ZebOS-XP®
Network Platform

Version 1.4
Extended Performance

Virtual Router Redundancy Protocol
Configuration Guide

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IP Infusion Inc.
3965 Freedom Circle, Suite 200
Santa Clara, CA 95054
+1 408-400-1900
http://www.ipinfusion.com/

For support, questions, or comments via E-mail, contact:
support@ipinfusion.com

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Preface

This guide describes how to configure Virtual Router Redundancy Protocol (VRRP) in ZebOS-XP.

Audience

This guide is intended for network administrators and other engineering professionals who configure VRRP.

Conventions

Table P-1 shows the conventions used in this guide.

Table P-1: Conventions

Convention	Description
Italics	Emphasized terms; titles of books
Note:	Special instructions, suggestions, or warnings
`monospaced type`	Code elements such as commands, functions, parameters, files, and directories

Contents

This guide contains these chapters:

- Chapter 1, *VRRP Configuration*
- Chapter 2, *VRRP IPv6 Configuration*

Related Documents

Use this guide with these command references for details about the commands used in the configurations.

- *Virtual Router Redundancy Protocol Command Reference*
- *Network Services Module Command Reference*

Note: All ZebOS-XP technical manuals are available to licensed customers at http://www.ipinfusion.com/support/document_list.

Chapter Organization

The chapters in this guide are organized into these major sections:

- An overview that explains a configuration in words
- Topology with a diagram that shows the devices and connections used in the configuration
- Configuration steps in a table for each device where the left-hand side shows the commands you enter and the right-hand side explains the actions that the commands perform
- Validation which shows commands and their output that verify the configuration

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CHAPTER 1 VRRP Configuration

This chapter provides an overview of Virtual Router Redundancy Protocol (VRRP) and its implementation with ZebOS-XP. VRRP eliminates the risk of a single point of failure inherent in a static default routing environment. It specifies an election protocol that dynamically assigns responsibility for a virtual router to one of the VRRP routers on a LAN. One of the major advantages of VRRP is that it makes default path available without requiring configuration of dynamic routing on every end-host.

ZebOS-XP only supports VRRP protocol version 3.

For details about the commands used, see the *Virtual Router Redundancy Protocol Command Reference*.

Terminology

Terms related to VRRP configuration are defined in the table below.

Backup Router	The VRRP router that is backing up an IP address. It assumes forwarding responsibility for the virtual IP address if the Master fails.
Critical IP	The IP address that a VRRP router sends/receives messages on for a particular session.
IP Address Owner	The VRRP Router that has the virtual router's IP address(es) as real interface address(es). This is the router that, when up, will respond to packets addressed to one of these IP addresses for ICMP pings, TCP connections, and so on
Master Router	The VRRP router that owns the IP address (i.e., is being backed up), and which is the default router for forwarding for that IP address.
Virtual IP	The IP address that is being backed up by a VRRP session.
Virtual Router	A router managed by VRRP that acts as a default router for hosts on a shared LAN. It consists of a Virtual Router Identifier and a set of associated IP addresses across a common LAN. A VRRP Router might backup one or more virtual routers.
VRRPv2 Router	A router running the Virtual Router Redundancy Protocol version 2. It might participate in one or more virtual routers.
VRRPv3 Router	A router running the Virtual Router Redundancy Protocol version 3. It might participate in one or more virtual routers.

VRRP Process

Typically, end hosts are connected to the enterprise network through a single router (first-hop router) that is in the same Local Area Network (LAN) segment. The most popular method of configuration is for the end hosts to configure statically this router as their default gateway. This minimizes configuration and processing overhead. The main problem with this configuration method is that it produces a single point of failure if this first-hop router fails.

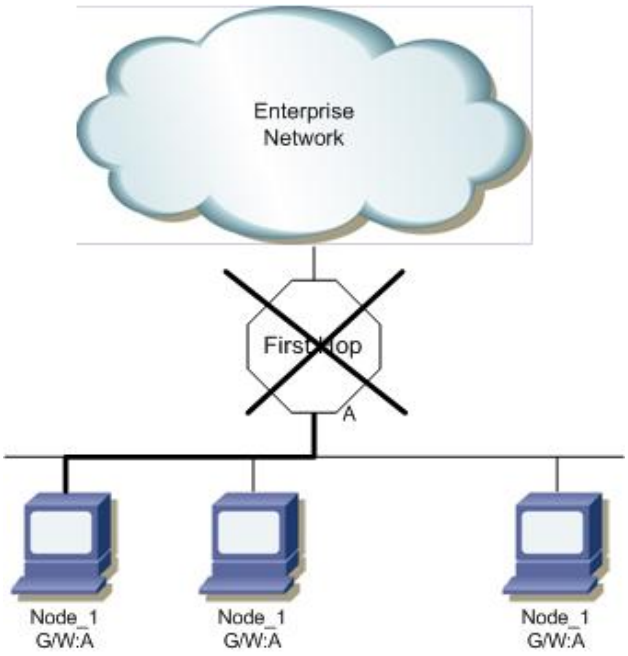


Figure 1-1: VRRP Process - First-Hop Not Reachable

The Virtual Router Redundancy Protocol attempts to solve this problem by introducing the concept of a virtual router, composed of two or more VRRP routers on the same subnet. The concept of a virtual IP address is also introduced, which is the address that end hosts configure as their default gateway. One of the routers called the “Master” forwards packets on behalf of this IP address. In the event that the Master router fails, one of the other routers (Backup) assumes forwarding responsibility for it.

