# Migrating from Cisco HSRP to industry standard VRRP

## Technical white paper

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Router Redundancy Protocol overview

Introduction to Cisco Hot Standby Router Protocol (HSRP)

In a LAN, if all packets destined to other network segments are forwarded by the same router, when the gateway fails, all the hosts that use the router as the default next-hop fail to communicate with external networks. To address this problem, Cisco developed a proprietary protocol HSRP, which provides redundancy for gateways of hosts in a LAN, increasing the network reliability.

HSRP is an error-tolerant protocol, which improves the network reliability and simplifies configurations on hosts. On a multicast and broadcast LAN such as Ethernet, HSRP provides highly reliable default links without configuration changes (such as dynamic routing protocols, route discovery protocols) when a router fails, and prevent network interruption due to a single link failure.

HSRP adds a group of routers that can act as network gateways to an HSRP group, which forms a virtual router. Routers in the HSRP group elect a master through the HSRP election mechanism to act as a gateway. The virtual router has its virtual MAC address and IP address. Hosts on a LAN use the virtual IP address and virtual MAC address as the IP address and MAC address of their default gateway.

An HSRP group comprises one active router, one standby router, and multiple listen routers. The active router forwards packets sent by hosts, and the standby router acts as the backup of the active router. When the active router fails, or it has a lower priority than the standby router, the standby router takes over as the active router. If the standby router fails or becomes the active router, then another router is elected as the standby router.

Routers in an HSRP group have six states: initial, learn, listen, speak, standby, and active.

HSRP has three types of packets, hello, resign, and coup packets. HSRP packets are encapsulated in UDP packets, with port number 1985, and destination IP a multicast address (224.0.0.2 for HSRPv1 and 224.0.0.102 for HSRPv2). Routers in speak, standby, and active states all send HSRP packets.

Introduction to RFC 3768 VRRP

VRRP is defined by Internet Engineering Task Force (IETF) to solve single-point failures. VRRP is an error-tolerant protocol, which improves the network reliability and simplifies configurations on hosts. On a multicast and broadcast LAN such as Ethernet, VRRP provides highly reliable default links without configuration changes (such as dynamic routing protocols, route discovery protocols) when a router fails, and prevents network interruption due to a single link failure.

VRRP adds a group of routers that can act as network gateways to a VRRP group, which forms a virtual router. Routers in the VRRP group elect a master through the VRRP election mechanism to act as a gateway, and hosts on a LAN only need to configure the virtual router as their default network gateway.

VRRP combines a group of routers (including a master and multiple backups) on a LAN into a virtual router called VRRP group. The virtual router has a virtual IP address. A host on the LAN only needs to know the IP address of the virtual router and uses the IP address as the next hop of the default route. Every host on the LAN communicates with external networks through the virtual router. Routers in the VRRP group elect a master that acts as the gateway according to their priorities. The other routers function as the backups. When the master fails, to ensure that the hosts in the network segment can uninterruptedly communicate with external networks, the backups in the VRRP group elect a new gateway to undertake the responsibility of the failed master.

Status of routers in a VRRP group includes initialize, master, and backup.

VRRP defines only one type of packet: VRRP advertisement. Only the master in a VRRP group periodically sends VRRP advertisements to notify status and parameters of the master and to elect the master, and the backups do not send VRRP advertisements. VRRP packets are encapsulated in IP packets, with the protocol number 112.

VRRP works as follows:

1. Routers in a VRRP group determine their roles by priority and IP address. The router with the highest priority is the master, and the others are the backups. If the routers have the same priority, the one with the highest IP address becomes the master. The master periodically sends VRRP advertisements to notify the backups that it is working properly, and each of the backups starts a timer to wait for advertisements from the master.
2. In preemptive mode, when a backup receives a VRRP advertisement, it compares the priority in the packet with its own priority. If the priority of the backup is higher, the backup becomes the master; otherwise, it remains as a backup. With the preemptive mode, a VRRP group always has a router with the highest priority as the master for packet forwarding.

3. In non-preemptive mode, a router in the VRRP group remains as a master or backup as long as the master does not fail. A backup does not become the master even if it is configured with a higher priority. The non-preemptive mode helps avoid frequent switchover between the master and backups.

4. If the timer of a backup expires but the backup still does not receive any VRRP advertisement, it considers that the master fails. In this case, the backup considers itself as the master and sends VRRP advertisements to start a new master election.

**Router Redundancy Protocols supported by HP devices**

HP devices support RFC 3768 compliant VRRP and do not support Cisco-proprietary HSRP.

