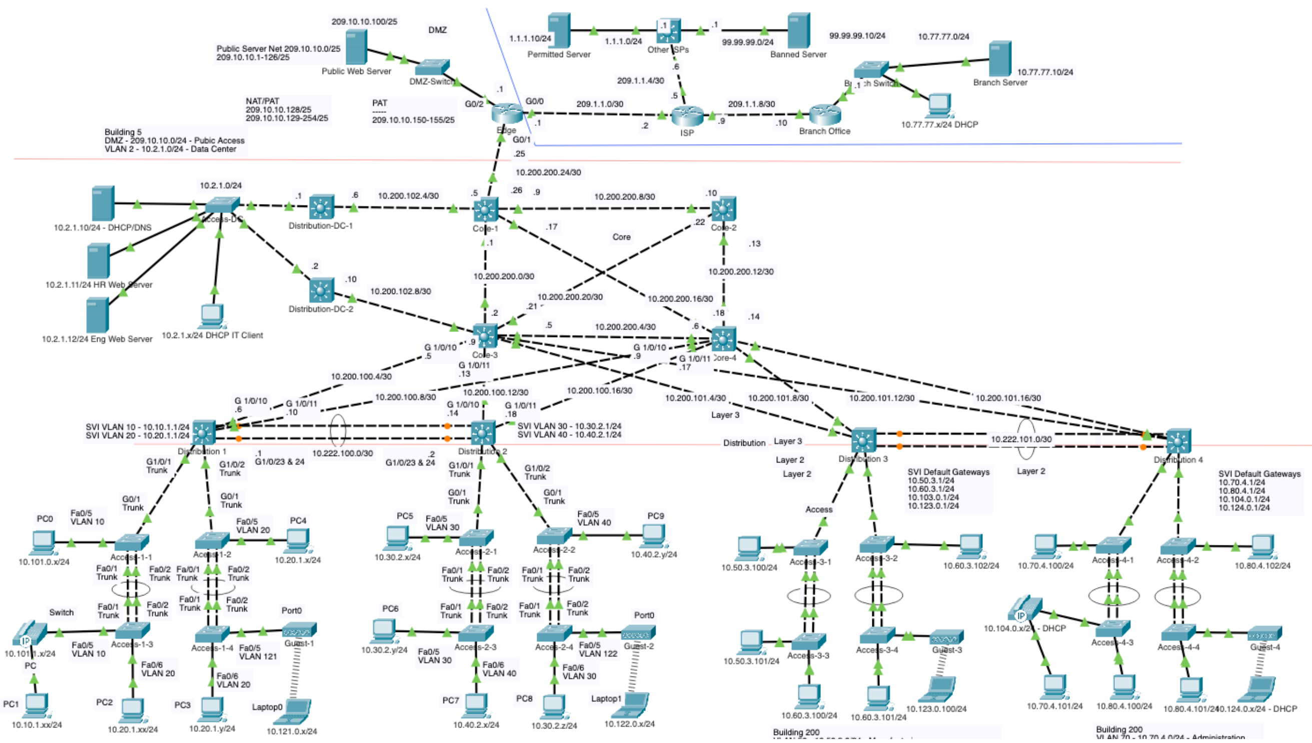
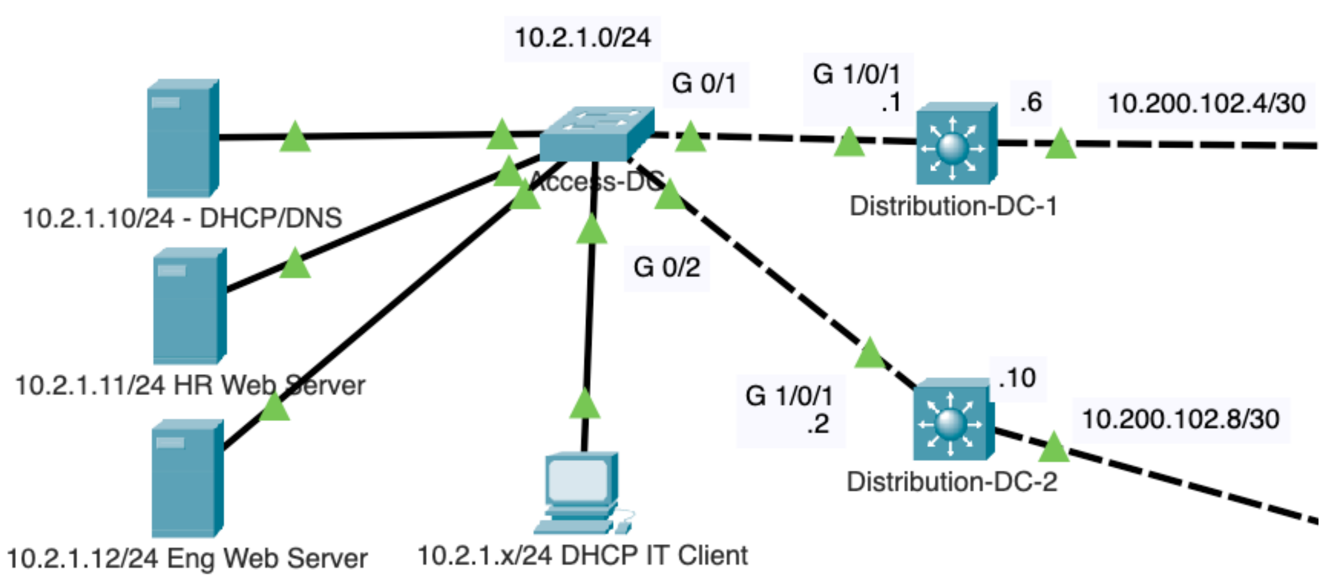
Enterprise Network

