrp version vrrp v3** **Example:** `Device(config)# fhrp version vrrp v3`	Enables the ability to configure VRRPv3 and VRRS. **Note** When VRRPv3 is in use, VRRPv2 is unavailable. The command **fhrp version vrrp v2** is not supported though it is configurable.
Step 4	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 0/0/0`	Enters interface configuration mode.
Step 5	**vrrp** *group-id* **address-family** {**ipv4** | **ipv6**} **Example:** `Device(config-if)# vrrp 3 address-family ipv4`	Creates a VRRP group and enters VRRP configuration mode.
Step 6	**address** *ip-address* [**primary** | **secondary**] **Example:** `Device(config-if-vrrp)# address 100.0.1.10 primary`	Specifies a primary or secondary address for the VRRP group. **Note** VRRPv3 for IPv6 requires that a primary virtual link-local IPv6 address is configured to allow the group to operate. After the primary link-local IPv6 address is established on the group, you can add the secondary global addresses.
Step 7	**description** *group-description* **Example:** `Device(config-if-vrrp)# description group 3`	(Optional) Specifies a description for the VRRP group.

	Command or Action	Purpose
Step 8	**match-address** **Example:** `Device(config-if-vrrp)# match-address`	(Optional) Matches secondary address in the advertisement packet against the configured address. • Secondary address matching is enabled by default.
Step 9	**preempt delay minimum** *seconds* **Example:** `Device(config-if-vrrp)# preempt delay minimum 30`	(Optional) Enables preemption of lower priority master device with an optional delay. • Preemption is enabled by default.
Step 10	**priority** *priority-level* **Example:** `Device(config-if-vrrp)# priority 3`	(Optional) Specifies the priority value of the VRRP group. • The priority of a VRRP group is 100 by default.
Step 11	**timers advertise** *interval* **Example:** `Device(config-if-vrrp)# timers advertise 1000`	(Optional) Sets the advertisement timer in milliseconds. • The advertisement timer is set to 1000 milliseconds by default.
Step 12	**vrrpv2** **Example:** `Device(config-if-vrrp)# vrrpv2`	(Optional) Enables support for VRRPv2 configured devices in compatibility mode. • VRRPv2 is not supported.
Step 13	**vrrs leader** *vrrs-leader-name* **Example:** `Device(config-if-vrrp)# vrrs leader leader-1`	(Optional) Specifies a leader's name to be registered with VRRS and to be used by followers. • A registered VRRS name is unavailable by default.
Step 14	**shutdown** **Example:** `Device(config-if-vrrp)# shutdown`	(Optional) Disables VRRP configuration for the VRRP group. • VRRP configuration is enabled for a VRRP group by default.
Step 15	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.

Configuring the Delay Period Before FHRP Client Initialization

To configure the delay period before the initialization of all FHRP clients on an interface, perform the following task:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **fhrp version vrrp v3**
4. **interface** *type number*
5. **fhrp delay** {[**minimum**] [**reload**] *seconds*}
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**fhrp version vrrp v3** **Example:** `Device(config)# fhrp version vrrp v3`	Enables the ability to configure VRRPv3 and VRRS. **Note** When VRRPv3 is in use, VRRPv2 is unavailable.
Step 4	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 0/0/0`	Enters interface configuration mode.
Step 5	**fhrp delay** {[**minimum**] [**reload**] *seconds*} **Example:** `Device(config-if)# fhrp delay minimum 5`	Specifies the delay period for the initialization of FHRP clients after an interface comes up. • The range is 0-3600 seconds.
Step 6	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.

Configuration Examples for VRRPv3 Protocol Support

Example: Enabling VRRPv3 on a Device

The following example shows how to enable VRRPv3 on a device:

```
Device> enable
Device# configure terminal
Device(config)# fhrp version vrrp v3
Device(config-if-vrrp)# end
```

Example: Creating and Customizing a VRRP Group

The following example shows how to create and customize a VRRP group:

```
Device> enable
Device# configure terminal
Device(config)# fhrp version vrrp v3
Device(config)# interface GigabitEthernet 1/0/1
Device(config-if)# vrrp 3 address-family ipv4
Device(config-if-vrrp)# address 100.0.1.10 primary
Device(config-if-vrrp)# description group 3
Device(config-if-vrrp)# match-address
Device(config-if-vrrp)# preempt delay minimum 30
Device(config-if-vrrp)# end
```

Note In the above example, the **fhrp version vrrp v3** command is used in the global configuration mode.

Example: Configuring the Delay Period Before FHRP Client Initialization

The following example shows how to configure the delay period before FHRP client initialization :

```
Device> enable
Device# configure terminal
Device(config)# fhrp version vrrp v3
Device(config)# interface GigabitEthernet 1/0/1
Device(config-if)# fhrp delay minimum 5
Device(config-if-vrrp)# end
```

Note In the above example, a five-second delay period is specified for the initialization of FHRP clients after the interface comes up. You can specify a delay period between 0 and 3600 seconds.