**Comparison of HSRP and VRRP**

<table>
<thead>
<tr>
<th>Protocol type</th>
<th>HSRP</th>
<th>VRRP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard</strong></td>
<td>Cisco-proprietary</td>
<td>RFC 3768</td>
</tr>
<tr>
<td><strong>Advertisement interval</strong></td>
<td>Ranges from 1 to 254 seconds, and defaults to 3 seconds</td>
<td>Ranges from 1 to 255 seconds, and defaults to 1 second</td>
</tr>
<tr>
<td><strong>Switchover time</strong></td>
<td>Hold time, which ranges from (Hello time + 1) to 255 seconds, and defaults to 10 seconds</td>
<td>Three advertisement intervals plus skew-time</td>
</tr>
<tr>
<td><strong>Interoperability</strong></td>
<td>Supported by a few vendors such as Cisco</td>
<td>Supported by most vendors</td>
</tr>
<tr>
<td><strong>Virtual IP address</strong></td>
<td>Cannot be the same as the real IP address of an interface</td>
<td>Can be the same as the real IP address of an interface</td>
</tr>
<tr>
<td><strong>Priority</strong></td>
<td>Ranges from 0 to 255</td>
<td>Ranges from 1 to 255, where 255 is reserved for the IP address owner.</td>
</tr>
<tr>
<td><strong>Authentication mode</strong></td>
<td>None, simple text, and MD5 authentication</td>
<td>None, simple text, and MD5 authentication</td>
</tr>
<tr>
<td><strong>Group number</strong></td>
<td>0 to 255 for HSRPv1</td>
<td>1 to 255</td>
</tr>
<tr>
<td></td>
<td>0 to 4095 for HSRPv2</td>
<td></td>
</tr>
</tbody>
</table>

VRRP can implement interoperability among different vendors as a standard protocol as opposed to HSRP.
Router Redundancy application

Network diagram

As shown in Figure 1, Router A and Router B back up each other to act as the gateway of the hosts in the LAN. Host A communicates with Host B on the Internet through the gateway.

- The default gateway of Host A is 202.38.160.111/24.
- Router A and Router B belong to standby group 1 with the virtual IP address of 202.38.160.111/24.
- When Router A operates normally, packets sent from Host A to Host B are forwarded by Router A; if Router A fails, packets sent from Host A to Host B are forwarded by Router B.
- Configure standby group 1 to monitor Track 1 on Router A. When the status of Track 1 becomes negative, the priority of Router A in group 1 decreases by 20 to trigger Router B to preempt as the master (active router).

Figure 1: Network diagram

Configuring HSRP

1. Configure Router A
   hostname RouterA
   !
   track 1 interface ethernet2/1 line-protocol
   !
   interface ethernet 1/1
   ip address 202.38.160.1 255.255.255.0
   standby 1 ip 202.38.160.111
   standby 1 priority 110
   standby 1 preempt
   standby 1 track 1 decrement 20
2. Configure Router B
   hostname RouterB
   !
   interface ethernet 1/1
   ip address 202.38.160.2 255.255.255.0 standby 1 ip 202.38.160.111
   standby 1 preempt

Verifying the configuration

# Display the status of Router A to verify that the configuration has taken effect, and the HSRP group is formed.
RouterA#show standby
Ethernet1/1 - Group 1
 State is Active
 15 state changes, last state change 00:44:06
 Virtual IP address is 202.38.160.111
 Active virtual MAC address is 0000.0c07.ac01
 Local virtual MAC address is 0000.0c07.ac01 (v1 default)
 Hello time 3 sec, hold time 10 sec
 Next hello sent in 2.264 sec
 Preemption enabled
 Active router is local
 Standby router is 202.38.160.2, priority 100 (expires in 7.716 sec)
 Priority 110 (configured 110)
 Track object 1 state Up decrement 20
 IP redundancy name is "hsrp-Et1/1-1" (default)

Migrating from Cisco HSRP to VRRP

Migration guidelines

VRRP implements all HSRP functions and its configuration is similar to HSRP. The key to migrating from an HSRP network to a VRRP network is to plan the virtual IP address, priorities of the master and backups, link monitoring, and switchover time when a fault occurs.

In the network shown in Figure 1, configure VRRP on Router A to replace Cisco HSRP configurations:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cisco HSRP</th>
<th>VRRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface IP address</td>
<td>202.38.160.1/24</td>
<td>202.38.160.1/24</td>
</tr>
<tr>
<td>VRRP group ID</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Virtual IP address</td>
<td>202.38.160.111</td>
<td>202.38.160.111</td>
</tr>
<tr>
<td>VRRP group priority</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>Preemption mode</td>
<td>Preempt</td>
<td>Preempt</td>
</tr>
<tr>
<td>Advertisement interval</td>
<td>3 seconds</td>
<td>3 seconds</td>
</tr>
<tr>
<td>Fault switch time</td>
<td>10 seconds</td>
<td>Unconfigurable. It takes the value of $(3\times3 + (256–110)/256)s = 9.57s$</td>
</tr>
<tr>
<td>Monitored object</td>
<td>Track 1</td>
<td>Track 1</td>
</tr>
<tr>
<td>Authentication mode</td>
<td>None authentication</td>
<td>None authentication</td>
</tr>
</tbody>
</table>
Configure VRRP on Router B to replace Cisco HSRP configurations:

<table>
<thead>
<tr>
<th>Configuration items</th>
<th>Cisco HSRP</th>
<th>VRRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface IP address</td>
<td>202.38.160.2/24</td>
<td>202.38.160.2/24</td>
</tr>
<tr>
<td>VRRP group ID</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Virtual IP address</td>
<td>202.38.160.111</td>
<td>202.38.160.111</td>
</tr>
<tr>
<td>VRRP group priority</td>
<td>Default value 100</td>
<td>Default value 100</td>
</tr>
<tr>
<td>Preemption mode</td>
<td>Preempt</td>
<td>Preempt</td>
</tr>
<tr>
<td>Advertisement interval</td>
<td>3 seconds</td>
<td>3 seconds</td>
</tr>
<tr>
<td>Monitored object</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Authentication mode</td>
<td>None authentication</td>
<td>None authentication</td>
</tr>
</tbody>
</table>

VRRP configuration and verification procedures

**Configuring VRRP**

1. Configure Router A

   `<RouterA> system-view
   [RouterA] interface ethernet 1/1
   [RouterA-Ethernet1/1] ip address 202.38.160.1 255.255.255.0

   # Create VRRP group 1 and configure its virtual IP address as 202.38.160.111.
   [RouterA-Ethernet1/1] vrrp vrid 1 virtual-ip 202.38.160.111

   # Configure the priority of Router A in the VRRP group 1 as 110, which is higher than that of Router B (100), so that Router A can become the master.
   [RouterA-Ethernet1/1] vrrp vrid 1 priority 110

   # Configure Router A to work in preemptive mode so that it can become the master whenever it works normally.
   [RouterA-Ethernet1/1] vrrp vrid 1 preempt-mode

   # Configure the preemption delay as three seconds to avoid frequent status switchover.
   [RouterA-Ethernet1/1] vrrp vrid 1 timer advertise 3

   # Set interface Ethernet 2/1 to be tracked, and configure the amount by which the priority value decreases to be 20, so that when Ethernet 2/1 fails, the priority of Router A in VRRP group 1 decreases to a value lower than 100 and thus Router B can become the master.
   [RouterA-Ethernet1/1] vrrp vrid 1 track 1 reduced 20
   [RouterA-Ethernet1/1] quit
   [RouterA] track 1 interface ethernet 2/1

2. Configure Router B

   `<RouterB> system-view
   [RouterB] interface ethernet 1/1
   [RouterB-Ethernet1/1] ip address 202.38.160.2 255.255.255.0

   # Create VRRP group 1 and configure its virtual IP address as 202.38.160.111.
   [RouterB-Ethernet1/1] vrrp vrid 1 virtual-ip 202.38.160.111

   # Configure Router B to work in preemptive mode.
   [RouterB-Ethernet1/1] vrrp vrid 1 preempt-mode
# Configure the preemption delay as three seconds to avoid frequent status switchover.

```bash
[RouterB-Ethernet1/1] vrrp vrid 1 timer advertise 3
```

## Verifying the configuration

Check that you can ping Host B from Host A. To verify your configuration, use the `display vrrp verbose` command.

```bash
# Display detailed information about VRRP group 1 on Router A.
[RouterA-Ethernet1/1] display vrrp verbose
```

IPv4 Standby Information:

- **Run Mode**: Standard
- **Run Method**: Virtual MAC
- **Total number of virtual routers**: 1
  - Interface Ethernet1/1
    - **VRID**: 1
    - **Admin Status**: Up
    - **Config Pri**: 110
    - **Preempt Mode**: Yes
    - **Auth Type**: None
    - **Virtual IP**: 202.38.160.111
    - **Master IP**: 202.38.160.1

VRRP Track Information:

- **Track Object**: 1
- **State**: Positive
- **Pri Reduced**: 20

```bash
# Display detailed information about VRRP group 1 on Router B.
[RouterB-Ethernet1/1] display vrrp verbose
```

IPv4 Standby Information:

- **Run Mode**: Standard
- **Run Method**: Virtual MAC
- **Total number of virtual routers**: 1
  - Interface Ethernet1/1
    - **VRID**: 1
    - **Admin Status**: Up
    - **Config Pri**: 100
    - **Preempt Mode**: Yes
    - **Auth Type**: None
    - **Virtual IP**: 202.38.160.111
    - **Master IP**: 202.38.160.1

The output shows that in VRRP group 1 Router A is the master, Router B is the backup and packets sent from Host A to Host B are forwarded by Router A.
Summary

- As a standard IETF protocol, VRRP is supported by most vendors.
- Migrate from Cisco HSRP to VRRP throughout the network.
- VRRP supports all functions of Cisco HSRP.

For more information visit www.hp.com