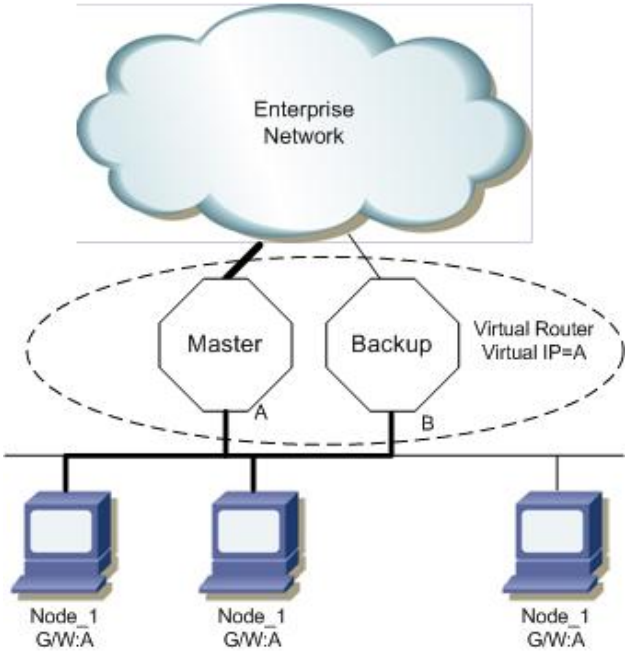


Figure 1-2: VRRP Process - Master and Backup VR

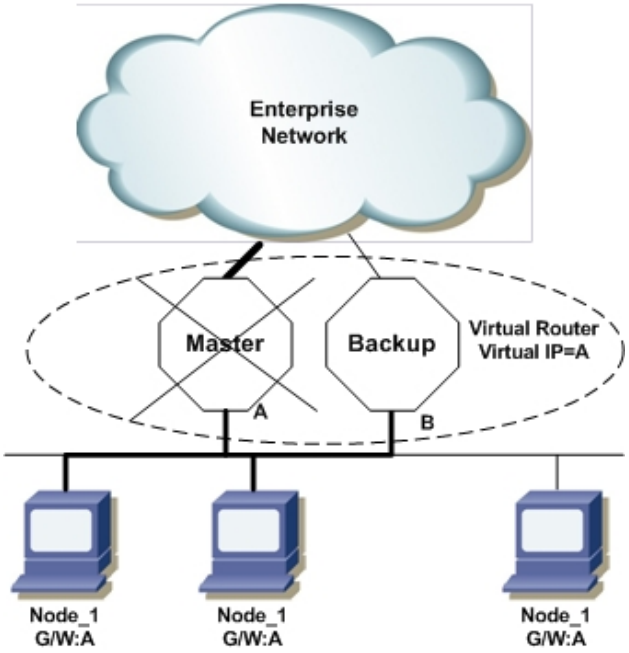


Figure 1-3: VRRP Process - Master Down and Backup Takeover

At first glance, the configuration outlined in might not seem very useful, as it doubles the cost, and leaves one router idle at all times. This, however, can be avoided by creating two virtual routers and splitting the traffic between them.

WARNING -- POTENTIAL DATA LOSS: Adding a default route in the kernel on the interface that is used for VRRP might cause loss of network connectivity. According to the VRRP guidelines, when the VRRP session changes, the MAC address for the machine that attains the master state also changes. The change causes the default route from the kernel to disappear and leads to loss of connectivity. To avoid this situation, add the default route in the NSM and not in the kernel. This ensures that the default route remains on the machine across changes in the VRRP state.

To add default route through NSM, run the following command in NSM:

```
ip route 0.0.0.0/0 <IPADDRESS>
```

where `<IPADDRESS>` is the IP address of the default gateway.

One Virtual Router

In this configuration, the end-hosts install a default route to the IP address of virtual router 1(VRID = 1), and both routers R1 and R2 run VRRP. R1 is configured to be the Owner for virtual router 1 (VRID = 1) and R2 as a Backup for virtual router 1. If R1 fails, R2 will take over virtual router 1 and its IP addresses, and provide uninterrupted service for the hosts. Configuring only one virtual router doubles the cost, and leaves R2 idle at all times.

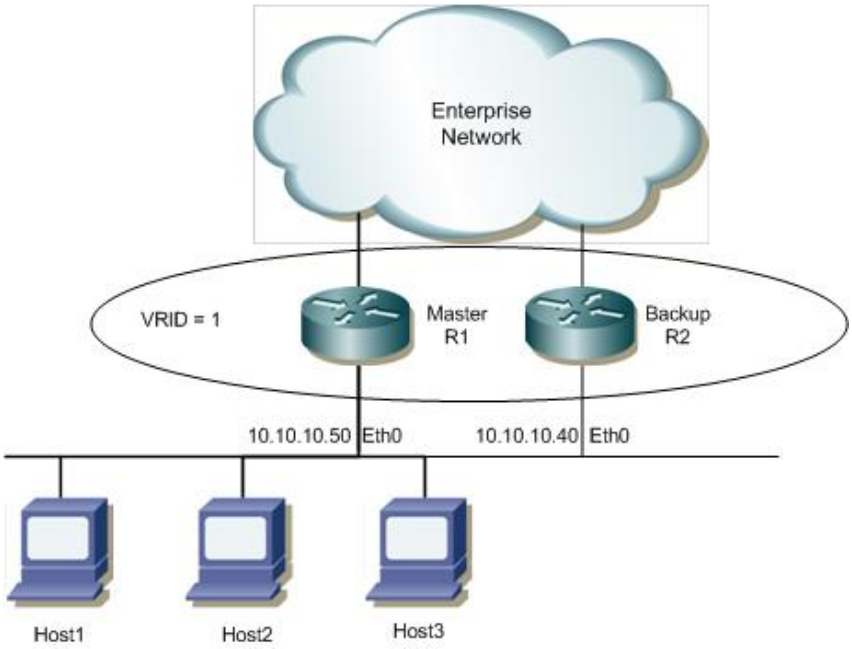


Figure 1-4: VRRP with One Virtual Router

R1

`#configure terminal`	Enter the `Configure` mode.
`(config)#router vrrp 1 eth0`	Create a VRRP instance for interface eth0.
`(config-router)#virtual-ip 10.10.10.50 owner`	Set the virtual IP address for the VRRP session. Define the default state (owner) of the VRRP router within the virtual router.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will function as a backup to master when master is unavailable.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#enable`	Enable the VRRP session on the router.

R2

`#configure terminal`	Enter the `Configure` mode.
`(config)#router vrrp 1 eth0`	Create a VRRP instance for interface eth0.
`(config-router)#virtual-ip 10.10.10.50`	Set the virtual IP address for the VRRP session.
`(config-router)#priority 200`	Configure the priority to 200 (less than 255), because R2 is the Backup router.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will function as a backup to master when master is unavailable.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#enable`	Enable the VRRP session on the router.

Validation

show vrrp

Two Virtual Routers

In the previous, one virtual router example, R2 is not backed up by R1. This example illustrates how to back up R2 by configuring a second virtual router. In this configuration, R1 and R2 are two virtual routers, and the hosts split their traffic between R1 and R2. R1and R2 functions as backups for each other.