Example: VRRP Status, Configuration, and Statistics Details

The following is a sample output of the status, configuration and statistics details for a VRRP group:

```
Device> enable
Device# show vrrp detail

 GigabitEthernet1/0/1 - Group 3 - Address-Family IPv4
  Description is "group 3"
  State is MASTER
  State duration 53.901 secs
  Virtual IP address is 100.0.1.10
```

```
  Virtual MAC address is 0000.5E00.0103
  Advertisement interval is 1000 msec
  Preemption enabled, delay min 30 secs (0 msec remaining)
  Priority is 100
  Master Router is 10.21.0.1 (local), priority is 100
  Master Advertisement interval is 1000 msec (expires in 832 msec)
  Master Down interval is unknown
  VRRPv3 Advertisements: sent 61 (errors 0) - rcvd 0
  VRRPv2 Advertisements: sent 0 (errors 0) - rcvd 0
  Group Discarded Packets: 0
    VRRPv2 incompatibility: 0
    IP Address Owner conflicts: 0
    Invalid address count: 0
    IP address configuration mismatch : 0
    Invalid Advert Interval: 0
    Adverts received in Init state: 0
    Invalid group other reason: 0
  Group State transition:
    Init to master: 0
    Init to backup: 1 (Last change Sun Mar 13 19:52:56.874)
    Backup to master: 1 (Last change Sun Mar 13 19:53:00.484)
    Master to backup: 0
    Master to init: 0
    Backup to init: 0

Device# exit
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Master Commands List, All Releases
FHRP commands	First Hop Redundancy Protocols Command Reference
Configuring VRRPv2	*Configuring VRRP*
VRRPv3 Commands	For complete syntax and usage information for the commands used in this chapter.

Standards and RFCs

Standard/RFC	Title
RFC5798	*Virtual Router Redundancy Protocol*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for VRRPv3 Protocol Support

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Table 3: Feature Information for VRRPv3 Protocol Support

Feature Name	Releases	Feature Information
VRRPv3 Protocol Support	Cisco IOS XE 3.6E Cisco IOS XE Everest 16.6.1	VRRP enables a group of devices to form a single virtual device to provide redundancy. The LAN clients can then be configured with the virtual device as their default gateway. The virtual device, representing a group of devices, is also known as a VRRP group. The VRRPv3 Protocol Support feature provides the capability to support IPv4 and IPv6 addresses. In Cisco IOS Release Cisco IOS XE Release 3.6E, this feature is supported on the following platforms: The following commands were introduced or modified: **fhrp delay**, **show vrrp**, **vrrp address-family**. This feature was introduced.

Glossary

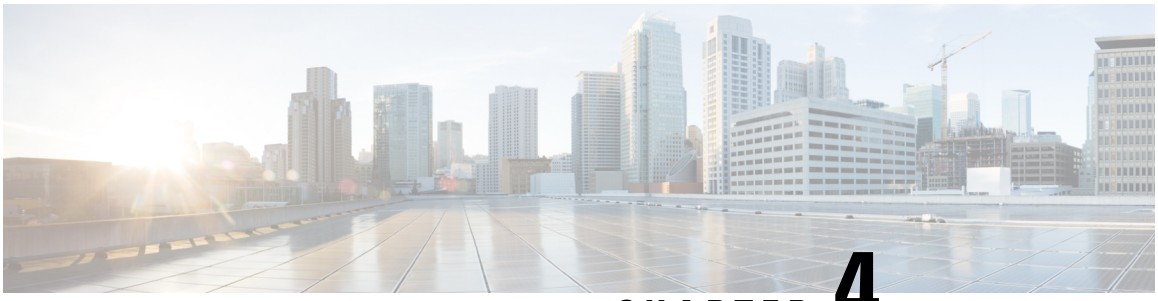
Virtual IP address owner—The VRRP device that owns the IP address of the virtual device. The owner is the device that has the virtual device address as its physical interface address.

Virtual device—One or more VRRP devices that form a group. The virtual device acts as the default gateway device for LAN clients. The virtual device is also known as a VRRP group.

Virtual device backup—One or more VRRP devices that are available to assume the role of forwarding packets if the virtual device master fails.

Virtual device master—The VRRP device that is currently responsible for forwarding packets sent to the IP addresses of the virtual device. Usually, the virtual device master also functions as the IP address owner.

VRRP device—A device that is running VRRP.



CHAPTER 4

Configuring GLBP

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Configuring GLBP

Gateway Load Balancing Protocol (GLBP) protects data traffic from a failed device or circuit, like Hot Standby Router Protocol (HSRP) and Virtual Router Redundancy Protocol (VRRP), while allowing packet load sharing between a group of redundant devices.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for GLBP

Enhanced Object Tracking (EOT) is not stateful switchover (SSO)-aware and cannot be used with GLBP in SSO mode.

Prerequisites for GLBP

Before configuring GLBP, ensure that the devices can support multiple MAC addresses on the physical interfaces. For each GLBP forwarder to be configured, an additional MAC address is used.

Information About GLBP

GLBP Overview

GLBP provides automatic device backup for IP hosts configured with a single default gateway on an IEEE 802.3 LAN. Multiple first-hop devices on the LAN combine to offer a single virtual first-hop IP device while sharing the IP packet forwarding load. Other devices on the LAN act as redundant GLBP devices that will become active if any of the existing forwarding devices fail.

GLBP performs a similar function for the user as HSRP and VRRP. HSRP and VRRP allow multiple devices to participate in a virtual device group configured with a virtual IP address. One member is elected to be the active device to forward packets sent to the virtual IP address for the group. The other devices in the group are redundant until the active device fails. These standby devices have unused bandwidth that the protocol is not using. Although multiple virtual device groups can be configured for the same set of devices, the hosts must be configured for different default gateways, which results in an extra administrative burden. The advantage of GLBP is that it additionally provides load balancing over multiple devices (gateways) using a single virtual IP address and multiple virtual MAC addresses. The forwarding load is shared among all devices in a GLBP group rather than being handled by a single device while the other devices stand idle. Each host is configured with the same virtual IP address, and all devices in the virtual device group participate in forwarding packets. GLBP members communicate between each other through hello messages sent every 3 seconds to the multicast address 224.0.0.102, UDP port 3222 (source and destination).

GLBP Packet Types

GLBP uses 3 different packet types to operate. The packet types are Hello, Request, and Reply. The Hello packet is used to advertise protocol information. Hello packets are multicast, and are sent when any virtual gateway or virtual forwarder is in Speak, Standby or Active state. Request and Reply packets are used for virtual MAC assignment. They are both unicast messages to and from the active virtual gateway (AVG).

GLBP Active Virtual Gateway

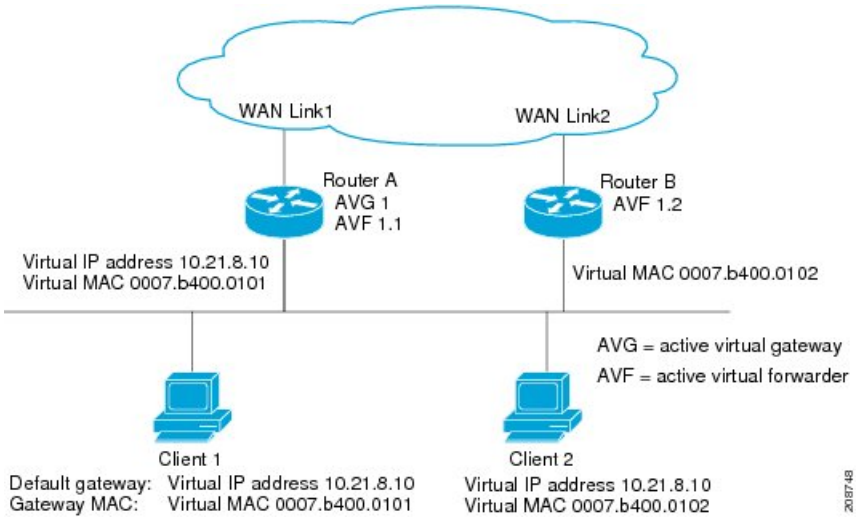
Members of a GLBP group elect one gateway to be the active virtual gateway (AVG) for that group. Other group members provide backup for the AVG if the AVG becomes unavailable. The AVG assigns a virtual MAC address to each member of the GLBP group. Each gateway assumes responsibility for forwarding packets sent to the virtual MAC address assigned to it by the AVG. These gateways are known as active virtual forwarders (AVFs) for their virtual MAC address.

The AVG is also responsible for answering Address Resolution Protocol(ARP) requests for the virtual IP address. Load sharing is achieved by the AVG replying to the ARP requests with different virtual MAC addresses.

When the **no glbp load-balancing**command is configured, if the AVG does not have an AVF, it preferentially responds to ARP requests with the MAC address of the first listening virtual forwarder (VF), which will causes traffic to route via another gateway until that VF migrates back to being the current AVG.

In the figure below, Router A (or Device A) is the AVG for a GLBP group, and is responsible for the virtual IP address 10.21.8.10. Router A is also an AVF for the virtual MAC address 0007.b400.0101. Router B (or Device B) is a member of the same GLBP group and is designated as the AVF for the virtual MAC address 0007.b400.0102. Client 1 has a default gateway IP address of 10.21.8.10 and a gateway MAC address of 0007.b400.0101. Client 2 shares the same default gateway IP address but receives the gateway MAC address 0007.b400.0102 because Router B is sharing the traffic load with Router A.

Figure 5: GLBP Topology



If Router A becomes unavailable, Client 1 will not lose access to the WAN because Router B will assume responsibility for forwarding packets sent to the virtual MAC address of Router A, and for responding to packets sent to its own virtual MAC address. Router B will also assume the role of the AVG for the entire GLBP group. Communication for the GLBP members continues despite the failure of a device in the GLBP group.

GLBP Virtual MAC Address Assignment

A GLBP group allows up to four virtual MAC addresses per group. The AVG is responsible for assigning the virtual MAC addresses to each member of the group. Other group members request a virtual MAC address after they discover the AVG through hello messages. Gateways are assigned the next MAC address in sequence. A virtual forwarder that is assigned a virtual MAC address by the AVG is known as a primary virtual forwarder. Other members of the GLBP group learn the virtual MAC addresses from hello messages. A virtual forwarder that has learned the virtual MAC address is referred to as a secondary virtual forwarder.

GLBP Virtual Gateway Redundancy

GLBP operates virtual gateway redundancy in the same way as HSRP. One gateway is elected as the AVG, another gateway is elected as the standby virtual gateway, and the remaining gateways are placed in a listen state.

If an AVG fails, the standby virtual gateway will assume responsibility for the virtual IP address. A new standby virtual gateway is then elected from the gateways in the listen state.

GLBP Virtual Forwarder Redundancy

Virtual forwarder redundancy is similar to virtual gateway redundancy with an AVF. If the AVF fails, one of the secondary virtual forwarders in the listen state assumes responsibility for the virtual MAC address.

The new AVF is also a primary virtual forwarder for a different forwarder number. GLBP migrates hosts away from the old forwarder number using two timers that start as soon as the gateway changes to the active virtual forwarder state. GLBP uses the hello messages to communicate the current state of the timers.

