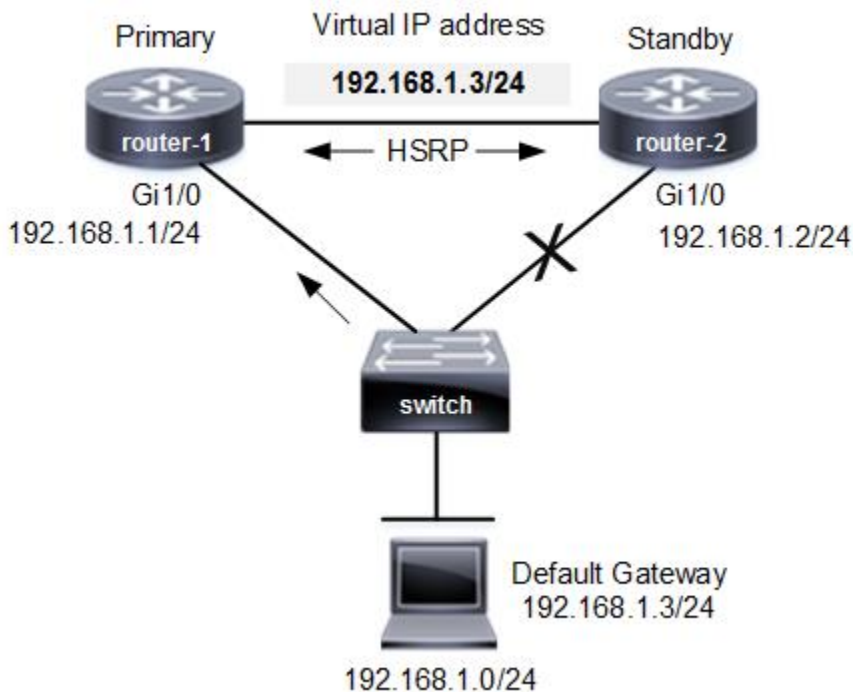


## First Hop Redundancy Protocol

The purpose of a default gateway is to provide routing services to endpoints. It is a network interface with an IP address on a Layer 3 network device. The default gateway is an upstream router or Layer 3 switch for client and server endpoints. Any packets destined for a remote subnet are forwarded to the default gateway. DHCP service is often enabled to automatically configure a default gateway address on each endpoint. There is only a single default gateway address on any host client or network server.

**Figure 1** First Hop Redundancy Protocol Operation



First Hop Redundancy Protocol (FHRP) is a routing configuration that creates a virtual router from at least two physical routers. The purpose is to enable default gateway redundancy or failover. All packets from a host are automatically forwarded to the standby default gateway when the primary gateway fails. As a result the standby router becomes the new default gateway for endpoints at the access layer. There are both open standard and Cisco proprietary protocols that enable FHRP. The most commonly deployed FHRP in the enterprise is Cisco HSRP.

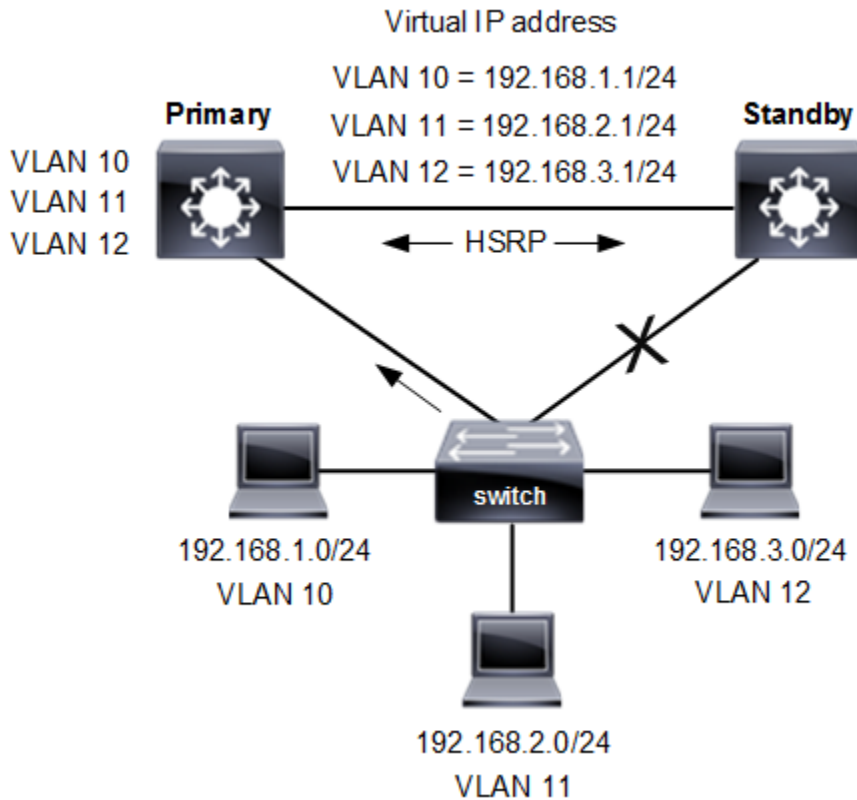
Cisco Gateway Load Balancing Protocol (GLBP) and open standard VRRP are available as well. The main usage for VRRP is firewall and load balancer failover. Consider that routing and path forwarding is always per hop between Layer 3 devices. It is the next hop neighbor that is identified for packet forwarding. That continues until packets arrive at a destination. The default gateway is first hop from an endpoint in the forwarding path to a destination endpoint.