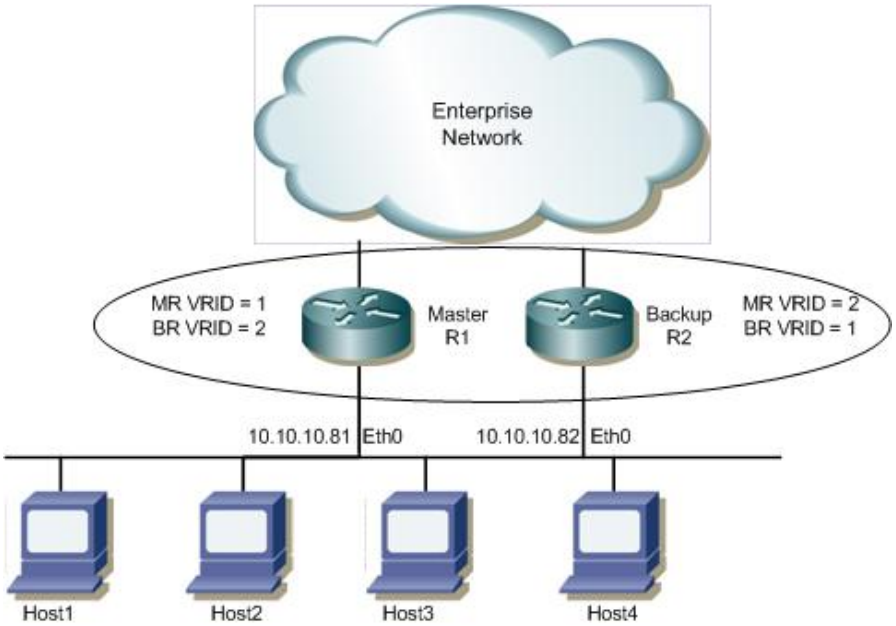


Figure 1-5: Configuring VRRP with Two Virtual Routers

R1

`#configure terminal`	Enter the `Configure` mode.
`(config)#router vrrp 1 eth0`	Create a VRRP instance for interface eth0.
`(config-router)#virtual-ip 10.10.10.81 owner`	Set the virtual IP address for the VRRP session. Define the default state (owner) of the VRRP router within the virtual router.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will function as a backup to master when master is unavailable.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#enable`	Enable the VRRP session 1 on the router.
`(config-router)#exit`	Exit `Router` mode and enter the `Configure` mode.
`(config)#router vrrp 2 eth0`	Create a VRRP instance for interface eth0.
`(config-router)#virtual-ip 10.10.10.82`	Set the virtual IP address for the VRRP session.
`(config-router)#priority 200`	Configure the priority to 200 (less than 255), because R2 is the Backup router.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will function as a backup to master when master is unavailable.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#enable`	Enable the VRRP session two on the router.

R2

`#configure terminal`	Enter the `Configure` mode.
`(config)#router vrrp 1 eth0`	Create a VRRP instance for interface eth0.
`(config-router)#virtual-ip 10.10.10.81`	Set the virtual IP address for the VRRP session.
`(config-router)#priority 200`	Configure the priority to 200 (less than 255), because R2 is the Backup router.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will function as a backup to master when master is unavailable.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#enable`	Enable the VRRP session 1 on the router.
`(config-router)#exit`	Exit the `Router` mode and enter the `Configure` mode.
`(config)#router vrrp 1 eth0`	Create a VRRP instance for interface eth0.
`(config-router)#virtual-ip 10.10.10.82 owner`	Set the virtual IP address for the VRRP session. Define the default state (owner) of the VRRP router within the virtual router.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will function as a backup to master when master is unavailable.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#enable`	Enable the VRRP session two on the router.

Validation

The following outputs on R1and R2 display the complete configuration for each session on R1 and R2. In session one, R1 is the master router, and in session two R2 is the master router.

```
R1#sh vrrp 1 eth0
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled
Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Master
 Virtual IP address: 10.10.10.81 (Owner)
 Priority is 255
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
-------------------------------------------
R1#sh vrrp 2 eth0
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled
Address family IPv4
VRRP Id: 2 on interface: eth0
 State: AdminUp   - Backup
 Virtual IP address: 10.10.10.82 (Not-owner)
 Priority is 100
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 60 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
-------------------------------------------
R2#sh vrrp 1 eth0
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled
Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Backup
 Virtual IP address: 10.10.10.81 (Not-Owner)
 Priority is 100
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
```

```
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
-------------------------------------------
R2#sh vrrp 2 eth0
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled
Address family IPv4
VRRP Id: 2 on interface: eth0
 State: AdminUp   - Master
 Virtual IP address: 10.10.10.82 (Owner)
 Priority is 255
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 60 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
```

Two Backup Routers

In this configuration, Host B could be a gateway router. As such, interface eth1 on Routers R1, R2, and R3, and the gateway router, would run the IGP protocol.

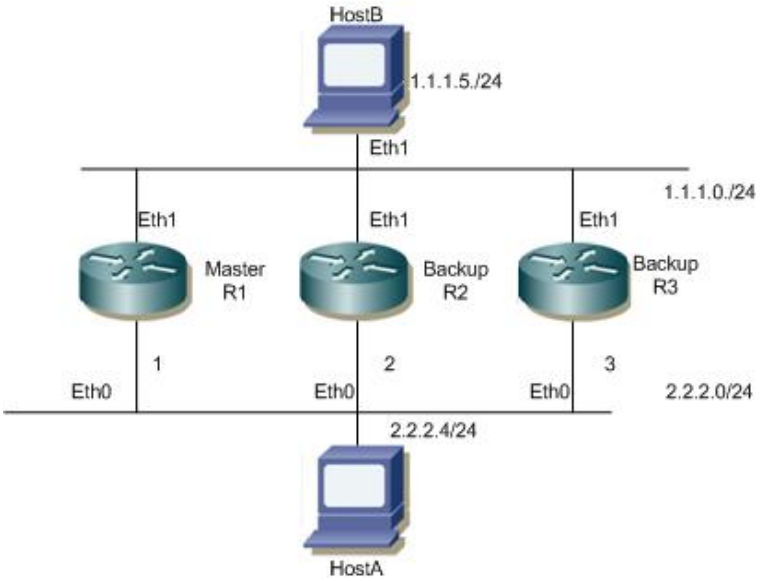


Figure 1-6: Configuring VRRP with Two Backup Routers

R1

`#configure terminal`	Enter the Configure mode.
`(config)#interface eth0`	Enter the Interface mode for eth0.

(config-if)#ip address 2.2.2.1/24	Configure the IP address for interface eth0 to be in network 0.
(config-if)#exit	Exit the Interface mode.
(config)#interface eth1	Enter the Interface mode for eth1.
(config-if)#ip address 1.1.1.1/24	Configure the IP address for interface eth1 to be in network 1.
(config-if)#exit	Exit the Interface mode.
(config)#router vrrp 1 eth0	Create a VRRP instance for interface eth0.
(config-router)#virtual-ip 2.2.2.1 owner	Configure R1 as the owner.
(config-router)#advertisement-interval 100	Configure the default value for the advertisement interval. The configurable range is 5 to 4095 centi seconds (value must be a multiple of 5).
(config-router)#preempt-mode true	Set `true` as the default value for the field.
(config-router)#enable	Enable the VRRP session on the router.
(config-router)#exit	Exit Router mode.

R2

#configure terminal	Enter the Configure mode.
(config)#interface eth0	Enter the Interface mode for eth0.
(config-if)#ip address 2.2.2.2/24	Configure the IP address for interface eth0 to be in network 0.
(config-if)#exit	Exit the Interface mode.
(config)#interface eth1	Enter the Interface mode for `eth1`.
(config-if)#ip address 1.1.1.2/24	Configure the IP address for interface `eth1` to be in network 1.
(config-if)#exit	Exit the Interface mode.
(config)#router vrrp 1 eth0	Create a VRRP instance for interface eth0.
(config-router)#virtual-ip 2.2.2.1	Configure R2 as the backup.
(config-router)#advertisement-interval 100	Configure the default value for the advertisement interval. The configurable range is 5 to 4095 centi seconds (value must be a multiple of 5).
(config-router)#priority 100	Set the default value for the backup router.
(config-router)#preempt-mode true	Set `true` as the default value for the field.
(config-router)#enable	Enable the VRRP session on the router.
(config-router)#exit	Exit Router mode.

R3

#configure terminal	Enter the Configure mode.
(config)#interface eth0	Enter the Interface mode for eth0.
(config-if)#ip address 2.2.2.3/24	Configure the IP address for interface eth0 to be in network 0.