The redirect time is the interval during which the AVG continues to redirect hosts to the old virtual forwarder MAC address. When the redirect time expires, the AVG stops using the old virtual forwarder MAC address

in ARP replies, although the virtual forwarder will continue to forward packets that were sent to the old virtual forwarder MAC address.

The secondary holdtime is the interval during which the virtual forwarder is valid. When the secondary holdtime expires, the virtual forwarder is removed from all gateways in the GLBP group. The expired virtual forwarder number becomes eligible for reassignment by the AVG.

GLBP Gateway Priority

GLBP gateway priority determines the role that each GLBP gateway plays and what happens if the AVG fails.

Priority also determines if a GLBP device functions as a backup virtual gateway and the order of ascendancy to becoming an AVG if the current AVG fails. You can configure the priority of each backup virtual gateway with a value of 1 through 255 using the **glbp priority** command.

In the "GLBP Topology" figure, if Router A (or Device A)—the AVG in a LAN topology—fails, an election process takes place to determine which backup virtual gateway should take over. In this example, Router B (or Device B) is the only other member in the group so it will automatically become the new AVG. If another device existed in the same GLBP group with a higher priority, then the device with the higher priority would be elected. If both devices have the same priority, the backup virtual gateway with the higher IP address would be elected to become the active virtual gateway.

By default, the GLBP virtual gateway preemptive scheme is disabled. A backup virtual gateway can become the AVG only if the current AVG fails, regardless of the priorities assigned to the virtual gateways. You can enable the GLBP virtual gateway preemptive scheme using the **glbp preempt** command. Preemption allows a backup virtual gateway to become the AVG, if the backup virtual gateway is assigned a higher priority than the current AVG.

GLBP Gateway Weighting and Tracking

GLBP uses a weighting scheme to determine the forwarding capacity of each device in the GLBP group. The weighting assigned to a device in the GLBP group can be used to determine whether it will forward packets and, if so, the proportion of hosts in the LAN for which it will forward packets. Thresholds can be set to disable forwarding when the weighting for a GLBP group falls below a certain value, and when it rises above another threshold, forwarding is automatically reenabled.

The GLBP group weighting can be automatically adjusted by tracking the state of an interface within the device. If a tracked interface goes down, the GLBP group weighting is reduced by a specified value. Different interfaces can be tracked to decrement the GLBP weighting by varying amounts.

By default, the GLBP virtual forwarder preemptive scheme is enabled with a delay of 30 seconds. A backup virtual forwarder can become the AVF if the current AVF weighting falls below the low weighting threshold for 30 seconds. You can disable the GLBP forwarder preemptive scheme using the **no glbp forwarder preempt** command or change the delay using the **glbp forwarder preempt delay minimum** command.

GLBP MD5 Authentication

GLBP MD5 authentication uses the industry-standard MD5 algorithm for improved reliability and security. MD5 authentication provides greater security than the alternative plain text authentication scheme and protects against spoofing software.

MD5 authentication allows each GLBP group member to use a secret key to generate a keyed MD5 hash that is part of the outgoing packet. A keyed hash of an incoming packet is generated and, if the hash within the incoming packet does not match the generated hash, the packet is ignored.

The key for the MD5 hash can either be given directly in the configuration using a key string or supplied indirectly through a key chain. The key string cannot exceed 100 characters in length.

A device will ignore incoming GLBP packets from devices that do not have the same authentication configuration for a GLBP group. GLBP has three authentication schemes:

- No authentication
- Plain text authentication
- MD5 authentication

GLBP packets will be rejected in any of the following cases:

- The authentication schemes differ on the device and in the incoming packet.
- MD5 digests differ on the device and in the incoming packet.
- Text authentication strings differ on the device and in the incoming packet.

ISSU-GLBP

This feature is not supported on the C9500-12Q, C9500-16X, C9500-24Q, C9500-40X models of the Cisco Catalyst 9500 Series Switches. GLBP supports In Service Software Upgrade (ISSU). ISSU allows a high-availability (HA) system to run in Stateful Switchover (SSO) mode even when different versions of Cisco IOS software are running on the active and standby Route Processors (RPs) or line cards.

ISSU provides the ability to upgrade or downgrade from one supported Cisco IOS release to another while continuing to forward packets and maintain sessions, thereby reducing planned outage time. The ability to upgrade or downgrade is achieved by running different software versions on the active RP and standby RP for a short period of time to maintain state information between RPs. This feature allows the system to switch over to a secondary RP running upgraded (or downgraded) software and continue forwarding packets without session loss and with minimal or no packet loss. This feature is enabled by default.

GLBP SSO

This feature is not supported on the C9500-12Q, C9500-16X, C9500-24Q, C9500-40X models of the Cisco Catalyst 9500 Series Switches. With the introduction of the GLBP SSO functionality, GLBP is stateful switchover (SSO) aware. GLBP can detect when a device is failing over to the secondary router processor (RP) and continue in its current group state.

SSO functions in networking devices (usually edge devices) that support dual RPs. SSO provides RP redundancy by establishing one of the RPs as the active processor and the other RP as the standby processor. SSO also synchronizes critical state information between the RPs so that network state information is dynamically maintained between RPs.

Without SSO-awareness, if GLBP is deployed on a device with redundant RPs, a switchover of roles between the active RP and the standby RP results in the device relinquishing its activity as a GLBP group member and then rejoining the group as if it had been reloaded. The GLBP SSO feature enables GLBP to continue its activities as a group member during a switchover. GLBP state information between redundant RPs is maintained so that the standby RP can continue the device's activities within the GLBP during and after a switchover.

This feature is enabled by default. To disable this feature, use the command **no glbp sso** in global configuration mode.

GLBP Benefits

Load Sharing

You can configure GLBP in such a way that traffic from LAN clients can be shared by multiple devices, thereby sharing the traffic load more equitably among available devices.

Multiple Virtual Devices

GLBP supports up to 1024 virtual devices (GLBP groups) on each physical interface of a device and up to four virtual forwarders per group.

Preemption

The redundancy scheme of GLBP enables you to preempt an active virtual gateway (AVG) with a higher priority backup virtual gateway that has become available. Forwarder preemption works in a similar way, except that forwarder preemption uses weighting instead of priority and is enabled by default.

Authentication

GLBP supports the industry-standard message digest 5 (MD5) algorithm for improved reliability, security, and protection against GLBP-spoofing software. A device within a GLBP group with a different authentication string than other devices will be ignored by other group members. You can alternatively use a simple text password authentication scheme between GLBP group members to detect configuration errors.

How to Configure GLBP

Enabling and Verifying GLBP

Perform this task to enable GLBP on an interface and verify its configuration and operation. GLBP is designed to be easy to configure. Each gateway in a GLBP group must be configured with the same group number, and at least one gateway in the GLBP group must be configured with the virtual IP address to be used by the group. All other required parameters can be learned.

Before you begin

If VLANs are in use on an interface, the GLBP group number must be different for each VLAN.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask* [**secondary**]
5. **glbp** *group* **ip** [*ip-address* [**secondary**]]
6. **end**
7. **show glbp** [*interface-type interface-number*] [*group*] [*state*] [**brief**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 1/0/1`	Specifies an interface type and number, and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Device(config-if)# ip address 10.21.8.32 255.255.255.0`	Specifies a primary or secondary IP address for an interface.
Step 5	**glbp** *group* **ip** [*ip-address* [**secondary**]] **Example:** `Device(config-if)# glbp 10 ip 10.21.8.10`	Enables GLBP on an interface and identifies the primary IP address of the virtual gateway. • After you identify a primary IP address, you can use the **glbp** *group* **ip** command again with the **secondary** keyword to indicate additional IP addresses supported by this group.
Step 6	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode, and returns the device to privileged EXEC mode.
Step 7	**show glbp** [*interface-type interface-number*] [*group*] [*state*] [**brief**] **Example:** `Device(config)# show glbp GigabitEthernet 1/0/1 10`	(Optional) Displays information about GLBP groups on a device. • Use the optional **brief** keyword to display a single line of information about each virtual gateway or virtual forwarder.

Example

In the following example, sample output is displayed about the status of the GLBP group, named 10, on the device:

