



# Implementing VRRP

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## Configuring VRRP

The Virtual Router Redundancy Protocol (VRRP) feature allows for transparent failover at the first-hop IP router, enabling a group of routers to form a single virtual router. For more information on VRRP and related concepts, see [Understanding VRRP, on page 1](#).

### Restrictions for Configuring VRRP

- Upto 64 VRRP sessions are permitted on Cisco NCS 5001 and NCS 5002 routers (including Hot Standby Router Protocol [HSRP] sessions, if any).
- Upto 16 VRRP sessions are permitted on Cisco NCS 5011 routers (including Hot Standby Router Protocol [HSRP] sessions, if any).
- ICMP redirects are not supported.
- Protocol Independent Multicast (PIM) is not supported with VRRP.
- VRRP is not supported over BVI interface.
- VRRP is not supported over BVI interface.

## Understanding VRRP

The Virtual Router Redundancy Protocol (VRRP) feature allows for transparent failover at the first-hop IP router, enabling a group of routers to form a single virtual router.

### VRRP Overview

A LAN client can use a dynamic process or static configuration to determine which router should be the first hop to a particular remote destination. The client examples of dynamic router discovery are as follows:

- Proxy ARP—The client uses Address Resolution Protocol (ARP) to get the destination it wants to reach, and a router responds to the ARP request with its own MAC address.

- Routing protocol—The client listens to dynamic routing protocol updates (for example, from Routing Information Protocol [RIP]) and forms its own routing table.
- IRDP (ICMP Router Discovery Protocol) client—The client runs an Internet Control Message Protocol (ICMP) router discovery client.

The drawback to dynamic discovery protocols is that they incur some configuration and processing overhead on the LAN client. Also, in the event of a router failure, the process of switching to another router can be slow.

An alternative to dynamic Cisco Discovery Protocols is to statically configure a default router on the client. This approach simplifies client configuration and processing, but creates a single point of failure. If the default gateway fails, the LAN client is limited to communicating only on the local IP network segment and is cut off from the rest of the network.

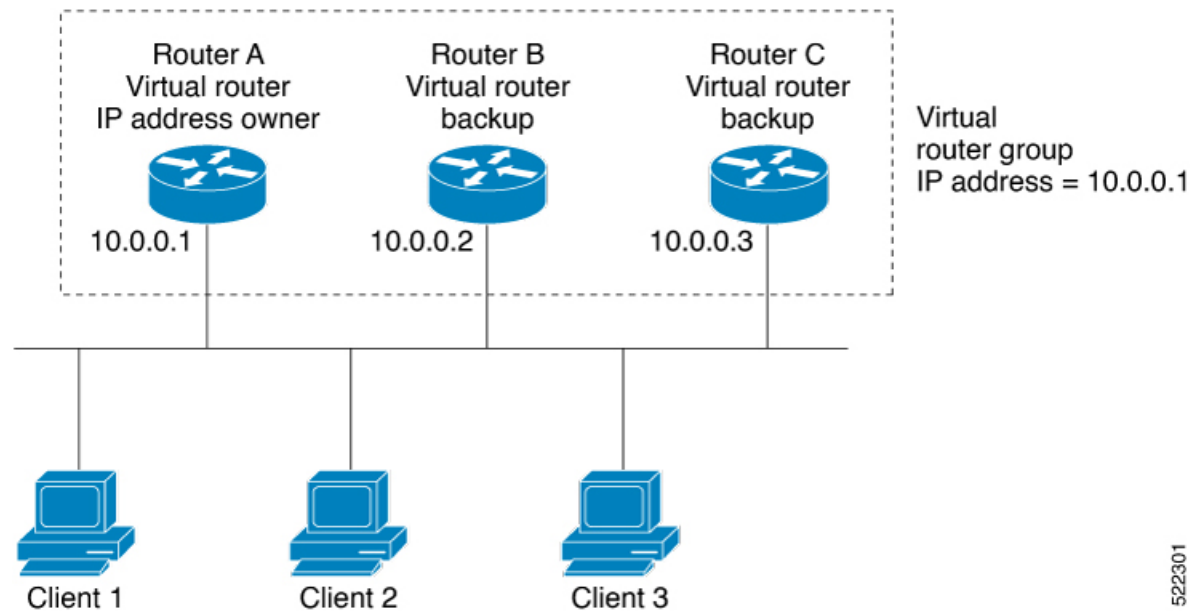
The Virtual Router Redundancy Protocol (VRRP) feature can solve the static configuration problem. VRRP is an IP routing redundancy protocol designed to allow for transparent failover at the first-hop IP router. VRRP enables a group of routers to form a single *virtual router*. The LAN clients can then be configured with the virtual router as their default gateway. The virtual router, representing a group of routers, is also known as a *VRRP group*.