`(config-if)#exit`	Exit the Interface mode.
`(config)#interface eth1`	Enter the Interface mode for eth1.
`(config-if)#ip address 1.1.1.3/24`	Configure the IP address for interface eth1 to be in network 1.
`(config-if)#exit`	Exit the Interface mode.
`(config)#router vrrp 1 eth0`	Create a VRRP instance for interface eth0.
`(config-router)#virtual-ip 2.2.2.1`	Configure R3 as the backup.
`(config-router)#advertisement-interval 100`	Configure the default value for the advertisement interval. The configurable range is 5 to 4095 centi seconds (value must be a multiple of 5).
`(config-router)#priority 254`	Configure the priority for R3. The configurable range is 1-255.
`(config-router)#preempt-mode true`	Set `true` as the default value for the field.
`(config-router)#enable`	Enable the VRRP session on the router.
`(config-router)#exit`	Exit Router mode.

Host A

`#configure terminal`	Enter the Configure mode.
`(config)#interface eth0`	Enter the Interface mode for eth0.
`(config-if)#ip address 2.2.2.4/24`	Configure the IP address for interface eth0 to be in network 0.
`(config-if)#exit`	Exit the Interface mode.
`(config)#ip route 1.1.1.0/24 2.2.2.1`	Configure a static route to reach network 1 through the virtual IP.

Host B

`#configure terminal`	Enter the Configure mode.
`(config)#interface eth1`	Enter the Interface mode for eth1.
`(config-if)#ip address 1.1.1.5/24`	Configure the IP address for interface eth1 to be in network 1.

Validation

Router 1

```
R1#sh vrrp
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Master
 Virtual IP address: 2.2.2.1 (Owner)
```

```
 Priority is 255
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
```

Router 2

```
R2#sh vrrp
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Backup
 Virtual IP address: 2.2.2.1 (Not-Owner)
 Priority is 100
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
```

Router 3

```
R3#sh vrrp
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Backup
 Virtual IP address: 2.2.2.1 (Not-Owner)
 Priority is 254
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
```

Ping Output at Host A

```
[root@HstA root]#ping 1.1.1.5
PING 1.1.1.5 (1.1.1.5) 56(84) bytes of data.
64 bytes from 1.1.1.5: icmp_seq=1 ttl=63 time=0.486 ms
64 bytes from 1.1.1.5: icmp_seq=2 ttl=63 time=0.290 ms
```

Disabling the Master/Owner

`#configure terminal`	Enter the Configure mode.

(config)#router vrrp 1 eth0	Create a VRRP instance for interface eth0.
(config-router)#disable	Disable the VRRP session.

Output After Disabling the Master

```
R1#sh vrrp
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminDown - Init (admin state down)
 Virtual IP address: 2.2.2.1 (Owner)
 Priority is 255
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
Multicast membership on IPv4 interface eth0: JOINED

R3#sh vrrp
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Master
 Virtual IP address: 2.2.2.1 (Not-Owner)
 Priority is 254
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
Multicast membership on IPv4 interface eth0: JOINED

[root@HstA root]#ping 1.1.1.5
PING 1.1.1.5 (1.1.1.5) 56(84) bytes of data.
64 bytes from 1.1.1.5: icmp_seq=1 ttl=63 time=0.572 ms
64 bytes from 1.1.1.5: icmp_seq=2 ttl=63 time=0.291 ms
```

Two Virtual Routers

This example illustrates two routers between two end-hosts. In this configuration, R1 and R2 are two virtual routers, and the hosts split their traffic between them. R1 and R2 function as backups for each other.

The following outputs display the configuration for the two-router example.

```
R1#show run
 if-arbiter interval 20
 interface eth0
  ip address 10.10.10.6/24
 interface eth2
  ip address 10.10.12.6/24
 router vrrp 1 eth0
  virtual-ip 10.10.10.6 owner
  enable
R2#show run
 if-arbiter interval 20
 interface eth0
  ip address 10.10.10.182/24
 interface eth2
  ip address 10.10.12.182/24
 router vrrp 1 eth0
  virtual-ip 10.10.10.6
  enable
```

Validation

The following outputs show how to use the `show vrrp` validation command with end-host configuration settings to verify the example two-router VRRP configuration.

1. Verify that VRRP is running, R1 is the Master, and R2 is the Backup:

```
R1#sh vrrp 1 eth0
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Master
 Virtual IP address: 10.10.10.6 (Owner)
 Priority is 255
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED

R2#sh vrrp 1 eth0
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv4
VRRP Id: 1 on interface: eth0
```

```
 State: AdminUp   - Backup
 Virtual IP address: 10.10.10.6 (Not-Owner)
 Priority is 100
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
```

2. Set R1 to be the gateway to be used by Host 2 for the verification:

```
 [root@host2 root]#route add -net 10.10.12.0 netmask 255.255.255.0 gw 10.10.10.6
```

3. Set R1 and R2 to be gateways to be used by Host 1 for the verification:

```
 [root@host1 root]#route add -net 10.10.10.0 netmask 255.255.255.0 gw 10.10.12.6
 [root@host1 root]#route add -net 10.10.10.0 netmask 255.255.255.0 gw 10.10.12.182
```

4. Verify that Host 2 can reach Host 1 through R1 via ping/traceroute:

```
 [root@host2 root]#ping 10.10.12.181
 PING 10.10.12.181 (10.10.12.181) from 10.10.10.7: 56 (84) bytes of data.
 64 bytes from 10.10.12.181: icmp_seq=1 ttl=63 time=0.541 ms
 64 bytes from 10.10.12.181: icmp_seq=2 ttl=63 time=0.539 ms
 64 bytes from 10.10.12.181: icmp_seq=3 ttl=63 time=0.523 ms
 64 bytes from 10.10.12.181: icmp_seq=4 ttl=63 time=0.527 ms
 [root@host2 root]#traceroute 10.10.12.181
 traceroute to 10.10.12.181 (10.10.12.181), 30 hops max, 38 byte packets
 1 10.10.10.6 (10.10.10.6) 0.307 ms 0.269 ms 0.235 ms
 2 10.10.12.181 (10.10.12.181) 0.524 ms 0.476 ms 0.455 ms
```

5. Bring down eth0 on R1 to disable the route through R1:

```
 [root@r1 root]#ifconfig eth0 down
```

6. Verify that the R2 state changes from Backup to Master:

```
R1#sh vrrp 1 eth0
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled
Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Init (interface is not running)
 Virtual IP address: 10.10.10.6 (Owner)
 Priority is 255
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED

R2#sh vrrp 1 eth0
VRRP Version: 3
VMAC enabled
```



```
Backward Compatibility disabled

Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Master
 Virtual IP address: 10.10.10.6 (Not-Owner)
 Priority is 100
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
```