```
Device# show glbp GigabitEthernet 1/0/1 10
GigabitEthernet1/0/1 - Group 10
  State is Active
    1 state change, last state change 00:04:52
  Virtual IP address is 10.21.8.10
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.608 secs
  Redirect time 600 sec, forwarder time-out 14400 sec
  Preemption disabled
  Active is local
  Standby is unknown
  Priority 100 (default)
  Weighting 100 (default 100), thresholds: lower 1, upper 100
  Load balancing: round-robin
  Group members:
    ac7e.8a35.6364 (10.21.8.32) local
  There is 1 forwarder (1 active)
  Forwarder 1
    State is Active
      1 state change, last state change 00:04:41
    MAC address is 0007.b400.0a01 (default)
    Owner ID is ac7e.8a35.6364
    Redirection enabled
    Preemption enabled, min delay 30 sec
    Active is local, weighting 100
```

Customizing GLBP

Customizing the behavior of GLBP is optional. Be aware that as soon as you enable a GLBP group, that group is operating. It is possible that if you first enable a GLBP group before customizing GLBP, the device could take over control of the group and become the AVG before you have finished customizing the feature. Therefore, if you plan to customize GLBP, it is a good idea to do so before enabling GLBP.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask* [**secondary**]
5. **glbp** *group* **timers** [**msec**] *hellotime* [**msec**] *holdtime*
6. **glbp** *group* **timers redirect** *redirect timeout*
7. **glbp** *group* **load-balancing** [**host-dependent** | **round-robin** | **weighted**]
8. **glbp** *group* **priority** *level*
9. **glbp** *group* **preempt** [**delay minimum** *seconds*]
10. **glbp** *group* **client-cache maximum** *number* [**timeout** *minutes*]
11. **glbp** *group* **name** *redundancy-name*
12. **exit**
13. **no glbp sso**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Device> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 1/0/1`	Specifies an interface type and number, and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Device(config-if)# ip address 10.21.8.32 255.255.255.0`	Specifies a primary or secondary IP address for an interface.
Step 5	**glbp** *group* **timers** [**msec**] *hellotime* [**msec**] *holdtime* **Example:** `Device(config-if)# glbp 10 timers 5 18`	Configures the interval between successive hello packets sent by the AVG in a GLBP group. • The *holdtime* argument specifies the interval in seconds before the virtual gateway and virtual forwarder information in the hello packet is considered invalid. • The optional **msec** keyword specifies that the following argument will be expressed in milliseconds, instead of the default seconds.
Step 6	**glbp** *group* **timers redirect** *redirect timeout* **Example:** `Device(config-if)# glbp 10 timers redirect 1800 28800`	Configures the time interval during which the AVG continues to redirect clients to an AVF. The default is 600 seconds (10 minutes). • The *timeout* argument specifies the interval in seconds before a secondary virtual forwarder becomes invalid. The default is 14,400 seconds (4 hours). **Note** The zero value for the *redirect* argument cannot be removed from the range of acceptable values because preexisting configurations of Cisco IOS software already using the zero value could be negatively affected during an upgrade. However, a zero setting is not recommended and, if used, results in a redirect timer that never expires. If the redirect timer does not expire, and the device fails, new hosts continue to be assigned to the failed device instead of being redirected to the backup.

	Command or Action	Purpose
Step 7	**glbp** *group* **load-balancing** [**host-dependent** | **round-robin** | **weighted**] **Example:** `Device(config-if)# glbp 10 load-balancing host-dependent`	Specifies the method of load balancing used by the GLBP AVG.
Step 8	**glbp** *group* **priority** *level* **Example:** `Device(config-if)# glbp 10 priority 254`	Sets the priority level of the gateway within a GLBP group. • The default value is 100.
Step 9	**glbp** *group* **preempt** [**delay minimum** *seconds*] **Example:** `Device(config-if)# glbp 10 preempt delay minimum 60`	Configures the device to take over as AVG for a GLBP group if it has a higher priority than the current AVG. • This command is disabled by default. • Use the optional **delay** and **minimum** keywords and the *seconds* argument to specify a minimum delay interval in seconds before preemption of the AVG takes place.
Step 10	**glbp** *group* **client-cache maximum** *number* [**timeout** *minutes*] **Example:** `Device(config-if)# glbp 10 client-cache maximum 1200 timeout 245`	(Optional) Enables the GLBP client cache. • This command is disabled by default. • Use the *number* argument to specify the maximum number of clients the cache will hold for this GLBP group. The range is from 8 to 2000. • Use the optional **timeout** *minutes* keyword and argument pair to configure the maximum amount of time a client entry can stay in the GLBP client cache after the client information was last updated. The range is from 1 to 1440 minutes (one day). **Note** For IPv4 networks, Cisco recommends setting a GLBP client cache timeout value that is slightly longer than the maximum expected end-host Address Resolution Protocol (ARP) cache timeout value.
Step 11	**glbp** *group* **name** *redundancy-name* **Example:** `Device(config-if)# glbp 10 name abc123`	Enables IP redundancy by assigning a name to the GLBP group. • The GLBP redundancy client must be configured with the same GLBP group name so the redundancy client and the GLBP group can be connected.

	Command or Action	Purpose
Step 12	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode, and returns the device to global configuration mode.
Step 13	**no glbp sso** **Example:** `Device(config)# no glbp sso`	(Optional) Disables GLBP support of SSO.

Configuring GLBP MD5 Authentication Using a Key String

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask* [**secondary**]
5. **glbp** *group-number* **authentication md5 key-string** [**0** | **7**] *key*
6. **glbp** *group-number* **ip** [*ip-address* [**secondary**]]
7. Repeat Steps 1 through 6 on each device that will communicate.
8. **end**
9. **show glbp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 1/0/1`	Configures an interface type and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:**	Specifies a primary or secondary IP address for an interface.

	Command or Action	Purpose
	`Device(config-if)# ip address 10.0.0.1 255.255.255.0`	
Step 5	**glbp** *group-number* **authentication md5 key-string** [**0** | **7**] *key* **Example:** `Device(config-if)# glbp 1 authentication md5 key-string d00b4r987654321a`	Configures an authentication key for GLBP MD5 authentication. • The key string cannot exceed 100 characters in length. • No prefix to the *key* argument or specifying **0** means the key is unencrypted. • Specifying **7** means the key is encrypted. The key-string authentication key will automatically be encrypted if the **service password-encryption** global configuration command is enabled.
Step 6	**glbp** *group-number* **ip** [*ip-address* [**secondary**]] **Example:** `Device(config-if)# glbp 1 ip 10.0.0.10`	Enables GLBP on an interface and identifies the primary IP address of the virtual gateway.
Step 7	Repeat Steps 1 through 6 on each device that will communicate.	—
Step 8	**end** **Example:** `Device(config-if)# end`	Returns to privileged EXEC mode.
Step 9	**show glbp** **Example:** `Device# show glbp`	(Optional) Displays GLBP information. • Use this command to verify your configuration. The key string and authentication type will be displayed if configured.

Configuring GLBP MD5 Authentication Using a Key Chain

Perform this task to configure GLBP MD5 authentication using a key chain. Key chains allow a different key string to be used at different times according to the key chain configuration. GLBP will query the appropriate key chain to obtain the current live key and key ID for the specified key chain.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **key chain** *name-of-chain*
4. **key** *key-id*
5. **key-string** *string*
6. **exit**

7. **exit**
8. **interface** *type number*
9. **ip address** *ip-address mask* [**secondary**]
10. **glbp** *group-number* **authentication md5 key-chain** *name-of-chain*
11. **glbp** *group-number* **ip** [*ip-address* [**secondary**]]
12. Repeat Steps 1 through 10 on each device that will communicate.
13. **end**
14. **show glbp**
15. **show key chain**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**key chain** *name-of-chain* **Example:** `Device(config)# key chain glbp2`	Enables authentication for routing protocols and identifies a group of authentication keys and enters key-chain configuration mode.
Step 4	**key** *key-id* **Example:** `Device(config-keychain)# key 100`	Identifies an authentication key on a key chain. • The value for the *key-id* argument must be a number.
Step 5	**key-string** *string* **Example:** `Device(config-keychain-key)# key-string abc123`	Specifies the authentication string for a key and enters key-chain key configuration mode. • The value for the *string* argument can be 1 to 80 uppercase or lowercase alphanumeric characters; the first character cannot be a numeral.
Step 6	**exit** **Example:** `Device(config-keychain-key)# exit`	Returns to key-chain configuration mode.