When the virtual router group IP address is the same as the IP address of the physical interface of any router in the VRRP group, then such router becomes the *IP address owner* and the VRRP group operates in the *Owner* mode. When a VRRP group operates in Owner mode, the IP address owner is responsible for forwarding packets that are sent to the VRRP group.

For operating in Owner mode in case of IPv6 VRRP sessions, the link-local address that is configured for the VRRP session must be the same as the link-local address of the physical interface in a router. The link-local address can be autoconfigured by the router or can be an address that is configured by the administrator.

For example, [Figure 1: Basic VRRP Topology, on page 3](#) shows a LAN topology in which VRRP is configured. In this example, Routers A, B, and C are *VRRP routers* (routers running VRRP) that compose a virtual router. The IP address of the virtual router is the same as that configured for the interface of Router A (10.0.0.1).

Figure 1: Basic VRRP Topology



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Because the virtual router uses the IP address of the physical interface of Router A, Router A assumes the role of the *IP address owner* and is responsible for forwarding packets that are sent to the VRRP group IP address. Clients 1 through 3 are configured with the default gateway IP address of 10.0.0.1.

Routers B and C function as *backup virtual routers*. If the router that is IP address owner fails, the router that is configured with the higher priority becomes the IP address owner and provides uninterrupted service for the LAN hosts. When Router A recovers, it becomes the IP address owner again.



**Note** We recommend that you disable Spanning Tree Protocol (STP) on switch ports to which the virtual routers are connected. Enable RSTP or rapid-PVST on the switch interfaces if the switch supports these protocols.

### Multiple Virtual Router Support

You can configure up to 100 virtual routers on a router interface. You can configure up to 256 virtual routers on a router interface. The actual number of virtual routers that a router interface can support depends on the following factors:

- Router processing capability
- Router memory capability
- Router interface support of multiple MAC addresses

In a topology where multiple virtual routers are configured on a router interface, the interface can act as an IP address owner for one or more virtual routers and as a backup for one or more virtual routers.

### VRRP Router Priority

An important aspect of the VRRP redundancy scheme is VRRP router priority. Priority determines the role that each VRRP router plays and what happens if the IP address owner virtual router fails.

If a VRRP router owns the IP address of the virtual router and the IP address of the physical interface, this router functions as a IP address owner virtual router.

If no VRRP router owns the IP address, the priority of a VRRP router, combined with the preempt settings, determines if a VRRP router functions as an IP address owner router or a backup virtual router. By default, the highest priority VRRP router functions as IP address owner router, and all the others function as backups. Priority also determines the order of ascendancy to becoming an IP address owner virtual router if the IP address owner virtual router fails. You can configure the priority of each backup virtual router with a value of 1 through 254, using the `vrrp priority` command.

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

By default, a preemptive scheme is enabled whereby a higher-priority backup virtual router that becomes available takes over from the current IP address owner virtual router. You can disable this preemptive scheme using the `vrrp preempt disable` command. If preemption is disabled, the backup virtual router that is elected to become IP address owner router upon the failure of the original higher priority IP address owner router, remains the IP address owner router even if the original IP address owner virtual router recovers and becomes available again.

### VRRP Advertisements

The IP address owner virtual router sends VRRP advertisements to other VRRP routers in the same group. The advertisements communicate the priority and state of the IP address owner virtual router. The VRRP advertisements are encapsulated in IP packets and sent to the IP Version 4 multicast address assigned to the VRRP group. The advertisements are sent every second by default; the interval is configurable.

### Benefits of VRRP

The benefits of VRRP are as follows:

- **Redundancy**— VRRP enables you to configure multiple routers as the default gateway router, 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 routers, thereby sharing the traffic load more equitably among available routers.
- **Multiple Virtual Routers**—VRRP supports up to 100 virtual routers (VRRP groups) on a router interface, subject to the platform supporting multiple MAC addresses. You can configure up to 256 virtual routers on a router interface. Multiple virtual router support enables you to implement redundancy and load sharing in your LAN topology.
- **Multiple IP Addresses**—The virtual router 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.