Lab 8: FHRP at the Data Center





In this lab we will enable the FHRP (First Hop Redundancy Protocol), HSRP (Hot Standby Router Protocol) on Distribution-DC-1 and Distribution-DC-2 Layer 3 switches to provide redundant default gateways for devices on the 10.2.1.0/24 network.

Note: Older version of the PKT file has Access-DC switch G0/1 interface connected as Fa0/24. Although it does not affect his lab, it is recommended that you make the change as shown above.

FHRP

First Hop Redundancy Protocol (FHRP) is a group of protocols used to ensure network availability by automatically forwarding traffic on failover to a standby router or L3 switch if the primary default gateway fails. FHRP, with protocols like HSRP (Hot Standby Router Protocol), allows for the configuration of a virtual router (or gateway) with a virtual IP and MAC address that network hosts use as their default gateway.

Both routers and layer 3 switches can participate in FHRP. On routers, FHRP provides redundancy for routed networks, while on layer 3 switches, it ensures continuous availability of routing paths for VLANs or inter-VLAN routing environments. The primary device handles the traffic until it fails or goes offline, at which point the standby device takes over, ensuring minimal disruption to the network.

FHRP, such as HSRP, VRRP, or GLBP, addresses the issue of gateway redundancy by creating a virtual router with a stable virtual IP (VIP) address used as the default gateway across the network. This setup negates the need for modifying the default gateway on the DHCP server or requiring clients and servers to renew or manually reconfigure their IP settings in case of gateway failure. When the primary gateway device fails, FHRP seamlessly transitions the VIP to a standby device, maintaining continuous network availability. This mechanism ensures that the network's default gateway remains consistent, eliminating downtime and the administrative burden associated with updating IP configurations during gateway transitions.

Preface to FHRP

Spanning Tree Enhancements

Before we begin with configuring FHRP let's take this opportunity to add the same changes to Spanning Tree Protocol in Access-DC switch that we made in the previous lab on other switches:

- Enable Rapid Spanning Tree, Cisco RSTP-PVST+
- Enable PortFast and BPDU Guard on ports with end-devices and routes (Layer 3 switches)

Enable Cisco's version of Rapid Spanning Tree with PVST.

```
Access-DC(config)# spanning-tree mode rapid-pvst
```

Enable PortFast and BPDU Guard

```
! Ports to End Devices
Access-DC(config)#interface range fa 0/1-3, fa 0/10
Access-DC(config-if-range)#spanning-tree portfast
<PortFast Warning>
<output omitted>

Access-DC(config-if-range)#spanning-tree bpduguard enable
Access-DC(config-if-range)#exit

! Ports to Layer 3 Switches
Access-DC(config)#inter range gig 0/1-2
Access-DC(config-if-range)#spanning-tree portfast
Access-DC(config-if-range)#spanning-tree bpduguard enable
Access-DC(config-if-range)#
```

It is best practice to configure **PortFast** and **BPDU Guard** on all Access-DC switch ports connected to end devices—such as PCs, servers, and printers—as well as ports connected to **routers or Layer 3 switches using routed ports**. Enabling PortFast allows these ports to immediately transition to the forwarding state, avoiding the default 30-second delay caused by the STP listening and learning states. This improves startup time for end devices and reduces unnecessary delays during link changes.

Since end devices and routed interfaces do not participate in Spanning Tree Protocol or send BPDUs, it is safe to enable PortFast. To add an extra layer of protection, BPDU Guard is used to shut down the port if a BPDU is unexpectedly received—such as when someone accidentally connects a switch—which could otherwise introduce a bridging loop into the network. This combination enhances both performance and security at the edge of the network.

Why CDP is Disabled on Routed Ports: Distribution-DC-1 & Distribution-DC-2

Access-DC switch is connected to Distribution-DC-1 and Distribution-DC-2. Both Distribution switches, use their GigabitEthernet 1/0/1 ports to connect to Access-DC. These are routed ports similar to what we have seen configured previously between Distribution-1 and Distribution-2 switches.