Step 7	**exit** **Example:**	Returns to global configuration mode.

	Command or Action	Purpose
	`Device(config-keychain)# exit`	
Step 8	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 1/0/1`	Configures an interface type and enters interface configuration mode.
Step 9	**ip address** *ip-address mask* [**secondary**] **Example:** `Device(config-if)# ip address 10.21.0.1 255.255.255.0`	Specifies a primary or secondary IP address for an interface.
Step 10	**glbp** *group-number* **authentication md5 key-chain** *name-of-chain* **Example:** `Device(config-if)# glbp 1 authentication md5 key-chain glbp2`	Configures an authentication MD5 key chain for GLBP MD5 authentication. • The key chain name must match the name specified in Step 3.
Step 11	**glbp** *group-number* **ip** [*ip-address* [**secondary**]] **Example:** `Device(config-if)# glbp 1 ip 10.21.0.12`	Enables GLBP on an interface and identifies the primary IP address of the virtual gateway.
Step 12	Repeat Steps 1 through 10 on each device that will communicate.	—
Step 13	**end** **Example:** `Device(config-if)# end`	Returns to privileged EXEC mode.
Step 14	**show glbp** **Example:** `Device# show glbp`	(Optional) Displays GLBP information. • Use this command to verify your configuration. The key chain and authentication type will be displayed if configured.
Step 15	**show key chain** **Example:** `Device# show key chain`	(Optional) Displays authentication key information.

Configuring GLBP Text Authentication

Text authentication provides minimal security. Use MD5 authentication if security is required.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask* [**secondary**]
5. **glbp** *group-number* **authentication text** *string*
6. **glbp** *group-number* **ip** [*ip-address* [**secondary**]]
7. Repeat Steps 1 through 6 on each device that will communicate.
8. **end**
9. **show glbp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 1/0/1`	Configures an interface type and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Device(config-if)# ip address 10.0.0.1 255.255.255.0`	Specifies a primary or secondary IP address for an interface.
Step 5	**glbp** *group-number* **authentication text** *string* **Example:** `Device(config-if)# glbp 10 authentication text stringxyz`	Authenticates GLBP packets received from other devices in the group. • If you configure authentication, all devices within the GLBP group must use the same authentication string.
Step 6	**glbp** *group-number* **ip** [*ip-address* [**secondary**]] **Example:** `Device(config-if)# glbp 1 ip 10.0.0.10`	Enables GLBP on an interface and identifies the primary IP address of the virtual gateway.
Step 7	Repeat Steps 1 through 6 on each device that will communicate.	—

	Command or Action	Purpose
Step 8	**end** **Example:** `Device(config-if)# end`	Returns to privileged EXEC mode.
Step 9	**show glbp** **Example:** `Device# show glbp`	(Optional) Displays GLBP information. • Use this command to verify your configuration.

Configuring GLBP Weighting Values and Object Tracking

GLBP weighting is used to determine whether a GLBP group can act as a virtual forwarder. Initial weighting values can be set and optional thresholds specified. Interface states can be tracked and a decrement value set to reduce the weighting value if the interface goes down. When the GLBP group weighting drops below a specified value, the group will no longer be an active virtual forwarder. When the weighting rises above a specified value, the group can resume its role as an active virtual forwarder.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **track** *object-number* **interface** *type number* {**line-protocol** |{**ip** | **ipv6**} **routing**}
4. **exit**
5. **interface** *type number*
6. **glbp** *group* **weighting** *maximum* [**lower** *lower*] [**upper** *upper*]
7. **glbp** *group* **weighting track** *object-number* [**decrement** *value*]
8. **glbp** *group* **forwarder preempt** [**delay minimum** *seconds*]
9. **exit**
10. **show track** [*object-number* | **brief**] [**interface** [**brief**] | **ip route** [**brief**] | **resolution** | **timers**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**track** *object-number* **interface** *type number* {**line-protocol** |{**ip** | **ipv6**} **routing**} **Example:** `Device(config)# track 2 interface GigabitEthernet 1/0/1 ip routing`	Configures an interface to be tracked where changes in the state of the interface affect the weighting of a GLBP gateway, and enters tracking configuration mode. • This command configures the interface and corresponding object number to be used with the **glbp weighting track** command. • The **line-protocol** keyword tracks whether the interface is up. The **ip routing** keywords also check that IP routing is enabled on the interface, and an IP address is configured.
Step 4	**exit** **Example:** `Device(config-track)# exit`	Returns to global configuration mode.
Step 5	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 1/0/1`	Enters interface configuration mode.
Step 6	**glbp** *group* **weighting** *maximum* [**lower** *lower*] [**upper** *upper*] **Example:** `Device(config-if)# glbp 10 weighting 110 lower 95 upper 105`	Specifies the initial weighting value, and the upper and lower thresholds, for a GLBP gateway.
Step 7	**glbp** *group* **weighting track** *object-number* [**decrement** *value*] **Example:** `Device(config-if)# glbp 10 weighting track 2 decrement 5`	Specifies an object to be tracked that affects the weighting of a GLBP gateway. • The *value* argument specifies a reduction in the weighting of a GLBP gateway when a tracked object fails.
Step 8	**glbp** *group* **forwarder preempt** [**delay minimum** *seconds*] **Example:** `Device(config-if)# glbp 10 forwarder preempt delay minimum 60`	Configures the device to take over as AVF for a GLBP group if the current AVF for a GLBP group falls below its low weighting threshold. • This command is enabled by default with a delay of 30 seconds. • Use the optional **delay** and **minimum** keywords and the *seconds* argument to specify a minimum delay interval in seconds before preemption of the AVF takes place.

	Command or Action	Purpose
Step 9	**exit** **Example:** `Device(config-if)# exit`	Returns to privileged EXEC mode.
Step 10	**show track** [*object-number* | **brief**] [**interface** [**brief**] | **ip route** [**brief**] | **resolution** | **timers**] **Example:** `Device# show track 2`	Displays tracking information.

Troubleshooting GLBP

GLBP introduces five privileged EXEC mode commands to enable display of diagnostic output concerning various events relating to the operation of GLBP. The **debug condition glbp**,**debug glbp errors**, **debug glbp events**, **debug glbp packets**, and **debug glbp terse** commands are intended only for troubleshooting purposes because the volume of output generated by the software can result in severe performance degradation on the device. Perform this task to minimize the impact of using the **debug glbp** commands.

This procedure will minimize the load on the device created by the **debug condition glbp**or **debug glbp** command because the console port is no longer generating character-by-character processor interrupts. If you cannot connect to a console directly, you can run this procedure via a terminal server. If you must break the Telnet connection, however, you may not be able to reconnect because the device may be unable to respond due to the processor load of generating the debugging output.

Before you begin

This task requires a device running GLBP to be attached directly to a console.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no logging console**
4. Use Telnet to access a device port and repeat Steps 1 and 2.
5. **end**
6. **terminal monitor**
7. **debug condition glbp** *interface-type interface-number group* [*forwarder*]
8. **terminal no monitor**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no logging console** **Example:** `Device(config)# no logging console`	Disables all logging to the console terminal. • To reenable logging to the console, use the**logging console** command in global configuration mode.
Step 4	Use Telnet to access a device port and repeat Steps 1 and 2.	Enters global configuration mode in a recursive Telnet session, which allows the output to be redirected away from the console port.
Step 5	**end** **Example:** `Device(config)# end`	Exits to privileged EXEC mode.
Step 6	**terminal monitor** **Example:** `Device# terminal monitor`	Enables logging output on the virtual terminal.
Step 7	**debug condition glbp** *interface-type interface-number group* [*forwarder*] **Example:** `Device# debug condition glbp GigabitEthernet 0/0/0 1`	Displays debugging messages about GLBP conditions. • Try to enter only specific **debug condition glbp** or **debug glbp** commands to isolate the output to a certain subcomponent and minimize the load on the processor. Use appropriate arguments and keywords to generate more detailed debug information on specified subcomponents. • Enter the specific **no debug condition glbp** or **no debug glbp** command when you are finished.
Step 8	**terminal no monitor** **Example:** `Device# terminal no monitor`	Disables logging on the virtual terminal.

Configuration Examples for GLBP

Example: Customizing GLBP Configuration