7. Verify via ping/traceroute that Host 2 can reach Host 1 through backup R2 now acting as the Master:

```
 [root@host2 root]#ping 10.10.12.181
 PING 10.10.12.181 (10.10.12.181) from 10.10.10.7 : 56 (84) bytes of data.
 64 bytes from 10.10.12.181: icmp_seq=1 ttl=63 time=0.541 ms
 64 bytes from 10.10.12.181: icmp_seq=2 ttl=63 time=0.539 ms
 64 bytes from 10.10.12.181: icmp_seq=3 ttl=63 time=0.523 ms
 64 bytes from 10.10.12.181: icmp_seq=4 ttl=63 time=0.527 ms
 [root@host2 root]#traceroute 10.10.12.181
 traceroute to 10.10.12.181 (10.10.12.181), 30 hops max, 38 byte packets
 1 10.10.10.182 (10.10.10.182) 0.313 ms 0.273 ms 0.251 ms
 2 10.10.12.181 (10.10.12.181) 0.486 ms 0.479 ms 0.465 ms
```

8. Bring up eth0 on R1 to re-enable the route through R1:

```
 [root@r1 root]#ifconfig eth0 up
```

9. Verify that the R2 state returns to Backup:

```
R1#sh vrrp 1 eth0
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Master
 Virtual IP address: 10.10.10.6 (Owner)
 Priority is 255
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED

R2#sh vrrp 1 eth0
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled
```

```
Address family IPv4
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Backup
 Virtual IP address: 10.10.10.6 (Not-Owner)
 Priority is 100
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth0: JOINED
```

10. Verify via ping/traceroute that Host 2 can reach Host 1 through Master R1, as before:

```
[root@host2 root]#ping 10.10.12.181
 PING 10.10.12.181 (10.10.12.181) from 10.10.10.7 : 56 (84) bytes of data.
 64 bytes from 10.10.12.181: icmp_seq=1 ttl=63 time=0.541 ms
 64 bytes from 10.10.12.181: icmp_seq=2 ttl=63 time=0.539 ms
 64 bytes from 10.10.12.181: icmp_seq=3 ttl=63 time=0.523 ms
 64 bytes from 10.10.12.181: icmp_seq=4 ttl=63 time=0.527 ms
 [root@host2 root]#traceroute 10.10.12.181
 traceroute to 10.10.12.181 (10.10.12.181), 30 hops max, 38 byte packets
 1 10.10.10.6 (10.10.10.6) 0.527 ms 0.266 ms 0.235 ms
 2 10.10.12.181 (10.10.12.181) 1.221 ms 0.478 ms 0.460 ms
```

Link-Address Enabled

For VRRP with link-address, the Virtual IP address is added to the interface, which allows users to connect to the current Master VRRP router, regardless of whether or not it is the IP owner. In this configuration, the end-hosts install a default route to the IP address of virtual router 1 (VRID = 1), and both routers R1 and R2 run VRRP. R1 is configured to be the Master for virtual router 1 (VRID = 1), and R2 as a Backup for virtual router 1. If R1 fails, R2 will take over the Virtual IP address, and provide uninterrupted service for the hosts.

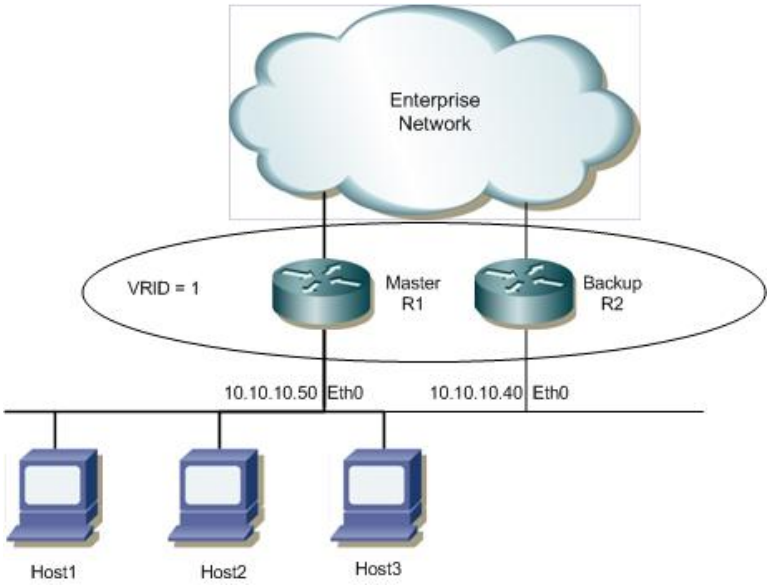


Figure 1-7: VRRP with Link-address Enabled

R1

`#configure terminal`	Enter the `Configure` mode.
`(config)#ip address 1.1.1.50/24 secondary`	Set the IP address for the interface as a secondary IP address.
`(config)#router vrrp 1 eth0`	Create a new VRRP instance for interface eth0.
`(config-router)#virtual-ip 1.1.1.50 owner`	Set the virtual IP address for the VRRP session.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will function as a backup to master when master is unavailable.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#enable`	Enable the VRRP session on the router.

R2

`#configure terminal`	Enter the `Configure` mode.
`(config)#ip address 1.1.1.60/24 secondary`	Set the IP address for the interface as a secondary IP address.
`(config)#router vrrp 1 eth0`	Create a new VRRP instance for interface eth0.
`(config-router)#virtual-ip 1.1.1.50`	Set the virtual IP address for the VRRP session.
`(config-router)#priority 200`	Configure the priority to 200 (less than 255), because R2 is the Backup router.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will function as a backup to master when master is unavailable.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#enable`	Enable the VRRP session on the router.

Validation

show vrrp

Interface Tracking

The need for VRRP Interface Tracking arose because VRRPv2 was unable to track the gateway interface status. The VRRP Interface Tracking feature provides dynamic failover of an entire circuit, in the event that one member of the group fails. It introduces the concept of a circuit, where two or more Virtual Routers on a single system can be grouped. In the event that a failure occurs, and one of the Virtual Routers performs the Master to Backup transition, the other Virtual Routers in the group are notified, and are forced into the Master to Backup transition, so that both incoming and outgoing packets are routed through the same gateway router, eliminating the problem for Firewall/NAT environments.

Note: Currently, only one interface is supported in an interface tracking for a VRRP session.

To configure VRRP Interface Tracking, each circuit is configured to have a corresponding priority-delta value, which is passed to VRRP when a failure occurs. The priority of each Virtual Router on the circuit is decremented by the priority-delta value, causing the VR Master to VR Backup transition.

In this example, two routers, R1 and R2, are configured as backup routers with different priorities. The priority-delta value is configured to be greater than the difference of both the priorities. R1 is configured to have a priority of 100, and R2 has a priority of 90. R1, with a greater priority, is the Virtual Router Master. The priority-delta value is 20, greater than 10 (100 minus 90). On R1, when the external interface `eth1` fails, the priority of R1 becomes 80 (100 minus 20). Since R2 has a greater priority (90) than R1, R2 becomes the VR Master, and routing of packages continues without interruption. When this VR Backup (R1) is up again, it regains its original priority (100), and becomes the VR Master again.