Distribution-DC-1

```
interface GigabitEthernet1/0/1
 no switchport
 ip address 10.2.1.1 255.255.255.0
 duplex auto
 speed auto
 no cdp enable
```

Distribution-DC-2

```
interface GigabitEthernet1/0/1
 no switchport
 ip address 10.2.1.2 255.255.255.0
 duplex auto
 speed auto
 no cdp enable
```

Although CDP (Cisco Discovery Protocol) is often used for neighbor discovery and network mapping, it can generate misleading or unnecessary alerts when used on routed ports connected to Layer 2 switches. In particular, CDP operates at Layer 2 and assumes that both sides of the link are either access ports or trunk ports.

When a **Layer 3 switch interface is configured as a routed port (no switchport)** and is connected to a **Layer 2 switch port that belongs to a VLAN**, CDP on the Layer 2 side may detect a **native VLAN mismatch**. This is because the Layer 3 routed port does not tag traffic or advertise any VLAN information—so CDP interprets this as a mismatch against the native VLAN on the Layer 2 switch, such as VLAN 1 or 2.

To avoid these false alerts and reduce unnecessary CDP traffic, it's best practice to disable CDP on routed interfaces that connect to Layer 2 switches using access mode. This not only cleans up CDP output but also improves clarity and security in the network.

Disabling the Current Default Gateway

Determine the IPv4 addressing on PC0. You may need to renew the address if the device did not get its IPv4 addressing from the DHCP server (Packet Tracer sometimes is slow).

PC0

```
C:\>ipconfig /renew

   IP Address......................: 10.10.1.150
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: 10.10.1.1
   DNS Server......................: 10.2.1.10

C:\>
```

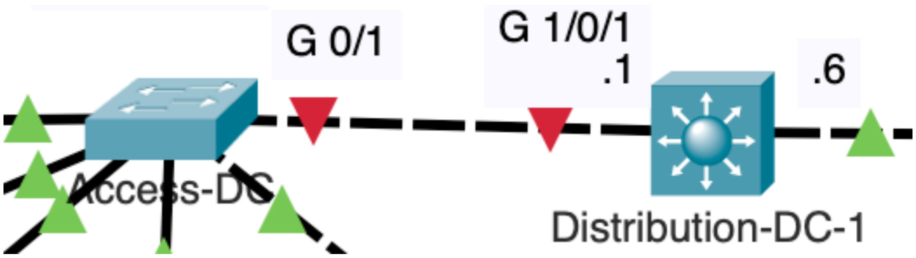
From the DHCP-DNS server, 10.2.1.10/24, verify the default gateway and ping the IPv4 address of PC0.

DHCP-DNS Sever (10.2.1.10/24)

```
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.........: FE80::207:ECFF:FEE2:48C
   IPv6 Address....................: ::
   IPv4 Address....................: 10.2.1.10
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     10.2.1.1

C:\>ping 10.10.1.150 -n 100

Pinging 10.10.1.150 with 32 bytes of data:

Request timed out.
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
<pings continue>
```

Distribution-DC-1 switch is the default gateway, 10.2.1.1, for 10.2.1.0/24 network. During the successive pings from, shutdown the GigabitEthernet 1/0/1 interface.

```
Distribution-DC-1(config)#interface g 1/0/1
Distribution-DC-1(config-if)#shutdown

%LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state to administratively
down

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed
state to down
```



Notice the pings are now failing to PC0.

DHCP-DNS Sever (10.2.1.10/24)

```
<continuation of previous pings>
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 10.10.1.150:
    Packets: Sent = 40, Received = 35, Lost = 5 (13% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 13ms, Average = 0ms

Control-C
^C
C:\>
```

Although there is an alternative forwarding path using Distribution-DC-2, there no automatic failover to use the IPv4 address of the Layer 3 switch, 10.2.1.3 as a new default gateway.

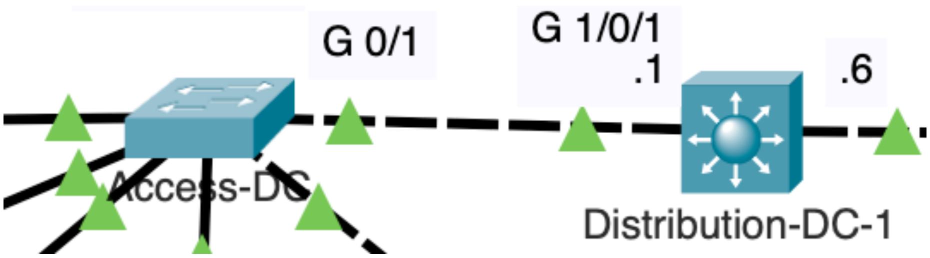
If there was actual failure of Distribution-DC-1, there are two alternatives to use Distribution-DC-2 as the new default gateway:

1. On Distribution-DC-2: Change IPv4 address to 10.2.1.1/24 to become to default gateway for 10.2.1.0/24 network.
2. On the end-devices (computers on 10.2.1.0/24): Modify default gateway address to be 10.2.1.2.

Note: If end-devices such as DHCP IT Client receive their IP address from a DHCP server, the DHCP server must change the default gateway for the network to 10.2.1.2. Devices may have to renew their IP addresses.