```
Device(config)# interface GigabitEthernet 1/0/1
Device(config-if)# ip address 10.21.8.32 255.255.255.0
```

```
Device(config-if)# glbp 10 timers 5 18
Device(config-if)# glbp 10 timers redirect 1800 28800
Device(config-if)# glbp 10 load-balancing host-dependent
Device(config-if)# glbp 10 priority 254
Device(config-if)# glbp 10 preempt delay minimum 60

Device(config-if)# glbp 10 client-cache maximum 1200 timeout 245
```

Example: Configuring GLBP MD5 Authentication Using Key Strings

The following example shows how to configure GLBP MD5 authentication using a key string:

```
Device(config)# interface GigabitEthernet 1/0/1
Device(config-if)# ip address 10.0.0.1 255.255.255.0
Device(config-if)# glbp 2 authentication md5 key-string ThisStringIsTheSecretKey
Device(config-if)# glbp 2 ip 10.0.0.10
```

Example: Configuring GLBP MD5 Authentication Using Key Chains

In the following example, GLBP queries the key chain "AuthenticateGLBP" to obtain the current live key and key ID for the specified key chain:

```
Device(config)# key chain AuthenticateGLBP
Device(config-keychain)# key 1
Device(config-keychain-key)# key-string ThisIsASecretKey
Device(config-keychain-key)# exit
Device(config-keychain)# exit
Device(config)# interface GigabitEthernet 1/0/1
Device(config-if)# ip address 10.0.0.1 255.255.255.0
Device(config-if)# glbp 2 authentication md5 key-chain AuthenticateGLBP
Device(config-if)# glbp 2 ip 10.0.0.10
```

Example: Configuring GLBP Text Authentication

```
Device(config)# interface GigabitEthernet 0/0/0
Device(config-if)# ip address 10.21.8.32 255.255.255.0
Device(config-if)# glbp 10 authentication text stringxyz
Device(config-if)# glbp 10 ip 10.21.8.10
```

Example: Configuring GLBP Weighting

In the following example, the device is configured to track the IP routing state of the POS interface 5/0/0 and 6/0/0, an initial GLBP weighting with upper and lower thresholds is set, and a weighting decrement value of 10 is set. If POS interface 5/0/0 and 6/0/0 go down, the weighting value of the device is reduced.

```
Device(config)# track 1 interface GigabitEthernet 1/0/1 line-protocol
Device(config)# track 2 interface GigabitEthernet 1/0/3 line-protocol
Device(config)# interface TenGigabitEthernet 0/0/1
Device(config-if)# ip address 10.21.8.32 255.255.255.0
Device(config-if)# glbp 10 weighting 110 lower 95 upper 105
Device(config-if)# glbp 10 weighting track 1 decrement 10
Device(config-if)# glbp 10 weighting track 2 decrement 10
```

Example: Enabling GLBP Configuration

In the following example, the device is configured to enable GLBP, and the virtual IP address of 10.21.8.10 is specified for GLBP group 10:

```
Device(config)# interface GigabitEthernet 0/0/0
Device(config-if)# ip address 10.21.8.32 255.255.255.0
Device(config-if)# glbp 10 ip 10.21.8.10
```

Additional References for GLBP

Related Documents

Related Topic	Document Title
GLBP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples.	Cisco IOS IP Application Services Command Reference
In Service Software Upgrade (ISSU) configuration	"In Service Software Upgrade" process module in the *Cisco IOS High Availability Configuration Guide*
Key chains and key management commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Routing Protocol-Independent Command Reference*
Object tracking	"Configuring Enhanced Object Tracking" module
Stateful Switchover	The "Stateful Switchover" module in the *Cisco IOS High Availability Configuration Guide*
VRRP	"Configuring VRRP" module
HSRP	"Configuring HSRP" module
GLBP Support for IPv6	“FHRP - GLBP Support for IPv6” module

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for GLBP

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 4: Feature Information for GLBP

Feature Name	Releases	Feature Configuration Information
Gateway Load Balancing Protocol	Cisco IOS XE 3.6E	GLBP protects data traffic from a failed router or circuit, like HSRP and VRRP, while allowing packet load sharing between a group of redundant routers. In Cisco IOS Release Cisco IOS XE Release 3.6E, this feature is supported on the following platforms: • Cisco 5760 Wireless LAN Controller The following commands were introduced or modified by this feature: **glbp forwarder preempt**, **glbp ip** , **glbp load-balancing** , **glbp name**, **glbp preempt** , **glbp priority** , **glbp sso** , **glbp timers** , **glbp timers redirect**, **glbp weighting** , **glbp weighting track**, **show glbp**.
GLBP MD5 Authentication	Cisco IOS XE 3.6E	MD5 authentication provides greater security than the alternative plain text authentication scheme. MD5 authentication allows each GLBP group member to use a secret key to generate a keyed MD5 hash that is part of the outgoing packet. A keyed hash of an incoming packet is generated and, if the hash within the incoming packet does not match the generated hash, the packet is ignored. In Cisco IOS Release Cisco IOS XE Release 3.6E, this feature is supported on the following platforms: • Cisco 5760 Wireless LAN Controller The following commands were modified by this feature: **glbp authentication**, **show glbp**.

Feature Name	Releases	Feature Configuration Information
ISSU—GLBP	Cisco IOS XE 3.6E	GLBP supports In Service Software Upgrade (ISSU). ISSU allows a high-availability (HA) system to run in Stateful Switchover (SSO) mode even when different versions of Cisco IOS software are running on the active and standby Route Processors (RPs) or line cards. This feature provides customers with the same level of HA functionality for planned outages due to software upgrades as is available with SSO for unplanned outages. That is, the system can switch over to a secondary RP and continue forwarding packets without session loss and with minimal or no packet loss. This feature is enabled by default. In Cisco IOS Release Cisco IOS XE Release 3.6E, this feature is supported on the following platforms: • Cisco 5760 Wireless LAN Controller There are no new or modified commands for this feature.
SSO—GLBP	Cisco IOS XE 3.6E	GLBP is now SSO aware. GLBP can detect when a router is failing over to the secondary RP and continue in its current GLBP group state. Prior to being SSO aware, GLBP was not able to detect that a second RP was installed and configured to take over in the event that the primary RP failed. When the primary failed, the GLBP device would stop participating in the GLBP group and, depending on its role, could trigger another router in the group to take over as the active router. With this enhancement, GLBP detects the failover to the secondary RP and no change occurs to the GLBP group. If the secondary RP fails and the primary is still not available, then the GLBP group detects this and re-elects a new active GLBP router. This feature is enabled by default. In Cisco IOS Release Cisco IOS XE Release 3.6E, this feature is supported on the following platforms: • Cisco 5760 Wireless LAN Controller The following commands were introduced or modified by this feature: **debug glbp events**,**glbp sso**, **show glbp**.

Glossary

active RP—The Route Processor (RP) controls the system, provides network services, runs routing protocols and presents the system management interface.

AVF—active virtual forwarder. One virtual forwarder within a GLBP group is elected as active virtual forwarder for a specified virtual MAC address, and it is responsible for forwarding packets sent to that MAC address. Multiple active virtual forwarders can exist for each GLBP group.

AVG—active virtual gateway. One virtual gateway within a GLBP group is elected as the active virtual gateway, and is responsible for the operation of the protocol.

GLBP gateway—Gateway Load Balancing Protocol gateway. A router or gateway running GLBP. Each GLBP gateway may participate in one or more GLBP groups.

GLBP group—Gateway Load Balancing Protocol group. One or more GLBP gateways configured with the same GLBP group number on connected Ethernet interfaces.

ISSU—In Service Software Upgrade. A process that allows Cisco IOS XE software to be updated or otherwise modified while packet forwarding continues. In most networks, planned software upgrades are a significant cause of downtime. ISSU allows software to be modified while packet forwarding continues, which increases network availability and reduces downtime caused by planned software upgrades.

NSF—nonstop forwarding. The ability of a router to continue to forward traffic to a router that may be recovering from a failure. Also, the ability of a router recovering from a failure to continue to correctly forward traffic sent to it by a peer.

RP—Route Processor. A generic term for the centralized control unit in a chassis. Platforms usually use a platform-specific term, such as RSP on the Cisco 7500, the PRE on the Cisco 10000, or the SUP+MSFC on the Cisco 7600.

RPR—Route Processor Redundancy. RPR provides an alternative to the High System Availability (HSA) feature. HSA enables a system to reset and use a standby Route Processor (RP) if the active RP fails. Using RPR, you can reduce unplanned downtime because RPR enables a quicker switchover between an active and standby RP if the active RP experiences a fatal error.

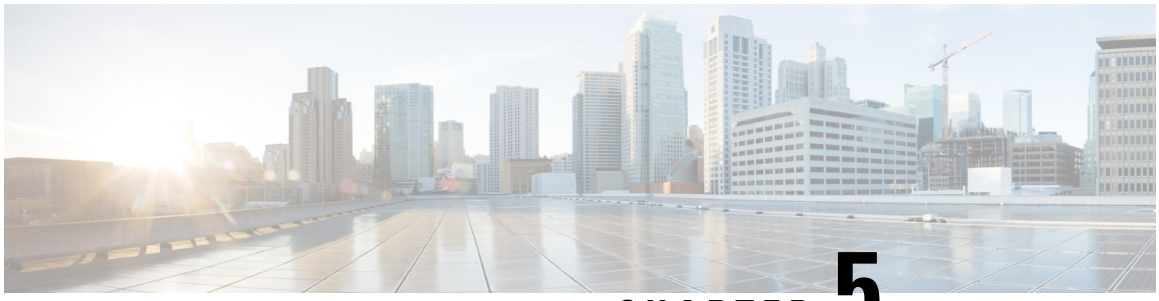
RPR+—An enhancement to RPR in which the standby RP is fully initialized.

SSO—Stateful Switchover. Enables applications and features to maintain state information between an active and standby unit.

standby RP—An RP that has been fully initialized and is ready to assume control from the active RP should a manual or fault-induced switchover occur.

switchover—An event in which system control and routing protocol execution are transferred from the active RP to the standby RP. Switchover may be a manual operation or may be induced by a hardware or software fault. Switchover may include transfer of the packet forwarding function in systems that combine system control and packet forwarding in an indivisible unit.

vIP—virtual IP address. An IPv4 address. There must be only one virtual IP address for each configured GLBP group. The virtual IP address must be configured on at least one GLBP group member. Other GLBP group members can learn the virtual IP address from hello messages.



CHAPTER 5

Configuring TCP MSS Adjustment

- Information about TCP MSS Adjustment, on page 71
- Configuring the MSS Value for Transient TCP SYN Packets, on page 72
- Configuring the MSS Value for IPv6 Traffic, on page 73
- Example: Configuring the TCP MSS Adjustment, on page 73
- Example: Configuring the TCP MSS Adjustment for IPv6 traffic, on page 74
- Feature History and Information for TCP MSS Adjustment, on page 74

Information about TCP MSS Adjustment

The Transmission Control Protocol (TCP) Maximum Segment Size (MSS) Adjustment feature enables the configuration of the maximum segment size for transient packets that traverse a router, specifically TCP segments with the SYN bit set. Use the ip tcp adjust-mss command in interface configuration mode to specify the MSS value on the intermediate router of the SYN packets to avoid truncation.

When a host (usually a PC) initiates a TCP session with a server, it negotiates the IP segment size by using the MSS option field in the TCP SYN packet. The value of the MSS field is determined by the MTU configuration on the host. The default MSS value for a PC is 1500 bytes.

The PPP over Ethernet (PPPoE) standard supports an MTU of only 1492 bytes. The disparity between the host and PPPoE MTU size can cause the router in between the host and the server to drop 1500-byte packets and terminate TCP sessions over the PPPoE network. Even if the path MTU (which detects the correct MTU across the path) is enabled on the host, sessions may be dropped because system administrators sometimes disable the ICMP error messages that must be relayed from the host in order for path MTU to work.

The ip tcp adjust-mss command helps prevent TCP sessions from being dropped by adjusting the MSS value of the TCP SYN packets.

The ip tcp adjust-mss command is effective only for TCP connections passing through the router.

In most cases, the optimum value for the max-segment-size argument of the ip tcp adjust-mss command is 1452 bytes. This value plus the 20-byte IP header, the 20-byte TCP header, and the 8-byte PPPoE header add up to a 1500-byte packet that matches the MTU size for the Ethernet link.

Supported Interfaces

TCP MSS Adjust is supported on the following interfaces:

- Physical L3 interface

- SVI
- L3 port channel
- L3 GRE tunnel

Configuring the MSS Value for Transient TCP SYN Packets

Before you begin

Perform this task to configure the MSS for transient packets that traverse a router, specifically TCP segments with the SYN bit set.

We recommend that you use the following commands and values:

- **ip tcp adjust-mss 1452**

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface***type number*
4. **ip tcp adjust-mss***max-segment-size*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `>enable`	Enables privileged EXEC mode. • Enter your password if prompted
Step 2	**configure terminal** **Example:** `#config terminal`	Enters the global configuration mode.
Step 3	**interface***type number* **Example:** `(config)#interface GigabitEthernet 1/0/0`	Configures an interface type and enters interface configuration mode.
Step 4	**ip tcp adjust-mss***max-segment-size* **Example:** `(config-if)#ip tcp adjust-mss 1452`	Adjusts the MSS value of TCP SYN packets going through a router. • The max-segment-size argument is the maximum segment size, in bytes. The range is from 500 to 1460.
Step 5	**end** **Example:**	Exits to global configuration mode.

	Command or Action	Purpose
	`(config-if)#end`	

Configuring the MSS Value for IPv6 Traffic

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface***type number*
4. **ipv6 tcp adjust-mss***max-segment-size*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `>enable`	Enables privileged EXEC mode. • Enter your password if prompted
Step 2	**configure terminal** **Example:** `#config terminal`	Enters the global configuration mode.
Step 3	**interface***type number* **Example:** `(config)#interface GigabitEthernet 1/0/0`	Configures an interface type and enters interface configuration mode.
Step 4	**ipv6 tcp adjust-mss***max-segment-size* **Example:** `(config-if)#ipv6 tcp adjust-mss 1440`	Adjusts the MSS value of TCP DF packets going through a device. • The max-segment-size argument is the maximum segment size, in bytes. The range is from 40 to 1440.
Step 5	**end** **Example:** `(config-if)#end`	Exits interface configuration mode and returns to privileged EXEC mode.

Example: Configuring the TCP MSS Adjustment