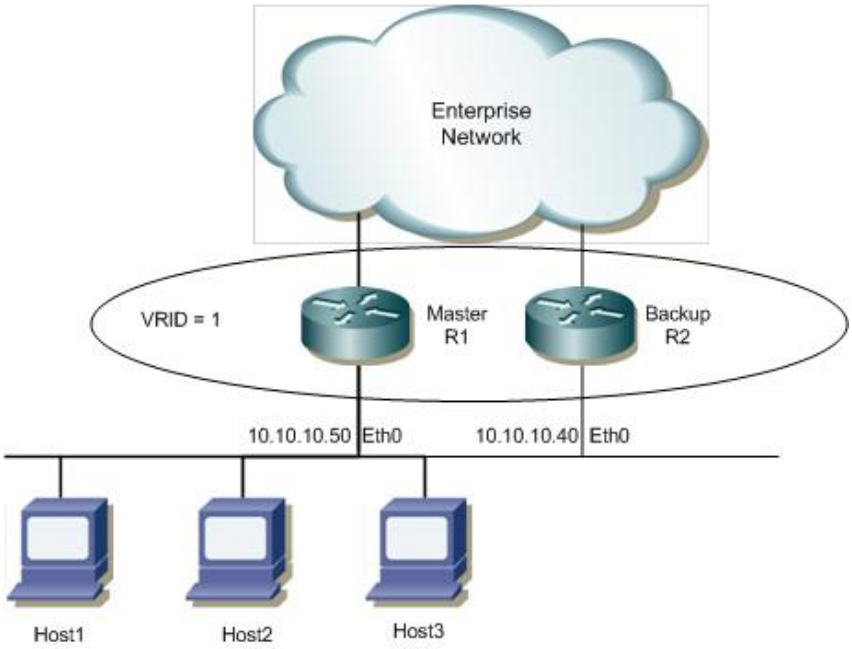


Figure 1-8: VRRP Interface Tracking

R1

`#configure terminal`	Enter the `Configure` mode.
`(config)#router vrrp 1 eth0`	Create a new VRRP instance for interface eth0.
`(config-router)#virtual-ip 10.10.10.1`	Set the virtual IP address for the VRRP session.
`(config-router)#priority 100`	Configure the priority to 100.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will own the external ip address when there is a failure.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#circuit-failover eth1 20`	Configure the priority-delta value to be 20. In case of failover, this priority-delta value is subtracted from the current VR Master.
`(config-router)#enable`	Enable the VRRP session on the router.

R2

`#configure terminal`	Enter the `Configure` mode.
`(config)#router vrrp 1 eth0`	Create a new VRRP instance for interface eth0.
`(config-router)#virtual-ip 10.10.10.1`	Set the virtual IP address for the VRRP session.
`(config-router)#priority 90`	Configure the priority to 90 (less than 100), because R2 is the VR Backup router.
`(config-router)#preempt true`	Set the preempt mode to specify that the highest priority will function as a primary backup router in case of failure.
`(config-router)#advertisement-interval 100`	Configure the advertisement interval to 100 centi seconds (value must be a multiple of 5).
`(config-router)#enable`	Enable the VRRP session on the router.

Validation

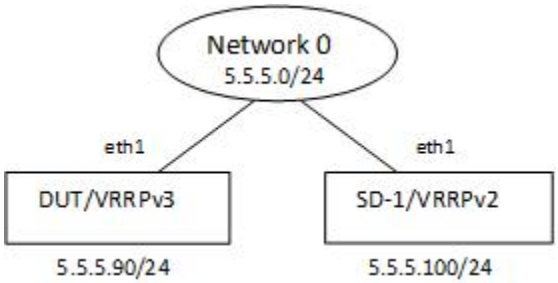
show vrrp

VRRP-Backward Compatibility

This section contains VRRP Backward Compatibility configuration examples.

The backward compatibility feature which implements version 3 of VRRP protocol recognizes the presence of VRRP version 2 compatible routers in the network and performs all operations normally. This support is intended for upgrade scenarios and is not recommended for permanent deployments. This should only occur when a router is transitioning from VRRPv2 to VRRPv3.

VRRP Backward Compatibility is applicable only for VRRP IPv4 because version 2 was not defined for VRRP IPv6.



DUT

`#configure terminal`	Enter the Configure mode.
`(config)# interface eth1`	Enter Interface configuration mode.
`(config-if)# ip address 5.5.5.90/24`	Configure IP address on the interface.
`(config-if)#end`	Exit from configuration mode.
`#configure terminal`	Enter Configuration mode.
`(config)# router vrrp 1 eth1`	Configure VRRP on DUT with Virtual router Identifier as 1 on the interface eth1.
`(config-router)#virtual-ip 5.5.5.190`	Configure Virtual-IP address as the interface IP address of Owner which is not actually present in the LAN.
`(config-router)#enable`	Enable VRRP session on DUT.
`(config-if)#end`	Exit from Interface mode.
`# configure terminal`	Enter Configuration mode.
`(config)# vrrp compatible-v2 enable`	Enable VRRP-Backward compatibility feature on a VRRPv3 running router.

SD-1

`#configure terminal`	Enter the Configure mode.
`(config)# interface eth1`	Enter Interface configuration mode.
`(config-if)# ip address 5.5.5.100/24`	Configure IP address on the interface.
`(config-if)#end`	Exit from configuration mode.
`#configure terminal`	Enter Configuration mode.
`(config)#router vrrp 1 eth1`	Configure VRRP on DUT with Virtual router Identifier as 1 on the interface eth1.
`(config-router)#virtual-ip 5.5.5.190`	Configure Virtual-IP address as the interface IP address of Owner which is not actually present in the LAN.
`(config-router)#enable`	Enable VRRP session on DUT.
`(config-if)#end`	Exit from Interface mode.

Validation

```
DUT# sh vrrp
VRRP Version: 3
```

```
VMAC enabled
Backward Compatibility enabled
Address family IPv4
VRRP Id: 20 on interface: eth1
 State: AdminUp   - Master
 Virtual IP address: 5.5.5.190 (Not-Owner)
 Priority is 100
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth1: JOINED

SD-1#sh vrrp
VRRP Version: 2
VMAC enabled
Address family IPv4
VRRP Id: 20 on interface: eth1
 State: AdminUp   - Backup
 Virtual IP address: 5.5.5.190 (Not-owner)
 Priority is 100
 Advertisement interval: 1 sec
 Preempt mode: TRUE
 Multicast membership on IPv4 interface eth1: JOINED
```

Redundancy Using VRRP and OSPF: Two Virtual Routers

This example illustrates a configuration of two routers between two end-hosts. R1 and R2 are two virtual routers functioning as backups for each other, with VRRP running on the 10.10.12.0/24 network (LAN), and OSPF running on the 10.10.10.0/24 network (ISP).