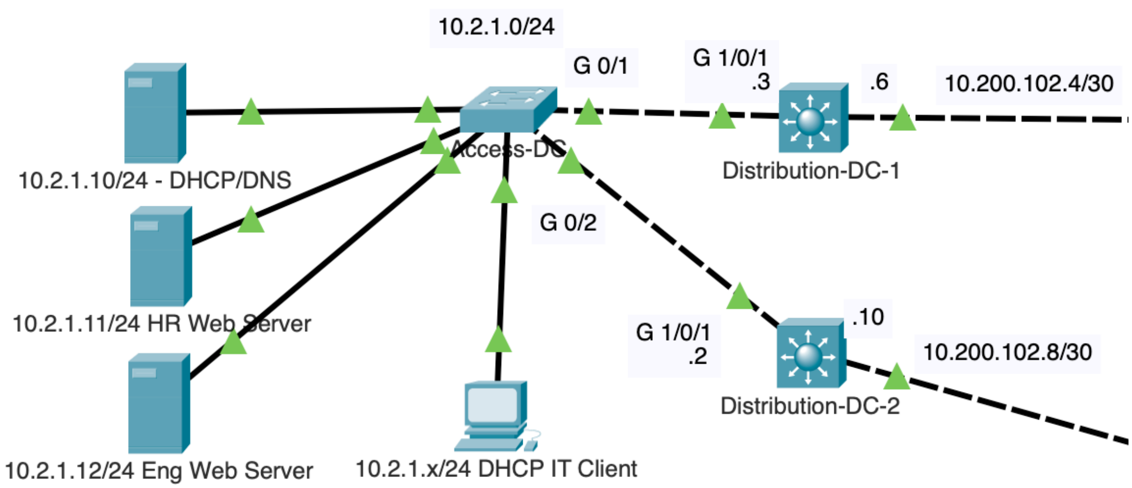
On Distribution-DC-1, GigabitEthernet 1/0/1, use the no shutdown command to re-enable the interface.

```
Distribution-DC-1(config-if)#no shutdown

Distribution-DC-1(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed
state to up

Distribution-DC-1(config-if)#
```



Modifying the IPv4 Address DC-1

It is common best practice to use the first IP address of a network address as the default gateway. So, we will reconfigure the IPv4 address of Distibution-DC-1 G 1/0/1 port to be 10.2.1.3.



Here are the commands to reconfigure the IPv4 addressing on Distibution-DC-1. The **no ip address** command is not required, as IPv4 only allows one IPv4 address on a physical interface.

```
Distribution-DC-1(config)#inter gig 1/0/1
Distribution-DC-1(config-if)#no ip address
Distribution-DC-1(config-if)#ip address 10.2.1.3 255.255.255.0
Distribution-DC-1(config-if)#end

Distribution-DC-1#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet1/0/1   10.2.1.3        YES manual up                    up
GigabitEthernet1/0/2   10.200.102.6    YES manual up                    up
GigabitEthernet1/0/3   unassigned      YES unset  down                  down
GigabitEthernet1/0/3   unassigned      YES unset  down                  down
<output omitted>
```

The devices on the 10.2.1.0/24 network no longer have a default gateway.

DHCP-DNS Sever (10.2.1.10/24)

```
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.........: FE80::207:ECFF:FEE2:48C
   IPv6 Address....................: ::
   IPv4 Address....................: 10.2.1.10
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     10.2.1.1

C:\>ping 10.2.1.1

Pinging 10.2.1.1 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.
```

HSRP

HSRP (Hot Standby Router Protocol) is a **Cisco proprietary protocol** designed to provide **gateway redundancy** for hosts on a LAN. It allows multiple Cisco routers or Layer 3 switches to work together in a group, with one device actively forwarding traffic while others remain on standby. If the active device fails, a standby device automatically takes over, ensuring uninterrupted connectivity. Because HSRP is proprietary, it is typically used in **Cisco-only environments**; for multi-vendor networks, open standards like **VRRP (Virtual Router Redundancy Protocol)** are preferred.

Configuring HSRP

In HSRP (Hot Standby Router Protocol), a **virtual IP address** is configured to serve as the default gateway for end devices on the network. This virtual IP is not tied to any single physical router—instead, it is shared between participating routers, with one router actively forwarding traffic while the other stands by to take over if needed, ensuring continuous gateway availability.

We will use the virtual IPv4 address 10.2.1.1.

HSRP configuration commands on Distribution-DC-1:

```
Distribution-DC-1(config)#interface gig 1/0/1
Distribution-DC-1(config-if)#standby 1 ip 10.2.1.1
Distribution-DC-1(config-if)#standby 1 priority 200
Distribution-DC-1(config-if)#standby 1 preempt
Distribution-DC-1(config-if)#exit
%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Speak -> Standby

%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Standby -> Active

Distribution-DC-1(config-if)#
```

The following is an explanation of the HSRP commands for Distribution-DC-1:

1. **interface gig 1/0/1**
   Enters interface configuration mode for GigabitEthernet1/0/1 on Distribution-DC-1. This is the routed port facing the Access-DC switch.
2. **standby 1 ip 10.2.1.1**
   Assigns the virtual IP address **10.2.1.1** to **HSRP group 1** on this interface. This IP address will be used by hosts on the 10.2.1.0/24 subnet as their default gateway.
3. **standby 1 priority 200**
   Sets the priority for HSRP group 1 to **200**, giving this router a higher chance of becoming the **active router** compared to other routers in the group (default is 100).
4. **standby 1 preempt**
   Enables the preemption feature. This allows the router to **take over the active role** if it has a higher priority and becomes available after a failure or reboot.

