Lab 08

Phase 1 — Enterprise Foundation

Lab 08 — First-Hop Redundancy with HSRP & VRRP

Section A — Enterprise Build Scenario

Lab Type

Enterprise Foundation Build Lab

Difficulty

Intermediate → Advanced

Estimated Time

150–180 Minutes

Lab Objective

In this lab, you will deploy enterprise First-Hop Redundancy Protocols (FHRP) using:

- HSRP,
- and VRRP.

You will learn how to:

- configure redundant default gateways,

- deploy enterprise gateway failover,
- validate active/standby operations,
- simulate gateway outages,
- verify failover recovery,
- troubleshoot FHRP inconsistencies,
- and implement highly available enterprise gateway architecture.

Why This Lab Matters

Enterprise users depend heavily on uninterrupted gateway availability.

Without gateway redundancy:

- a single router failure disconnects users,
- enterprise services become unreachable,
- productivity drops,
- and network resiliency disappears.

Modern enterprise networks rely heavily on:

- HSRP,
- VRRP,
- gateway failover,
- and operational redundancy.

Understanding FHRP operations is critical for:

- enterprise campus environments,
- branch offices,
- distribution layer design,
- and high availability engineering.

Enterprise Scenario

Your organization requires highly available enterprise gateway services for critical departments.

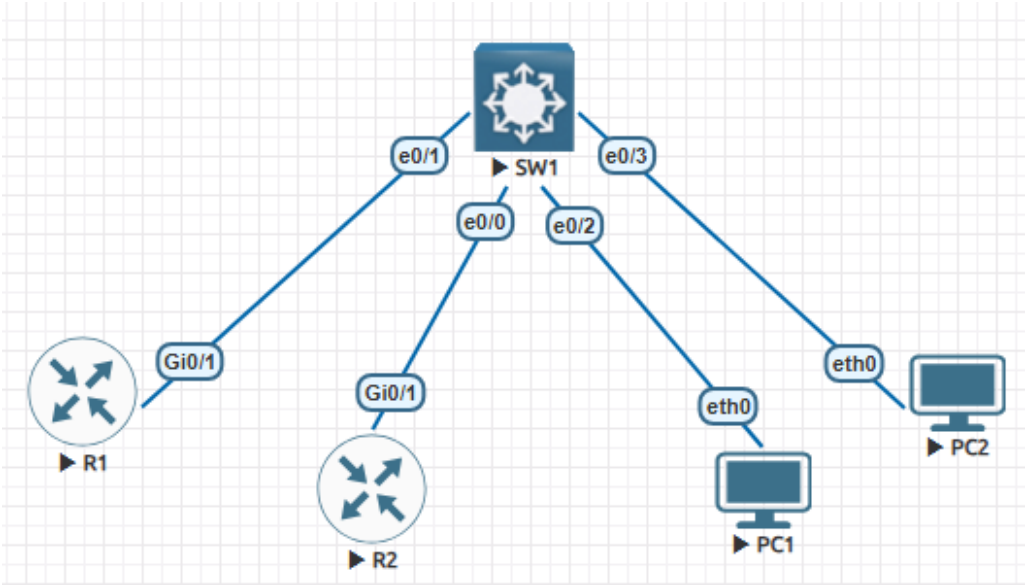
Management requires:

- gateway redundancy,
- seamless failover,
- minimized downtime,
- and resilient Layer 3 operations.

You are assigned to deploy:

- HSRP for Sales VLAN,
- VRRP for Engineering VLAN,
- and validate enterprise failover operations.

Topology for EVE-NG & GNS3



Connection Table

Device	Interface	Connected To	Interface
R1	GigabitEthernet0/1	SW1	Ethernet0/0

Device	Interface	Connected To	Interface
R2	GigabitEthernet0/1	SW1	Ethernet0/1
SW1	Ethernet0/2	PC1	eth0
SW1	Ethernet0/3	PC2	eth0

VLAN Design Table

VLAN ID	VLAN Name
10	SALES
20	ENGINEERING

IP Addressing Table

Device	Interface	IP Address	Gateway
R1	G0/1.10	10.10.10.2/24	N/A
R2	G0/1.10	10.10.10.3/24	N/A
HSRP VIP	VLAN 10	10.10.10.1	N/A
R1	G0/1.20	10.20.20.2/24	N/A
R2	G0/1.20	10.20.20.3/24	N/A
VRRP VIP	VLAN 20	10.20.20.1	N/A
PC1	eth0	10.10.10.10/24	10.10.10.1
PC2	eth0	10.20.20.10/24	10.20.20.1

Enterprise Naming Standards

Device Type	Naming Convention
Primary Router	R1
Secondary Router	R2
Enterprise Switch	SW1
Sales Endpoint	PC1
Engineering Endpoint	PC2

Required Images

Device	Purpose
Cisco vIOS L3	Enterprise routing
Cisco IOL L2	Enterprise switching
VPCS	Endpoint validation

Step 1 — Deploy Nodes in EVE-NG

Goal

Deploy the enterprise redundant gateway topology.