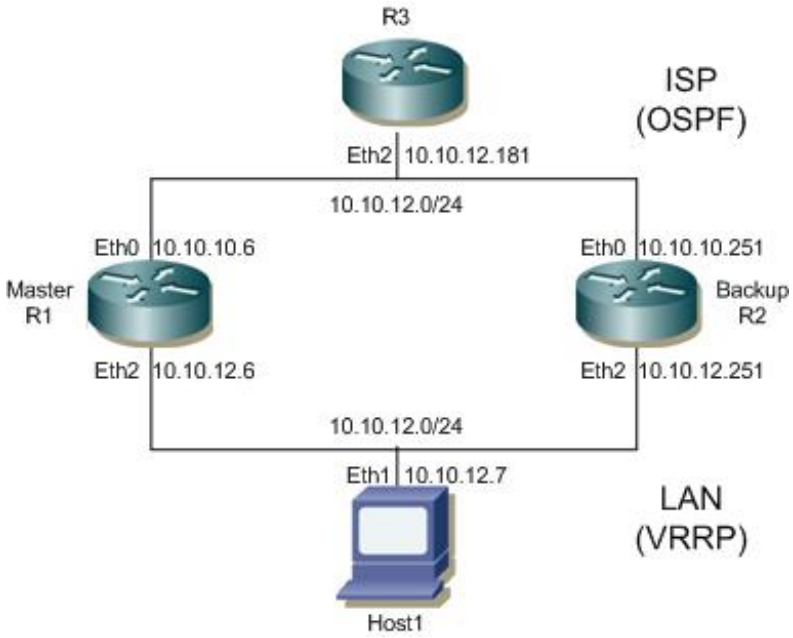


Figure 1-9: Redundancy Using VRRP and OSPF

In this example:

- R3 is an OSPF router representing an OSPF network to an ISP.
- R1 is the VRRP Master/OSPF router.
- R2 is the VRRP Backup/OSPF router.
- Host 1 is an end-host.

VRRP handles any failure of the Master's link to the LAN. Failures in the OSPF network that could cause the Master to lose routing information would cause packets from Host 1 that are targeted for R3 to be dropped. Running VRRP on the OSPF network to create redundancy is undesirable, because doing so would cause erroneous VRRP packets to be sent to the ISP.

An alternative method to achieve redundancy is to run OSPF on the LAN side. By running OSPF on the LAN, any routing information lost by the Master would be regained from the Backup on the LAN interface, resulting in ICMP redirects to R2 for traffic received from Host 1. To reduce OSPF control traffic, R1 and R2 are configured as Area Border Routers (ABR), and the LAN is configured as a stub network to reduce LSA advertisement traffic on the LAN. Before enabling OSPF on the LAN, verify that VRRP is running with R1 as the Master and R2 as the Backup.

```
R1#show vrrp
 VrId <1>
 State is Master
 Virtual IP is 10.10.12.6 (IP owner)
 Interface is eth0
 Priority is 255
 Advertisement interval is 1 sec
 Preempt mode is TRUE
R2#show vrrp
 VrId <1>
  State is Backup
  Virtual IP is 10.10.12.6 (Not IP owner)
  Interface is eth0
  Priority is 100
  Advertisement interval is 1 sec
  Preempt mode is TRUE
```

Steps to configure OSPF on the LAN are given below.

R3

`#configure terminal`	Enter the Configure mode.
`(config)#router ospf 1`	Configure the routing process and specify the process ID (`1`). The process ID should be a unique integer.
`(config-router)#ospf router-id 10.10.10.181`	Specify the OSPF router ID.
`(config-router)#timers spf 0 0`	Set `timers` to minimum time for quick convergence.
`(config-router)#network 10.10.10.0/24 area 0`	Define one interface (`10.10.10.0/24`) on which OSPF runs and associate the area ID (0).

R1

`#configure terminal`	Enter the Configure mode.
`(config)#router ospf 1`	Configure the routing process and specify the process ID (`1`). The process ID should be a unique integer.
`(config-router)#ospf router-id 10.10.12.6`	Specify the OSPF router ID.
`(config-router)#area 1 stub`	Define area 1 as a stub network.
`(config-router)#network 10.10.10.0/24 area 0`	Define one interface (`10.10.10.0/24`) on which OSPF runs and associate the area ID (`0`).
`(config-router)#network 10.10.12.0/24 area 1`	Define the other interface (`10.10.12.0/24`) on which OSPF runs and associate the area ID (`1`)

R2

`#configure terminal`	Enter the Configure mode.
`(config)#router ospf 1`	Configure the routing process, and specify the process ID (`1`). The process ID should be a unique integer
`(config-router)#ospf router-id 10.10.12.251`	Specify the OSPF router ID.
`(config-router)#area 1 stub`	Define area 1 as a stub network.
`(config-router)#network 10.10.10.0/24 area 0`	Define one interface (`10.10.10.0/24`) on which OSPF runs and associate the area ID (`0`).
`(config-router)#network 10.10.12.0/24 area 1`	Define the other interface (`10.12.10.0/24`) on which OSPF runs and associate the area ID (`1`)

Verification

1. Set gateway on the end-host (statically):

```
(root@host1)#route add -net 10.10.10.0 netmask 255.255.255.0 gw 10.10.12.6
```

2. Verify end-host reachability via traceroute:

```
(root@host1)#traceroute 10.10.10.181
traceroute to 10.10.10.181 (10.10.10.181), 30 hops max, 38 byte packets
 1  10.10.12.6 (10.10.12.6)  0.835 ms  0.350 ms  0.341 ms
 2  10.10.10.181 (10.10.10.181)  9.557 ms  0.572 ms  0.545 ms
```

3. Bring down eth0 of R1:

```
[root@r1 sbin]#ifconfig eth0 down
```

4. Verify end-host reachability via traceroute:

```
(root@host1)#traceroute 10.10.10.181
traceroute to 10.10.10.181 (10.10.10.181), 30 hops max, 38 byte packets
 1  10.10.12.6 (10.10.12.6)  0.461 ms  0.352 ms  0.334 ms
 2  10.10.12.251 (10.10.12.251)  0.425 ms  0.432 ms  0.410 ms
 3  10.10.10.181 (10.10.10.181)  0.691 ms  0.639 ms  0.607 ms
```

5. Bring up eth0 of R1:

```
[root@r1 sbin]#ifconfig eth0 up
```

6. Verify end-host reachability via traceroute:

```
(root@host1)#traceroute 10.10.10.181
traceroute to 10.10.10.181 (10.10.10.181), 30 hops max, 38 byte packets
 1  10.10.12.6 (10.10.12.6)  0.457 ms  0.356 ms  0.443 ms
 2  10.10.10.181 (10.10.10.181)  0.698 ms  0.642 ms  0.618 ms
```

CHAPTER 2 VRRP IPv6 Configuration

This chapter contains a Virtual Router Redundancy Protocol IPv6 (VRRPv6) configuration example.

VRRPv6 eliminates the risk of a single point of failure inherent in a static default routing environment. It specifies an election protocol that dynamically assigns responsibility for a virtual router to one of the VRRPv6 routers on a LAN. In this sample, OSPFv3 is enabled on Router 1 (R1), the master router, and the backup router. In R1, the connected routes are redistributed.

Note: IPv6 VRRP can be configured only on a link-local address.