The syslog messages:

1. **%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Speak -> Standby**
   Indicates that the router has moved from the **Speak** state (sending hello messages, waiting to determine its role) to the **Standby** state (it is now the backup router, ready to take over if the active router fails).
2. **%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Standby -> Active**
   Indicates that the router has **transitioned from Standby to Active**, becoming the active router now responsible for forwarding traffic to and from the virtual IP address 10.2.1.1.

On **Distribution-DC-2**, similar HSRP commands are configured as on Distribution-DC-1, using the **same HSRP group number (1)** and the **shared virtual IP address 10.2.1.1**. However, Distribution-DC-2 is assigned a **lower priority of 100**, making it the **Standby router** in the HSRP group. Like Distribution-DC-1, it also includes the preempt command, allowing it to take over the active role if its priority were to be raised in the future and the active router became unavailable. The syslog message confirms that this router has entered the **Standby state**, ready to take over if needed.

HSRP configuration commands on Distribution-DC-2:

```
Distribution-DC-2(config)#interface gig 1/0/1
Distribution-DC-2(config-if)#standby 1 ip 10.2.1.1
Distribution-DC-2(config-if)#standby 1 priority 100
Distribution-DC-2(config-if)#standby 1 preempt
Distribution-DC-2(config-if)#exit
Distribution-DC-2(config)#
%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Speak -> Standby

Distribution-DC-2(config)#
```

HSRP in Action

HSRP uses periodic **hello messages** to monitor the health of the active router. By default, the active router sends hello messages every **3 seconds**, and the standby router listens for these messages to ensure the active device is still functioning. If the standby router fails to receive **three consecutive hello messages** (a total of **10 seconds**, the default hold time), it assumes the active router has failed. At that point, the standby router **transitions to the active state** and begins forwarding traffic on behalf of the virtual IP address. This automatic failover ensures continuous gateway availability without requiring manual intervention.

Current Forwarding Path

The traceroute output shows that the current forwarding path from the **DHCP/DNS server (10.2.1.10)** to **10.10.1.150** begins with **10.2.1.3**, the IP address of **Distribution-DC-1**. This confirms that **Distribution-DC-1 is currently the active HSRP router**, forwarding traffic for the virtual gateway IP 10.2.1.1. All outbound traffic from the 10.2.1.0/24 subnet is routed through Distribution-DC-1, as expected when it holds the active role in the HSRP group.

DHCP-DNS Sever (10.2.1.10/24)

```
C:\>tracert 10.10.1.150

Tracing route to 10.10.1.150 over a maximum of 30 hops:

  1    *         0 ms      0 ms      10.2.1.3
  2    0 ms      0 ms      0 ms      10.200.102.5
  3    0 ms      0 ms      0 ms      10.200.102.9
  4    0 ms      0 ms      0 ms      10.200.100.6
  5    0 ms      0 ms      0 ms      10.10.1.150

Trace complete.

C:\>
```

Virtual MAC Address

In HSRP, each **virtual IP address** is associated with a specific **virtual MAC address**, which allows hosts on the network to send traffic to a consistent gateway, regardless of which router is currently active. In the example shown, the virtual IP address 10.2.1.1 is paired with the virtual MAC address 0000.0C07.AC01. This MAC address is generated based on the HSRP group number—in this case, **group 1**, resulting in the hexadecimal value **AC01** at the end of the MAC address.

DHCP-DNS Sever (10.2.1.10/24)

```
C:\>arp -a
  Internet Address      Physical Address      Type
  10.2.1.1              0000.0c07.ac01        dynamic
```

This virtual MAC address is critical for maintaining **transparency and continuity**. End devices—like PCs, servers, and printers—use ARP to resolve the IP address of their default gateway to a MAC address. Once resolved, they send traffic to that MAC address, unaware of which physical router is currently acting as the gateway.

When the active router fails and the standby router takes over, the virtual IP address remains the same, and the **virtual MAC address does not change**. The new active router sends a **gratuitous ARP request** to inform the downstream switch that the virtual MAC is now reachable via a different port. The switch updates its MAC address table accordingly, but from the perspective of the end device, **nothing has changed**—it continues to send traffic to the same IP and MAC address combination. This design is what allows HSRP to provide **seamless failover** with no reconfiguration required on end devices.

Fail-Over with HSRP

In this example, the active HSRP router (**Distribution-DC-1**) was intentionally shut down by issuing the shutdown command on its interface **GigabitEthernet1/0/1**, which was participating in **HSRP group 1**. As a result, the router transitioned from the **Active** state to **Init**, and the interface status changed to **administratively down**. This simulated a failure of the active router.