- **Preemption**—The redundancy scheme of VRRP enables you to preempt a backup virtual router that has taken over for a failing IP address owner virtual router with a higher-priority backup virtual router that has become available.
- **Text Authentication**—You can ensure that VRRP messages received from VRRP routers that comprise a virtual router are authenticated by configuring a simple text password.
- **Advertisement Protocol**—VRRP uses a dedicated Internet Assigned Numbers Authority (IANA) standard multicast address (224.0.0.18) for VRRP advertisements. This addressing scheme minimizes the number of routers that must service the multicasts and allows test equipment to accurately identify VRRP packets on a segment. The IANA assigns VRRP the IP protocol number 112.

### Hot Restartability for VRRP

In the event of failure of a VRRP process in one group, forced failovers in peer VRRP IP address owner router groups should be prevented. Hot restartability supports warm RP failover without incurring forced failovers to peer VRRP routers.

## Configuring VRRP for IPv4 Networks

This section describes the procedure for configuring and verifying VRRP for IPv4 networks.

### Configuration

Use the following configuration for configuring VRRP for IPv4 networks.



#### Note

Certain customizations (as mentioned) are recommended to control the behavior of the VRRP group on committing the VRRP configuration on the Router. If the following customizations are not configured, then the Router seizes control of the VRRP group, and immediately assumes the role of the IP address owner virtual Router.

```

/* Enter the interface configuration mode and configure an IPv4 address for the interface.
*/
Router(config)# interface gigabitEthernet 0/0/0/1
Router(config-if)# ipv4 address 10.10.10.1 255.255.255.0
Router(config-if)# no shut
Router(config-if)# commit
Fri Dec 8 13:49:24.142 IST
Router:Dec 8 13:49:24.285 : ifmgr[402]: %PKT_INFRA-LINK-3-UPDOWN : Interface
GigabitEthernet0/0/0/1, changed state to Down
Router:Dec 8 13:49:24.711 : ifmgr[402]: %PKT_INFRA-LINK-3-UPDOWN : Interface
GigabitEthernet0/0/0/1, changed state to Up

Router(config-if)# exit
Router(config)# do show ip int brief
Fri Dec 8 13:50:05.505 IST

Interface                               IP-Address      Status           Protocol         Vrf-Name
GigabitEthernet0/0/0/0                  unassigned      Shutdown         Down             default
GigabitEthernet0/0/0/1                  10.10.10.1      Up               Up               default
GigabitEthernet0/0/0/2                  unassigned      Shutdown         Down             default
GigabitEthernet0/0/0/3                  unassigned      Shutdown         Down             default

```

```

GigabitEthernet0/0/0/4          unassigned          Shutdown          Down          default

/* Enter the VRRP configuration mode and add the configured interface. */
Router(config)# router vrrp
Router(config-vrrp)# interface GigabitEthernet 0/0/0/1

/* CUSTOMIZATION: Configure a delay for the startup of the state machine when the interface
comes up. */
Router(config-vrrp)# delay minimum 2 reload 10 */

/* Configure VRRP version 3 for IPv4 */
Router(config-vrrp-if)# address-family ipv4 vrrp 100 version 3
Router(config-vrrp-virtual-router)# address 10.10.10.1

/* CUSTOMIZATION: Disable the installation of routes for the VRRP virtual addresses. */
Router(config-vrrp-virtual-Router)# accept-mode disable

/* CUSTOMIZATION: Set a priority for the virtual Router. */
Router(config-vrrp-virtual-Router)# priority 254

/* CUSTOMIZATION: Configure a preempt delay value that controls the selection of the IP
address owner virtual Router. */
Router(config-vrrp-virtual-Router)# preempt delay 15

/* CUSTOMIZATION: Configure the interval between successive advertisements by the IP address
owner virtual Router. */
Router(config-vrrp-virtual-Router)#timer 4

/* CUSTOMIZATION: Configure VRRP to track an interface. */
Router(config-vrrp-virtual-Router)# track interface GigabitEthernet0/0/0/1 30

/* Commit the configuration */
Router(config-vrrp-virtual-Router)# commit

```

---

You have successfully configured VRRP for IPv4 networks.