Add The Following Nodes

Node	Quantity
vIOS Router	2
IOLL2 Switch	1
VPCS Host	2

Step 2 — Connect The Enterprise Topology

Goal

Deploy all enterprise Layer 2 and Layer 3 connections.

Use the Connection Table above.

Step 3 — Configure VPCS Hosts

PC1

```
VPCS> ip 10.10.10.10/24 10.10.10.1
Checking for duplicate address...
VPCS : 10.10.10.10 255.255.255.0 gateway 10.10.10.1

VPCS> set pcname pc1

PC1> save
Saving startup configuration to startup.vpc
.  done
```

PC2

```
VPCS> ip 10.20.20.10/24 10.20.20.1
Checking for duplicate address...
VPCS : 10.20.20.10 255.255.255.0 gateway 10.20.20.1

VPCS> set pcname PC2

PC2> save
Saving startup configuration to startup.vpc
.  done
```

Verification

```
pc1> show ip

NAME        : pc1[1]
IP/MASK     : 10.10.10.10/24
GATEWAY     : 10.10.10.1
DNS         :
MAC         : 00:50:79:66:68:05
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Expected Result

Both endpoints should display:

- correct IP addressing,

- correct gateways,
- and operational interfaces.

Step 4 — Configure SW1 VLANs

Goal

Deploy enterprise VLAN segmentation.

Commands

```
enable
conf t

hostname SW1

vlan 10
 name SALES

vlan 20
 name ENGINEERING

interface Ethernet0/0
 switchport trunk encapsulation dot1q
 switchport mode trunk
 switchport trunk allowed vlan 10,20
 no shutdown

interface Ethernet0/1
 switchport trunk encapsulation dot1q
 switchport mode trunk
 switchport trunk allowed vlan 10,20
 no shutdown

interface Ethernet0/2
 switchport mode access
 switchport access vlan 10
 spanning-tree portfast
 no shutdown

interface Ethernet0/3
 switchport mode access
 switchport access vlan 20
 spanning-tree portfast
 no shutdown
```

```
end
write memory
```

Verification

```
SW1#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active
10   SALES                            active    Et0/2
20   ENGINEERING                      active    Et0/3
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

```
SW1#show interfaces trunk

Port           Mode             Encapsulation  Status
Native vlan
Et0/0          on               802.1q         trunking
1
Et0/1          on               802.1q         trunking
1

Port           Vlans allowed on trunk
Et0/0          10,20
Et0/1          10,20

Port           Vlans allowed and active in management domai
n
Et0/0          10,20
Et0/1          10,20

Port           Vlans in spanning tree forwarding state and
not pruned
```

```
Et0/0           10,20
Et0/1           10,20
```

Expected Result

- VLANs should appear active
- Trunks should operate correctly
- Access ports should map properly

Step 5 — Configure R1

Goal

Deploy primary enterprise gateway services.

Commands

```
Would you like to enter the initial configuration dialog? [yes/no]: n

enable
conf t

hostname R1

interface GigabitEthernet0/1
 no shutdown

interface GigabitEthernet0/1.10
 encapsulation dot1Q 10
 ip address 10.10.10.2 255.255.255.0
 standby 10 ip 10.10.10.1
 standby 10 priority 110
 standby 10 preempt

interface GigabitEthernet0/1.20
 encapsulation dot1Q 20
 ip address 10.20.20.2 255.255.255.0
 vrrp 20 ip 10.20.20.1
 vrrp 20 priority 110
 vrrp 20 preempt
```

```
end
write memory

%HSRP-5-STATECHANGE: GigabitEthernet0/1.10 Grp 10 state Standby -> Active
```

Verification (wait 2 minutes and verify)

```
R1#show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State   Active          Standby         Virtual IP
Gi0/1.10    10   110 P Active  local           unknown         10.10.10.1
```

```
R1#show vrrp brief
Interface          Grp Pri Time  Own Pre State   Master add
r     Group addr
Gi0/1.20           20  110 3570       Y  Master  10.20.20.2
10.20.20.1
```

Expected Result

R1 should appear:

- Active for HSRP VLAN 10
- Master for VRRP VLAN 20

Step 6 — Configure R2

Goal

Deploy secondary enterprise gateway services.