DHCP-DNS Sever (10.2.1.10/24)

```
C:\>ping 10.10.1.150 -n 50

Pinging 10.10.1.150 with 32 bytes of data:

Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
```

```
Access-DC#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

   2    0000.0c07.ac01    DYNAMIC     Gig0/1
   2    0001.6392.8d01    DYNAMIC     Gig0/1
   2    0007.ece2.048c    DYNAMIC     Fa0/1
   2    00d0.ff0e.d701    DYNAMIC     Gig0/2
Access-DC#
%LINK-3-UPDOWN: Interface GigabitEthernet0/1, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state
to down

Access-DC#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

   2    0000.0c07.ac01    DYNAMIC     Gig0/2
   2    0007.ece2.048c    DYNAMIC     Fa0/1
   2    00d0.ff0e.d701    DYNAMIC     Gig0/2
Access-DC#
```

```
Distribution-DC-1(config)#interface gig 1/0/1
Distribution-DC-1(config-if)#shutdown

%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Active -> Init

%LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state to administratively
down
```

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed
state to down
```

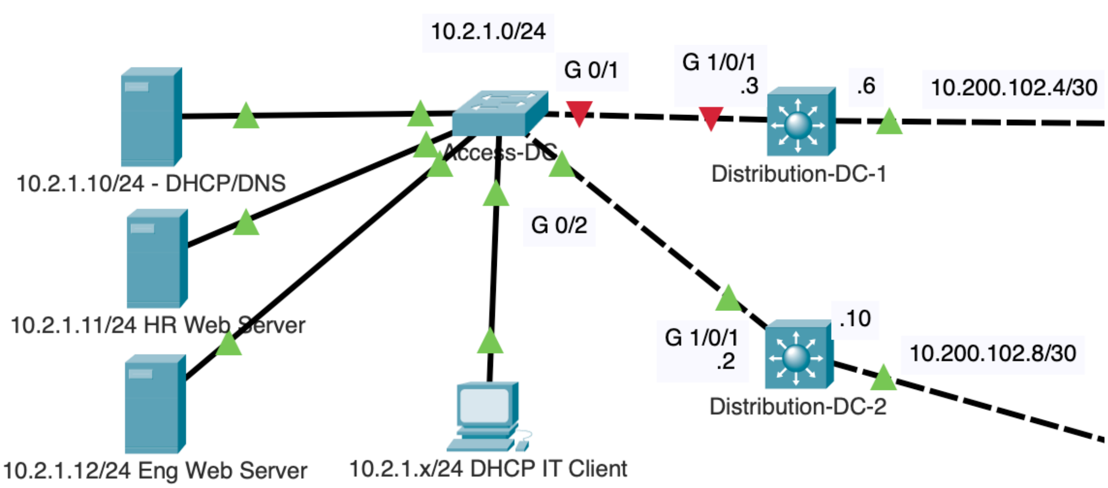
Following this shutdown, **Distribution-DC-2**, which was previously in the **Standby** state, detected the loss of HSRP hello messages and after the default **10-second hold time**, transitioned to the **Active** state. This failover is confirmed by the %HSRP-6-STATECHANGE message on Distribution-DC-2 indicating Standby -> Active.

During this transition, only **one ping request timed out**, showing a brief interruption in connectivity. The successful replies that quickly resumed confirm that **Distribution-DC-2 seamlessly took over forwarding traffic for the virtual IP address**, maintaining continuous access to the destination host at **10.10.1.150**. This demonstrates HSRP's ability to provide high availability with minimal disruption.

```
Distribution-DC-2#
%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Standby -> Active

Distribution-DC-2#
```

DHCP-DNS Sever (10.2.1.10/24)

```
Request timed out.
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
Reply from 10.10.1.150: bytes=32 time<1ms TTL=125
<pings continue>
<output omitted>
```



The traceroute output confirms that the new forwarding path is now through **Distribution-DC-2**, with the first hop showing **10.2.1.2**—the IP address assigned to Distribution-DC-2's interface. This verifies that Distribution-DC-2 has successfully taken over as the **active HSRP router**, forwarding traffic on behalf of the virtual IP address **10.2.1.1** after the failure or shutdown of Distribution-DC-1.

DHCP-DNS Sever (10.2.1.10/24)