### Validation

Use the following commands to validate the configuration.

```

/* Validate the configuration */
Router(config-vrrp-virtual-router)# do show run interface GigabitEthernet 0/0/0/1
Fri Dec  8 15:04:38.140 IST
interface GigabitEthernet0/0/0/1
  ipv4 address 10.10.10.1 255.255.255.0
!

```

---

```

Router(config)# show running-config router vrrp
Fri Dec  8 13:50:18.959 IST
router vrrp
  interface GigabitEthernet0/0/0/1
    delay minimum 2 reload 10
  address-family ipv4
    vrrp 100 version 3
    priority 254
    preempt delay 15
    timer 4
    track interface GigabitEthernet0/0/0/2 30

```

```

    address 10.10.10.1
    accept-mode disable
  !
!
!

```

```

Router(config-vrrp-virtual-router)# do show vrrp ipv4 interface gigabitEthernet 0/0/0/1
Fri Dec  8 15:02:56.952 IST
IPv4 Virtual Routers:
      A indicates IP address owner
      | P indicates configured to preempt
      | |
Interface   vrID Prio A P State   Master addr   VRouter addr
Gi0/0/0/1   100 255 A P Master   local         10.10.10.1

```

```

Router(config-vrrp-virtual-router)# end
Router# show vrrp detail
Fri Dec  8 15:08:36.469 IST
GigabitEthernet0/0/0/1 - IPv4 vrID 100
  State is Master, IP address owner
    1 state changes, last state change 01:19:06
  State change history:
    Dec  8 13:49:30.147 IST Init      -> Master   Delay timer expired
  Last resign sent:      Never
  Last resign received: Never
Virtual IP address is 10.10.10.1
Virtual MAC address is 0000.5E00.0164, state is active
Master router is local
Version is 3
  Advertise time 1 secs
    Master Down Timer 3.003 (3 x 1 + (1 x 1/256))
  Minimum delay 1 sec, reload delay 5 sec
  Current priority 255
    Configured priority 100, may preempt
    minimum delay 0 secs

```

You have successfully validated VRRP for IPv4 networks.

## Configuring VRRP for IPv6 Networks

This section describes the procedure for configuring and verifying VRRP for IPv6 networks.

### Configuration

The following sample includes the configuration and customization of VRRP for IPv6 networks.



**Note** Certain customizations (as mentioned) are recommended to control the behavior of the VRRP group on committing the VRRP configuration on the Router. If the following customizations are not configured, then the Router seizes control of the VRRP group, and immediately assumes the role of the IP address owner virtual Router.

```

/* Enter the interface configuration mode and configure an IPv6 address */
Router# interface GigabitEthernet 0/0/0/2
Router(config-if)# ipv6 address 10::1/64
Router(config-if)# no shut

```

```

/* Exit the interface configuration mode and enter the vrrp configuration mode */
Router(config-if)# exit
Router(config)# Router vrrp

/* Add the configured interface for VRRP */
Router(config-vrrp)# interface GigabitEthernet 0/0/0/2

/* CUSTOMIZATION: Configure a delay for the startup of the state machine when the interface
comes up. */
Router(config-vrrp)# delay minimum 2 reload 10 */

/* Enable the IPv6 global and link local address family on the interface */
Router(config-vrrp-if)# address-family ipv6 vrrp 50
Router(config-vrrp-virtual-Router)# address linklocal autoconfig

/* CUSTOMIZATION: Disable the installation of routes for the VRRP virtual addresses. */
Router(config-vrrp-virtual-Router)# accept-mode disable

/* CUSTOMIZATION: Set a priority for the virtual Router. */
Router(config-vrrp-virtual-Router)# priority 254

/* CUSTOMIZATION: Configure a preempt delay value that controls the selection of the IP
address owner virtual Router. */
Router(config-vrrp-virtual-Router)# preempt delay 15

/* CUSTOMIZATION: Configure the interval between successive advertisements by the IP address
owner virtual Router. */
Router(config-vrrp-virtual-Router)#timer 4

/* CUSTOMIZATION: Configure VRRP to track an interface. */
Router(config-vrrp-virtual-Router)# track interface GigabitEthernet0/0/0/2 30

/* Commit the configuration */
Router(config-vrrp-virtual-Router)# commit

```

You have successfully configured VRRP for IPv6 networks.