Figure 1 is an example of FHRP operation configured for endpoints in 192.168.1.0/24 subnet. The router interface is assigned within that same subnet. Since there are often multiple host VLANs at the access layer, it is more common to use a Layer 3 switch. The VLAN interface, called an SVI, serves as default gateway for each host VLAN on Layer 3 switch. It is a logical interface and not physical interface.

## FHRP Operation

- FHRP creates a virtual shared router from at least two physical routers. The endpoints always forward packets to the same default gateway address.
- The virtual router is based on a shared virtual IP address and virtual Ethernet MAC address. That enables redundancy for fast failover to the standby router. All Layer 3 communication requires an IP address and MAC address.
- The active router is assigned the virtual IP address and MAC address for packet forwarding. The standby router is assigned the virtual address when the active router is not available.
- FHRP virtual IP address is the default gateway for hosts on the common subnet.
- FHRP is not a routing protocol and virtual IP address is not installed in the routing table. It is a default gateway address where packets are forwarded for routing services.
- Hello packets are sent between active and standby router at fixed intervals to detect neighbor operational state (up/up).
- Layer 3 switches are configured with an SVI (default gateway address) for each host VLAN.

**Figure 2** Layer 3 Switch Configuration (FHRP)



## Hot Standby Router Protocol (HSRP)

The virtual IP address assigned to an HSRP group is configured on both routers along with virtual MAC address. Multiple groups across multiple routers enable configuration of load balancing. At least one HSRP group is associated with at least two physical routers. There are hello packets sent between active and standby HSRP router at 3 second intervals to detect neighbor state.

### Priority Setting

The default HSRP priority is 100. The active router is configured with a higher priority than standby router. The router with highest IP address is elected the active router when all priorities are equal. HSRP provides a tracking feature that detects when the active HSRP router is not available. That triggers failover to the standby HSRP router. The priority of failed router is decremented by **10** as a default. The standby router has a higher priority and becomes the active router.

## Preemption

The **preempt** command enables comparison of priority between routers to elect an active HSRP router. It is configured on all HSRP enabled routers so the router with highest priority becomes active. The following command configures an interface as standby so it becomes active when the current active router interface fails.

```
router(config-if)# standby 1 preempt
```

## HSRP Configuration

The following IOS commands will configure HSRP on router-1 interface Gi0/1. It is active for group 1 with HSRPv2 enabled. The **priority 110** command assigns router-1 as the active router. That is higher than the default priority of 100.

```
router-1(config)# interface gigabitethernet0/1  
router-1(config-if)# ip address 172.16.1.2 255.255.255.0  
router-1(config-if)# standby version 2 (enable HSRPv2)  
router-1(config-if)# standby 1 preempt (compare router priority)  
router-1(config-if)# standby 1 priority 110 (active router)  
router-1(config-if)# standby 1 ip 172.16.1.1 (virtual IP address)
```

## HSRP Operational Command

The following command displays the HSRP operational status for all groups including active router and virtual IP address.

```
router# show standby  
  
Ethernet0/1 - Group 1  
Local state is Active, priority 110, may preempt  
Hello time 3 holdtime 10  
Next hello sent in 00:00:01.154  
Virtual IP address is 172.16.1.1 configured  
Active router is 172.16.1.2 expires in 00:00:03  
Active router is local  
Standby router is 172.16.1.3 expires in 00:00:07  
Virtual mac address is 0000.0c07.ac01  
Name is cisco
```

**Table 1** HSRP States

HSRP State	Description
<b>Initial (Init)</b>	HSRP is not operational.
<b>Learn</b>	virtual IP address is unassigned and no hello message received from any active router yet.
<b>Listen</b>	<ul style="list-style-type: none"><li>• virtual IP address and MAC address is known</li><li>• active and standby router are unassigned</li><li>• router listens for hello messages from HSRP group</li></ul>
<b>Speak</b>	all routers send hello messages to elect an active router and standby router for a group.
<b>Standby</b>	local router is in standby mode monitoring hello packets sent from the active router. It becomes active when the active router fails
<b>Active</b>	active router forwards packets from endpoints and sends hello packets to confirm operational status is up.