```
C:\>tracert 10.10.1.150
```

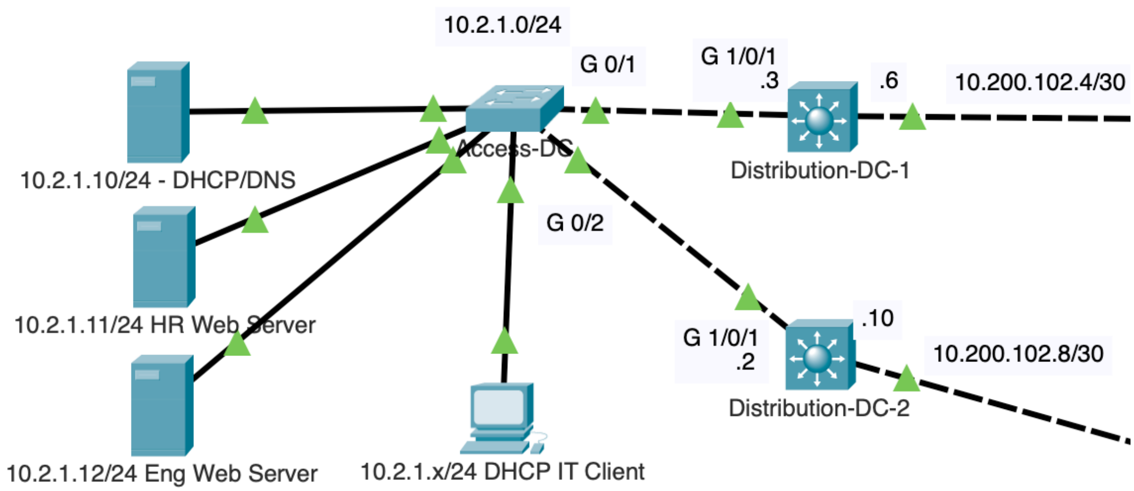
```
Tracing route to 10.10.1.150 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      10.2.1.2
  2   0 ms      0 ms      0 ms      10.200.102.9
  3   0 ms      0 ms      0 ms      10.200.100.6
  4   0 ms      0 ms      0 ms      10.10.1.150

Trace complete.

C:\>
```

Preempt

When **Distribution-DC-1** was originally configured with a higher HSRP priority (200), it was the **active router**. After its interface was shut down, **Distribution-DC-2**, with a lower priority (100), detected the failure and transitioned from **Standby to Active**, taking over gateway responsibilities.

Later, when **Distribution-DC-1's interface was brought back up** (no shutdown), HSRP hello messages resumed. Because **both routers were configured with the preempt command**, Distribution-DC-1 evaluated its own **higher priority** and **automatically reclaimed the active role**. This is reflected in the HSRP syslog message:
%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Standby -> Active.

```
Distribution-DC-1(config-if)#no shutdown

%LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed
state to up

%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Standby -> Active
```



Simultaneously, **Distribution-DC-2**, detecting that a higher-priority router had returned, stepped down and transitioned back to the **Standby** state, shown by the message:
%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Speak -> Standby.

```
Distribution-DC-2#
%HSRP-6-STATECHANGE: GigabitEthernet1/0/1 Grp 1 state Speak -> Standby

Distribution-DC-2#
```

The traceroute confirms this transition, showing that traffic is once again being forwarded through **10.2.1.3** (Distribution-DC-1), verifying that **preemption has restored the original preferred forwarding path**. This demonstrates how HSRP with preempt ensures that the most preferred router (highest priority) always resumes control when available.

DHCP-DNS Sever (10.2.1.10/24)

```
C:\>tracert 10.10.1.150

Tracing route to 10.10.1.150 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      10.2.1.3
  2   0 ms      0 ms      0 ms      10.200.102.5
  3   0 ms      0 ms      0 ms      10.200.102.9
  4   0 ms      0 ms      0 ms      10.200.100.6
  5   0 ms      0 ms      0 ms      10.10.1.150

Trace complete.

C:\>
```

Verifying HSRP – show standby

The show standby command is used to verify the status of HSRP (Hot Standby Router Protocol) on a router or Layer 3 switch interface. It provides detailed information about the HSRP group state, including role (Active or Standby), virtual IP address, priority settings, hello/hold timers, and the identity of peer devices participating in the group.

```
Distribution-DC-1#show standby
GigabitEthernet1/0/1 - Group 1
  State is Active
    9 state changes, last state change 01:27:34
  Virtual IP address is 10.2.1.1
  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 0.075 secs
  Preemption enabled
  Active router is local
  Standby router is 10.2.1.2, priority 100 (expires in 9 sec)
  Priority 200 (configured 200)
  Group name is hsrp-Gig1/0/1-1 (default)
Distribution-DC-1#
```

In general, the show standby output provides the following information for each **interface and HSRP group**:

- **State**: Indicates whether the router is currently the **Active** or **Standby** router for the HSRP group on this interface.
- **State changes**: Shows how many times the HSRP state has changed on this interface and how long ago the last state change occurred.
- **Virtual IP address**: The shared IP address used by hosts on the subnet as their **default gateway**.
- **Active virtual MAC address**: The MAC address used by the router currently acting as the active HSRP router. This is a **virtual MAC** and may move between routers.
- **Local virtual MAC address**: The virtual MAC address that this local router would use if it becomes active.
- **Hello time**: The interval in seconds at which hello packets are sent by the active and standby routers (default: 3 seconds).
- **Hold time**: The time in seconds that a router will wait without hearing a hello message before assuming the active router has failed (default: 10 seconds).
- **Preemption**: Indicates whether the router is configured to automatically take over as active if it has a **higher priority** than the current active router.
- **Active router**: Shows the IP address of the current active router. If "local", this router is the active router.
- **Standby router**: Shows the IP address of the standby router. If "local", this router is currently the standby.
- **Priority**: The HSRP **priority value** used to determine which router should be active. A higher number is preferred. The configured priority is shown in parentheses.
- **Group name**: The internal name assigned to the HSRP group, based on the interface and group number (e.g., hsrp-Gig1/0/1-1 for group 1 on Gig1/0/1).

Similar output for Distribution-DC-2