### Validation

Use the following commands to validate the configuration.

```

/* Validate the configuration */
Router(config-vrrp-virtual-router)# do show run interface GigabitEthernet 0/0/0/2
Fri Dec 8 14:55:48.378 IST
interface GigabitEthernet0/0/0/2
  ipv6 address 10::1/64
!
-----
Router(config-vrrp-virtual-router)# do show running-config router vrrp
...
router vrrp
interface GigabitEthernet0/0/0/2
  delay minimum 2 reload 10
  address-family ipv6
  vrrp 50
  priority 254
  preempt delay 15
  timer 4
  track interface GigabitEthernet0/0/0/2 30
  address linklocal autoconfig
  accept-mode disable
!

```



```

!
!
!
-----
Router(config-vrrp-virtual-router)# do show vrrp ipv6 interface gigabitEthernet 0/0/0/2
Fri Dec  8 14:59:25.547 IST
IPv6 Virtual Routers:
                A indicates IP address owner
                | P indicates configured to preempt
                | |
Interface   vrID Prio A P State   Master addr   VRouter addr
Gi0/0/0/2      50 254  P Master  local          fe80::200:5eff:fe00:203
-----
Router(config-vrrp-virtual-router)# end
Router# show vrrp detail
Fri Dec  8 15:08:36.469 IST
GigabitEthernet0/0/0/2 - IPv6 vrID 50
  State is Master
    2 state changes, last state change 00:18:01
    State change history:
      Dec  8 14:50:23.326 IST  Init      -> Backup  Virtual IP configured
      Dec  8 14:50:35.365 IST  Backup   -> Master  Master down timer expired
  Last resign sent:      Never
  Last resign received: Never
Virtual IP address is fe80::200:5eff:fe00:203
Virtual MAC address is 0000.5E00.0203, state is active
Master router is local

  Advertise time 4 secs
    Master Down Timer 12.031 (3 x 4 + (2 x 4/256))
  Minimum delay 2 sec, reload delay 10 sec
  Current priority 254
    Configured priority 254, may preempt
      minimum delay 15 secs
  Tracked items: 1/1 up: 0 decrement
    Object name          State      Decrement
    GigabitEthernet0/0/0/2  Up        30

```

You have successfully validated VRRP for IPv6 networks.

## BFD for VRRP

Bidirectional Forwarding Detection (BFD) is a network protocol used to detect faults between two forwarding engines. BFD sessions operate in asynchronous mode. In asynchronous mode, both endpoints periodically send hello packets to each other. If a number of those packets are not received, the session is considered down.

### Advantages of BFD

- BFD provides failure detection in less than one second.
- BFD supports all types of encapsulation.
- BFD is not tied to any particular routing protocol, supports almost all routing protocols.

## BFD Process

VRRP uses BFD to detect a link failure and facilitate fast failover times without excessive control packet overhead.

The VRRP process creates BFD sessions as required. When a BFD session goes down, each backup group monitoring the session transitions to the active state.

After a transition to active state triggered by a BFD session going down, VRRP does not participate in any state elections for 10 seconds.



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**Note** IPv4 only supports BFD for VRRP.

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## Configuring BFD

### Enabling BFD

```
Router# configure
Router(config)# router vrrp
Router(config-vrrp)# interface <type> <interface-path-id>
Router(config-vrrp-if)# address-family ipv4
Router(config-vrrp-ipv4)# vrrp[group number] version <version-no> bfd
fast-detect [peer ipv4 <ipv4-address> <interface-type> <interface-path-id>]
commit
```

### Verifying BFD on VRRP

```
router vrrp
interface TenGigE0/0/0/3.1
bfd minimum-interval 4
bfd multiplier 3
address-family ipv4
vrrp 1
priority 200
address 41.41.1.3
bfd fast-detect peer ipv4 41.41.1.2
```

### Modifying BFD timers (minimum interval)

Minimum interval determines the frequency of sending BFD packets to BFD peers (in milliseconds). The default minimum interval is 15ms.

```
Router# configure
Router(config)# router vrrp
```

```

Router(config-vrrp)# interface <type> <interface-path-id>

Router(config-vrrp-if)# bfd minimum-interval <interval>

Router(config-vrrp-if)# bfd multiplier <multiplier>

router(config-vrrp-if)# address-family ipv4

commit

```

### Modifying BFD timers (multiplier)

Multiplier is the number of consecutive BFD packets which must be missed from a BFD peer before declaring that peer unavailable. The default multiplier is 3.

```

Router# configure

Router(config)# router vrrp

Router(config-vrrp)# interface <type> <interface-path-id>

Router(config-vrrp-if)# bfd multiplier <multiplier>

router(config-vrrp-if)# address-family ipv4

commit