Topology

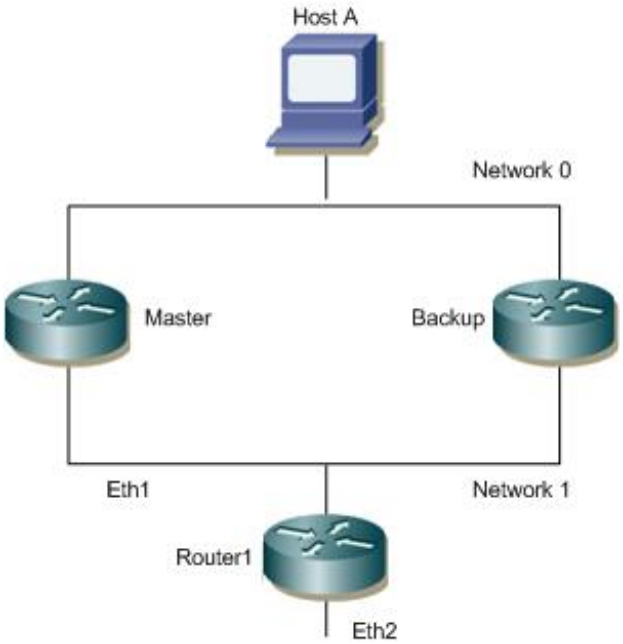


Figure 2-1: Topology

Owner/Master Router

#`configure terminal`	Enter the Configure mode.
(config)#`interface eth0`	Enter the Interface mode for eth0.
`(config-if)#ipv6 address fe80::3037:3aff:fe3a:3a32/64`	Configure the IPv6 address for interface eth0 to be in network 0.
(config-if)#`exit`	Exit the Interface mode.
(config)#`interface eth1`	Enter the Interface mode for eth1.

`(config-if)#ipv6 address fe80::3037:a0ff:fea4:3539/64`	Configure the IPv6 address for interface eth1 to be in network 1.
`(config-if)#``exit`	Exit the Interface mode.
`(config)#``router ipv6 vrrp 1 eth0`	Create a VRRPv6 instance for interface eth0.
`(config-router)#virtual-ipv6 fe80::3037:3aff:fe3a:3a32 owner`	Configure R1 as the owner.
`(config-router)#``advertisement-interval 100`	Configure the default value for the advertisement interval. The configurable range is <5-4095> (value must be a multiple of 5).
`(config-router)#``preempt-mode true`	Set `true` as the default value for the field.
`(config-router)#``enable`	Enable the VRRPv6 session on the router.
`(config-router)#``exit`	Exit Router mode.

Backup Router

`#``configure terminal`	Enter the Configure mode.
`(config)#``interface eth0`	Enter the Interface mode for eth0.
`(config-if)#ipv6 address fe80::3037:3aff:fe3a:3b45/64`	Configure the IPv6 address for interface eth0 to be in network 0.
`(config-if)#``exit`	Exit the Interface mode.
`(config)#``interface eth1`	Enter the Interface mode for eth1.
`(config-if)#ipv6 address fe80::3037:a0ff:fea4:3a40/64`	Configure the IPv6 address for interface eth1 to be in network 1.
`(config-if)#``exit`	Exit the Interface mode.
`(config)#``router ipv6 vrrp 1 eth0`	Create a VRRPv6 instance for interface eth0.
`(config-router)#virtual-ipv6 fe80::3037:3aff:fe3a:3a32`	Configure Router 2 (R2) as the backup.
`(config-router)#``advertisement-interval 100`	Configure the default value for the advertisement interval. The configurable range is <5-4095> (value must be a multiple of 5).
`(config-router)#``priority 100`	Set the default value for the backup router.
`(config-router)#``preempt-mode true`	Set `true` as the default value for the field.
`(config-router)#``enable`	Enable the VRRPv6 session on the router.
`(config-router)#``exit`	Exit Router mode.

Host A

`#``configure terminal`	Enter the Configure mode.
`(config)#``interface eth0`	Enter the Interface mode for eth0.
`(config-if)#ipv6 address fe80::3037:3aff:fe3a:3a11/64`	Configure the IPv6 address for interface eth0 to be in network 0.

(config-if)#exit	Exit the Interface mode.
(config)#ipv6 route 5ffe:14:14:14::/64 fe80::3037:3aff:fe3a:3a32	Configure a static route to reach interface eth2 of R1 through the virtual IPv6 address.

Router 1

#configure terminal	Enter the Configure mode.
(config)#interface eth1	Enter the Interface mode for eth1.
(config-if)#ipv6 address fe80::3037:a0ff:fea4:1111/64	Configure the IPv6 address for interface eth1 to be in network 1.
(config-if)#exit	Exit the Interface mode.
(config)#interface eth2	Enter the Interface mode for eth2.
(config-if)#ipv6 address fe80::3437:30ff:fe35:a6ac/64	Configure the IPv6 address of interface eth2.

Validation

Master Router

```
R1#sh vrrp
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv6
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Master
 Virtual IP address: fe80::3037:3aff:fe3a:3a32 (Owner)
 Priority is 255
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv6 interface  eth0: JOINED
```

Backup Router

```
R1#sh vrrp
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv6
VRRP Id: 1 on interface: eth0
```

```
 State: AdminUp   - Backup
 Virtual IP address: fe80::3037:3aff:fe3a:3a32 (Not-Owner)
 Priority is 100
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv6 interface  eth0: JOINED
```

Ping Output at Host A

```
[[root@HstA root]#ping ipv6 fe80::3437:30ff:fe35:a6ac
PING fe80::3437:30ff:fe35:a6ac(fe80::3437:30ff:fe35:a6ac) 56 data bytes
64 bytes from fe80::3437:30ff:fe35:a6ac: icmp_seq=1 ttl=63 time=0.398 ms
64 bytes from fe80::3437:30ff:fe35:a6ac: icmp_seq=2 ttl=63 time=0.230 ms
64 bytes from fe80::3437:30ff:fe35:a6ac: icmp_seq=3 ttl=63 time=0.234 ms
64 bytes from fe80::3437:30ff:fe35:a6ac: icmp_seq=4 ttl=63 time=0.230 ms
```

Disabling the Master

#configure terminal	Enter the Configure mode.
(config)#interface eth0	Enter the Interface mode for eth0.
(config-router)#shutdown	Shut down the interface

Validation

```
R1#sh vrrp
VRRP Version: 3
VMAC enabled
Backward Compatibility disabled

Address family IPv6
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Init (interface is not running)
 Virtual IP address: fe80::3037:3aff:fe3a:3a32 (Owner)
 Priority is 255
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv6 interface eth0: LEFT
```

Backup Router

```
R1#sh vrrp
VRRP Version: 3
```

```
VMAC enabled
Backward Compatibility disabled

Address family IPv6
VRRP Id: 1 on interface: eth0
 State: AdminUp   - Backup
 Virtual IP address: fe80::3037:3aff:fe3a:3a32 (Not-Owner)
 Priority is 100
 Advertisement interval: 100 centi sec
 Master Advertisement interval: 100 centi sec
 Skew time: 0 centi sec
 Accept mode: FALSE
 Preempt mode: TRUE
 Multicast membership on IPv6 interface  eth0: LEFT
```

Ping Output at Host A

```
[root@HstA root]#ping ipv6 fe80::3437:30ff:fe35:a6ac
PING fe80::3437:30ff:fe35:a6ac(fe80::3437:30ff:fe35:a6ac) 56 data bytes
64 bytes from fe80::3437:30ff:fe35:a6ac: icmp_seq=1 ttl=63 time=0.423 ms
64 bytes from fe80::3437:30ff:fe35:a6ac: icmp_seq=2 ttl=63 time=0.291 ms
```

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