```
Distribution-DC-2#show standby
GigabitEthernet1/0/1 - Group 1
  State is Standby
    9 state changes, last state change 01:27:44
  Virtual IP address is 10.2.1.1
  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 1.872 secs
  Preemption enabled
  Active router is 10.2.1.3, priority 200 (expires in 8 sec)
    MAC address is 0000.0C07.AC01
  Standby router is local
  Priority 100 (default 100)
  Group name is hsrp-Gig1/0/1-1 (default)
Distribution-DC-2#
```

Key differences:

Distribution-DC-1

- **State is Active**
  This router is currently forwarding traffic for the virtual IP (10.2.1.1).
- **Active router is local**
  Indicates that this router itself is the active router.
- **Standby router is 10.2.1.2, priority 100**
  Distribution-DC-2 is the standby router.
- **Priority 200 (configured 200)**
  Higher priority, configured to become active when available.

Distribution-DC-2

- **State is Standby**
  This router is on standby, ready to take over if the active router fails.
- **Active router is 10.2.1.3, priority 200**
  Indicates Distribution-DC-1 (10.2.1.3) is currently the active router.
- **Standby router is local**
  Confirms this router (Distribution-DC-2) is the standby.
- **Priority 100 (default 100)**
  Lower priority, so it will not become active unless the higher-priority router fails.

Verifying HSRP – show standby brief

The show standby brief command provides a **concise summary** of the current HSRP status on each interface and group. It is especially useful for quickly identifying which router is **active**, which is **standby**, and verifying **preemption**, **priority**, and the configured **virtual IP address** across all interfaces participating in HSRP.

Explanation of Output Fields:

- **Interface**: The interface on which HSRP is configured (e.g., Gig1/0/1).
- **Grp**: The HSRP group number assigned to that interface.
- **Pri**: The router's configured priority value (higher = more preferred to be active).
- **P**: Indicates that **preemption is enabled**, allowing the router to take over if it has a higher priority.
- **State**: The router's current HSRP state for that group (e.g., Active or Standby).
- **Active**: The IP address of the current **active router** for the group. If listed as "local," this router is the active device.
- **Standby**: The IP address of the current **standby router**. If listed as "local," this router is the standby device.
- **Virtual IP**: The shared virtual IP address used as the **default gateway** by hosts on the subnet.

```
Distribution-DC-1#show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active          Standby         Virtual IP
Gig1/0/1    1    200 P Active   local           10.2.1.2        10.2.1.1
Distribution-DC-1#
```

```
Distribution-DC-2#show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active          Standby         Virtual IP
Gig1/0/1    1    100 P Standby  10.2.1.3        local           10.2.1.1
Distribution-DC-2#
```

Differences in the Output:

Distribution-DC-1

- **State**: Active — This router is currently forwarding traffic for the virtual IP.
- **Active**: local — Confirms this router is the active router.
- **Standby**: 10.2.1.2 — Distribution-DC-2 is in standby.
- **Pri**: 200 — Higher priority.
- **P**: Preempt is enabled, allowing it to reclaim active status if it goes down and comes back.

Distribution-DC-2

- **State**: Standby — This router is on standby, ready to take over.
- **Active**: 10.2.1.3 — Distribution-DC-1 is currently the active router.
- **Standby**: local — Confirms this router is the standby.
- **Pri**: 100 — Lower priority.
- **P**: Preempt is also enabled, though it won't take over unless its priority is increased.

Fail-Over and Access-DC Switch

When the active router in an HSRP group fails, the standby router detects the failure—typically after missing three consecutive hello messages, which by default takes about 10 seconds. Once the standby router transitions to the **active** state, it immediately assumes responsibility for forwarding traffic to and from the **virtual IP address**.

To ensure a seamless transition, the new active router sends out a **gratuitous ARP request**. This is a special type of ARP message in which the router announces its ownership of the **virtual IP address**, even though no one asked for it. The key purpose of this gratuitous ARP is to **update the MAC address table** on any connected switches.

Because the virtual IP address is always associated with a **virtual MAC address** (e.g., 0000.0C07.ACxx for HSRP group xx), the switch needs to know which **port** now leads to the router that owns that virtual MAC. The gratuitous ARP provides this update: when the switch receives the ARP request, it learns the new location of the virtual MAC address and updates its table to map it to the **port connected to the new active router**. This ensures that packets destined for the virtual IP are forwarded to the correct port without delay, enabling fast convergence and minimal disruption to network traffic.