```

## Disabling State Change Logging

### Configuration Example

Disables the task of logging the VRRP state change events via syslog.

```

Router#configure
Router(config)#router vrrp
router(config-vrrp)#message state disable
router(config-vrrp)#commit

```

## Enabling Multiple Group Optimization (MGO) for VRRP

### Configuration Examples

Multiple Group Optimization for Virtual Router Redundancy Protocol (VRRP) provides a solution for reducing control traffic in a deployment consisting of many subinterfaces. By running the VRRP control traffic for just one session, the control traffic is reduced for the subinterfaces with identical redundancy requirements. All other sessions are subordinates of this primary session, and inherit their states from it.

### Configuring VRRP Session Name

```

Router#configure
Router(config)#router vrrp
router(config-vrrp)#interface TenGigE 0/0/0/2
router(config-vrrp-if)#address-family ipv4
router(config-vrrp-address-family)#vrrp 1
/* Enables VRRP group configuration mode on a specific interface. */

router(config-vrrp-vritual-router)#name m1
/* Specifies the VRRP session name. */

```

```
router(config-vrrp-gp)#commit
```

### Configuring the Subordinate Group to Inherit its State from a Specified Group

```
Router#configure
Router(config)#router vrrp
router(config-vrrp)#interface TenGigE 0/0/0/2
router(config-vrrp-if)#address-family ipv4

router(config-vrrp-address-family)#vrrp 2 slave
/* Enables VRRP slave configuration mode on a specific interface. */

router(config-vrrp-slave)#follow m1
/* Instructs the subordinate group to inherit its state from the specified group, m1 (MGO
session name). */

router(config-vrrp-slave)#address 10.2.3.2
/* Specifies the primary virtual IPv4 address for subordinate group. */

router(config-vrrp-slave)#address 10.2.3.3 secondary
/* Specifies the secondary virtual IPv4 address for subordinate group. */

router(config-vrrp-gp)#commit
```

### Primary and Secondary Virtual IPv4 Addresses for the Subordinate Group

```
Router#configure
Router(config)#router vrrp
router(config-vrrp)#interface TenGigE 0/0/0/2
router(config-vrrp-if)#address-family ipv4

router(config-vrrp-address-family)#vrrp 2 slave
/* Enables VRRP slave configuration mode on a specific interface. */

router(config-vrrp-slave)#address 10.2.3.2
/* Specifies the primary virtual IPv4 address for subordinate group. */

router(config-vrrp-slave)#address 10.2.3.3 secondary
/* Specifies the secondary virtual IPv4 address for subordinate group. */

router(config-vrrp-slave)#commit
```

### Running Configuration

```
Router#show running-config router vrrp 1
router vrrp
interface TenGigE 0/0/0/2
address-family ipv4
vrrp 1
name m1
!

/* Subordinate group */
Router#show running-config router vrrp 2
router vrrp
interface TenGigE 0/0/0/2
address-family ipv4
vrrp 2 slave
follow m1
address 10.2.3.2
address 10.2.3.3 secondary
!
```

# Configuring SNMP Server Notifications for VRRP Events

## MIB support for VRRP

VRRP enables one or more IP addresses to be assumed by a router when a failure occurs. For example, when IP traffic from a host reaches a failed router because the failed router is the default gateway, the traffic is transparently forwarded by the VRRP router that has assumed control. VRRP does not require configuration of dynamic routing or router discovery protocols on every end host. The VRRP router controlling the IP address(es) associated with a virtual router is called the IP address owner router, and forwards packets sent to these IP addresses. The election process provides dynamic fail over (standby) in the forwarding responsibility should the IP address owner router become unavailable. This allows any of the virtual router IP addresses on the LAN to be used as the default first hop router by end-hosts.

The advantage gained from using VRRP is a higher availability default path without requiring configuration of dynamic routing or router discovery protocols on every end-host. Simple Network Management Protocol (SNMP) traps provide information of the state changes, when the virtual routers (in standby) are moved to IP address owner router's state or if the standby router is made IP address owner router.

## Configuration Example

Enables SNMP server notifications (traps) for VRRP.

```
Router#configure
Router(config)#snmp-server traps vrrp events
router(config)#commit
```

Use the **show snmp traps details** command to view details of SNMP server notifications.