```
Device(config)#vpdn enable
Device(config)#no vpdn logging
Device(config)#vpdn-group 1
Device(config-vpdn)#request-dialin
```

```
Device(config-vpdn-req-in)#protocol pppoe
Device(config-vpdn-req-in)#exit
Device(config-vpdn)#exit
Device(config)#interface GigabitEthernet 0/0/0
Device(config-if)#ip address 192.168.100.1.255.255.255.0
Device(config-if)#ip tcp adjust-mss 1452
Device(config-if)#ip nat inside
Device(config-if)#exit
```

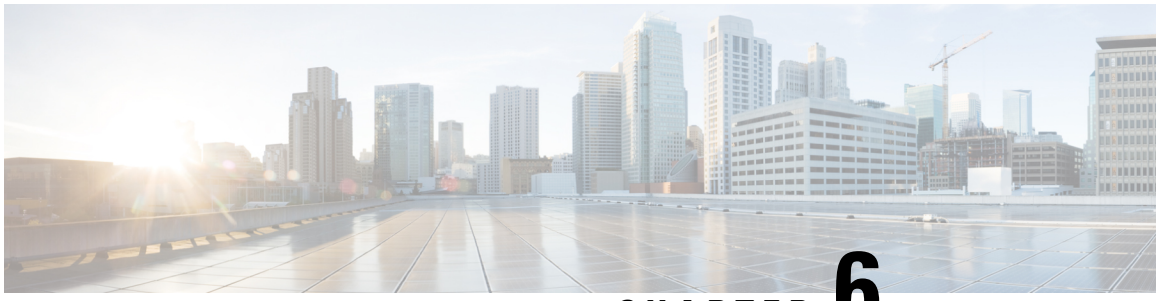
Example: Configuring the TCP MSS Adjustment for IPv6 traffic

```
Device>enable
Device#configure terminal
Device(config)#interface GigabitEthernet 0/0/0
Device(config)#ipv6 tcp adjust-mss 1440
Device(config)#end
```

Feature History and Information for TCP MSS Adjustment

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Release	Modification
Cisco IOS XE Fuji 16.8.1a	This feature was introduced.



CHAPTER 6

Enhanced IPv6 Neighbor Discovery Cache Management

- Enhanced IPv6 Neighbor Discovery Cache Management , on page 75
- Customizing the Parameters for IPv6 Neighbor Discovery , on page 76
- Examples: Customizing Parameters for IPv6 Neighbor Discovery, on page 77
- Additional References, on page 77
- Feature Information for IPv6 Neighbor Discovery, on page 77

Enhanced IPv6 Neighbor Discovery Cache Management

Neighbor discovery protocol enforces neighbor unreachability detection, which can detect failing nodes or devices, and changes to link-layer addresses. Neighbor unreachability detection is used to maintain reachability information for all paths between hosts and neighboring nodes, including host-to-host, host-to-device, and device-to-host communication.

The neighbor cache maintains mapping information about the IPv6 link-local or global address to the link-layer address. The neighbor cache also maintains the neighbor's reachability state, which is updated using neighbor unreachability detection. Neighbors can be in one of the following five possible states:

- DELAY—Neighbor is pending re-resolution, and traffic might flow to this neighbor.
- INCOMPLETE—Address resolution is in progress, and the link-layer address is not yet known.
- PROBE—Neighbor re-resolution is in progress, and traffic might flow to this neighbor.
- REACHABLE—Neighbor is known to be reachable within the last reachable time interval.
- STALE—Neighbor requires re-resolution, and traffic may flow to this neighbor.

Use the **ipv6 nd na glean** command to configure neighbor discovery to glean an entry from an unsolicited neighbor advertisement.

Use the **ipv6 nd nud retry** command to configure neighbor discovery to maintain an neighbor discovery cache entry for a neighbor during network disruption.

Use the **ipv6 nd cache expire refresh** command to configure the neighbor to maintain an neighbor discovery cache entry, when no traffic is sent to the neighbor.

Customizing the Parameters for IPv6 Neighbor Discovery

To customize the parameters for IPv6 neighbor discovery, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface gigabitethernet 1/1/4`	Specifies an interface type and identifier; enters the interface configuration mode.
Step 4	**ipv6 nd nud retry** *base interval max-attempts* [*final-wait-time*] **Example:** `Device(config-if)# ipv6 nd nud retry 1 1000 3`	Configures the number of times neighbor unreachability detection resends neighbor solicitations.
Step 5	**ipv6 nd cache expire** *expire-time-in-seconds* [**refresh**] **Example:** `Device(config-if)# ipv6 nd cache expire 7200`	Configures the length of time before an IPv6 neighbor discovery cache entry expires.
Step 6	**ipv6 nd na glean** **Example:** `Device(config-if)# ipv6 nd na glean`	Configures the length of time before an IPv6 neighbor discovery cache entry expires.
Step 7	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.
Step 8	**show ipv6 interface** **Example:** `Device# show ipv6 interface`	(Optional) Displays the usability status of interfaces that are configured for IPv6 along with neighbor discovery cache management.

Examples: Customizing Parameters for IPv6 Neighbor Discovery

In the following example, IPv6 neighbor advertisement gleaning is enabled and the IPv6 neighbor discovery cache expiry is set to 7200 seconds (2 hours):

```
Device> enable
Device# configure terminal
Device(config)# interface Port-channel 189
Device(config-if)# no ip address
Device(config-if)# ipv6 address 2001:BD8::/64
Device(config-if)# ipv6 nd reachable-time 2700000
Device(config-if)# ipv6 nd na glean
Device(config-if)# ipv6 nd cache expire 7200
Device(config-if)# no ipv6 redirects
Device(config-if)# end
```

Additional References

Related Documents

Related Topic	Document Title
For complete syntax and usage information for the commands used in this chapter.	See the *IP Command Reference (Catalyst 3650 Switches)*
For information on IPv6 Neighbor Discovery Inspection	See the *Security Configuration Guide (Catalyst 3650 Switches)*

Feature Information for IPv6 Neighbor Discovery

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 5: Feature Information for IPv6 Neigbor Discovery

Feature Name	Releases	Feature Information
Enhanced IPv6 Neighbor Discovery Cache Management	Cisco IOS XE 3.3SE	Neighbor discovery protocol enforces neighbor unreachability detection, which can detect failing nodes or routers, and changes to link-layer addresses.