Commands

```
enable
conf t
```

```
hostname R2

interface GigabitEthernet0/1
 no shutdown

interface GigabitEthernet0/1.10
 encapsulation dot1Q 10
 ip address 10.10.10.3 255.255.255.0
 standby 10 ip 10.10.10.1
 standby 10 priority 100
 standby 10 preempt

interface GigabitEthernet0/1.20
 encapsulation dot1Q 20
 ip address 10.20.20.3 255.255.255.0
 vrrp 20 ip 10.20.20.1
 vrrp 20 priority 100
 vrrp 20 preempt

end
write memory

%HSRP-5-STATECHANGE: GigabitEthernet0/1.10 Grp 10 state Speak -> Standby
```

Verification (wait a few seconds to establish hsrp connection)

```
R2#show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State   Active          Standby         Virtual IP
Gi0/1.10    10   100 P Standby 10.10.10.2      local           10.10.10.1
```

```
R2#show vrrp brief
Interface          Grp Pri Time  Own Pre State   Master add
r     Group addr
Gi0/1.20           20  100 3609       Y  Backup  10.20.20.2
10.20.20.1
```

Expected Result

R2 should appear:

- Standby for HSRP VLAN 10

- Backup for VRRP VLAN 20

Step 7 — Validate Gateway Reachability

Goal

Validate enterprise FHRP gateway operations.

From PC1

```
pc1> ping 10.10.10.1

84 bytes from 10.10.10.1 icmp_seq=1 ttl=255 time=1.267 ms
84 bytes from 10.10.10.1 icmp_seq=2 ttl=255 time=1.447 ms
84 bytes from 10.10.10.1 icmp_seq=3 ttl=255 time=1.656 ms
```

Expected Result

HSRP virtual gateway should respond successfully.

From PC2

```
PC2> ping 10.20.20.1

84 bytes from 10.20.20.1 icmp_seq=1 ttl=255 time=1.451 ms
84 bytes from 10.20.20.1 icmp_seq=2 ttl=255 time=1.483 ms
84 bytes from 10.20.20.1 icmp_seq=3 ttl=255 time=1.424 ms
```

Expected Result

VRRP virtual gateway should respond successfully.

Step 8 — Validate Inter-VLAN Connectivity

Goal

Validate enterprise Layer 3 forwarding.

From PC1

```
pc1> ping 10.20.20.10

84 bytes from 10.20.20.10 icmp_seq=1 ttl=63 time=2.193 ms
84 bytes from 10.20.20.10 icmp_seq=2 ttl=63 time=1.790 ms
84 bytes from 10.20.20.10 icmp_seq=3 ttl=63 time=1.565 ms
```

Expected Result

PC2 should respond successfully.

Step 9 — Simulate Enterprise Failover

Goal

Validate enterprise gateway redundancy.

On R1

```
enable
conf t

interface GigabitEthernet0/1
 shutdown

end
```

Verification on R2 (wait afew seconds anf verify)

```
R2#show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State   Active          Standby         Virtual IP
Gi0/1.10    10   100 P Active  local           unknown         10.10.10.1
```

```
R2#show vrrp brief
Interface          Grp Pri Time  Own Pre State   Master add
r     Group addr
Gi0/1.20           20  100 3609       Y  Master  10.20.20.3
10.20.20.1
```

Expected Result

R2 should automatically become:

- HSRP Active router
- VRRP Master router

Step 10 — Validate Connectivity During Failover

Goal

Validate enterprise resiliency.

From PC1

```
pc1> ping 10.20.20.10

84 bytes from 10.20.20.10 icmp_seq=1 ttl=63 time=3.812 ms
84 bytes from 10.20.20.10 icmp_seq=2 ttl=63 time=1.694 ms
84 bytes from 10.20.20.10 icmp_seq=3 ttl=63 time=1.777 ms
```

From PC2

```
PC2> ping 10.10.10.10

84 bytes from 10.10.10.10 icmp_seq=1 ttl=63 time=1.901 ms
84 bytes from 10.10.10.10 icmp_seq=2 ttl=63 time=1.720 ms
84 bytes from 10.10.10.10 icmp_seq=3 ttl=63 time=1.670 ms
```

Expected Result

Connectivity should continue successfully after failover.

Step 11 — Restore Primary Router

Goal

Validate enterprise preemption behavior.

On R1

```
enable
conf t

interface GigabitEthernet0/1
 no shutdown

end
```

Verification on R2

```
R2#show standby brief
                     P indicates configured to preempt.
                     |
```

```
Interface   Grp  Pri P State   Active          Standby         Virtual IP
Gi0/1.10    10   100 P Standby 10.10.10.2      local           10.10.10.1
```

```
R2#show vrrp brief
Interface          Grp Pri Time  Own Pre State   Master add
r     Group addr
Gi0/1.20           20  100 3609       Y  Backup  10.20.20.2
10.20.20.1
```

Expected Result

R1 should regain:

- HSRP Active role
- VRRP Master role

Step 12 — Enterprise Operational Verification

R1 Verification

```
show standby brief
show vrrp brief
show ip interface brief
```

R2 Verification

```
show standby brief
show vrrp brief
show ip interface brief
```

SW1 Verification

```
show vlan brief
show interfaces trunk
```

Common Mistakes

Problem	Cause
HSRP not forming	Wrong group number
VRRP failure	IP mismatch
Failover failure	Missing preempt
Gateway unreachable	Trunk failure
Split-brain behavior	Incorrect priorities

Enterprise Engineering Notes

- HSRP is Cisco proprietary.
- VRRP is open standard.
- FHRP provides enterprise gateway resiliency.
- Preemption allows preferred routers to regain active role.
- Gateway redundancy is critical for enterprise uptime.

Step 13 — Save Configurations

R1

```
write memory
```

R2

```
write memory
```

SW1

```
write memory
```

Step 14 — Backup Enterprise Gateway Documentation

Goal

Document enterprise FHRP deployment.

Suggested Documentation

```
HSRP VLAN 10
 Virtual IP -> 10.10.10.1

VRRP VLAN 20
 Virtual IP -> 10.20.20.1

Primary Router -> R1
Secondary Router -> R2
```

What You Learned

In this lab you learned:

- enterprise HSRP deployment,
- enterprise VRRP deployment,
- gateway redundancy operations,

- failover validation,
- preemption behavior,
- enterprise resiliency engineering,
- and FHRP troubleshooting workflows.

Verification Score

Task	Status
VLANs configured	☐
HSRP operational	☐
VRRP operational	☐
Gateway redundancy verified	☐
Failover tested	☐
Preemption validated	☐
Configurations saved	☐

Section B — Enterprise Troubleshooting Scenario

Incident Scenario

Users report intermittent gateway failures after maintenance activities.

Your task:

- investigate the FHRP instability,
- identify the root cause,
- and restore enterprise gateway redundancy.

Step 1 — Introduce Failure

On R2

```
enable
conf t

interface GigabitEthernet0/1.10
 standby 10 priority 255

end
```

Step 2 — Verify Failure Symptoms

Verification Commands

```
show standby brief
```

Expected Result

Unexpected HSRP Active role changes should appear.

Step 3 — Begin Investigation

Verification Commands

```
show running-config interface GigabitEthernet0/1.10
```

Expected Result

HSRP priorities should appear inconsistent.

Root Cause Analysis

Incorrect HSRP priority caused unexpected active gateway election.

This creates:

- unstable gateway ownership,
- unpredictable failover behavior,
- and enterprise traffic disruption.

Step 4 — Restore Enterprise Stability

Commands

```
enable
conf t

interface GigabitEthernet0/1.10
 standby 10 priority 100

end
```

Step 5 — Validate Recovery

Verification Commands

```
show standby brief
```

Expected Result

R1 should regain Active gateway role consistently.

Final Enterprise Validation

R1

```
show standby brief
show vrrp brief
```

R2

```
show standby brief
show vrrp brief
```

SW1

```
show interfaces trunk
```

Final Engineering Note

Enterprise FHRP troubleshooting should always follow a structured workflow:

1. Verify physical connectivity
2. Verify VLAN operations
3. Verify trunk state
4. Verify FHRP group consistency
5. Verify priorities and preemption
6. Restore gateway stability
7. Validate end-to-end recovery

End of Lab 08 — First-Hop Redundancy with HSRP & VRRP