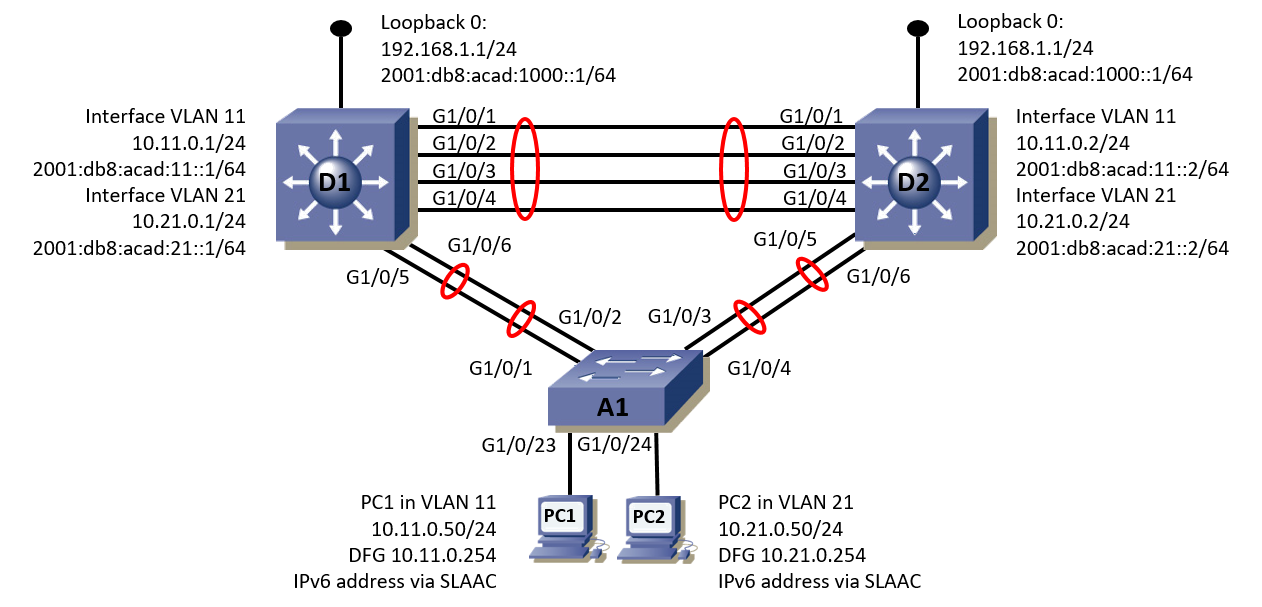
Lab 9.1.1 - Implement HSRP Topology CCRI Lab



# Addressing Table

| Device | Interface | IP Address | Default Gateway |
| --- | --- | --- | --- |
| D1 | Lo 0 | 192.168.1.1/24 | N/A |
| D1 | Lo 0 | 2001:db8:acad:1000::1/64 | N/A |
| D1 | VLAN 11 | 10.11.0.1/24 | N/A |
| D1 | VLAN 11 | 2001:db8:acad:11::1/64 | N/A |
| D1 | VLAN 21 | 10.21.0.1/24 | N/A |
| D1 | VLAN 21 | 2001:db8:acad:21::1/64 | N/A |
| D2 | Lo 0 | 192.168.1.1/24 | N/A |
| D2 | Lo 0 | 2001:db8:acad:1000::1/64 | N/A |
| D2 | VLAN 11 | 10.11.0.2/24 | N/A |
| D2 | VLAN 11 | 2001:db8:acad:11::1/64 | N/A |
| D2 | VLAN 21 | 10.21.0.2/24 | N/A |
| D2 | VLAN 21 | 2001:db8:acad:21::2/64 | N/A |
| PC1 | NIC | 10.11.0.50/24 | 10.11.0.254 |
| PC1 | NIC | IPv6 SLAAC |  |
| PC2 | NIC | 10.21.0.50/24 | 10.21.0.254 |
| PC2 | NIC | IPv6 SLAAC |  |

# Objectives

Part 1: Build the Network and Configure Basic Device Settings and Interface Addressing

Part 2: Configure and Observe HSRP for IPv4 and IPv6

Part 3: Configure and Observe HSRP Authentication

Part 4: Configure and Observe HSRP Object Tracking

# Background / Scenario

Hot Standby Router Protocol (HSRP) is a Cisco-proprietary redundancy protocol for establishing a fault-tolerant default gateway. It is described in RFC 2281. HSRP provides a transparent failover mechanism to the end stations on the network. This provides users at the access layer with uninterrupted service to the network if the primary gateway becomes inaccessible.

**Note:** This lab is an exercise in deploying and verifying HSRP and does not necessarily reflect networking best practices.

**Note**: The switches used with CCNP hands-on labs are Cisco 3650 with Cisco IOS XE release 16.9.4 (universalk9 image) and Cisco 2960 with IOS release 15.2 (lanbase image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and the output produced might vary from what is shown in the labs.

**Note**: Ensure that the switches have been erased and have no startup configurations. If you are unsure contact your instructor.

**Note**: The default Switch Database Manager (SDM) template on a Catalyst 3650 running IOS XE supports dual-stacked operations and requires no additional configuration for our purposes.

If you are using a device, such as Cisco 2960, running Cisco IOS, check the SDM template with the privileged EXEC command **show sdm prefer**.

S1# **show sdm prefer**

The **default bias** template used by the Switch Database Manager (SDM) does not provide IPv6 address capabilities. Verify that SDM is using either the **dual-ipv4-and-ipv6** template or the **lanbase-routing** template. The new template will be used after reboot even if the configuration is not saved.

Use the following commands to assign the **dual-ipv4-and-ipv6** template as the default SDM template.

S1# **configure terminal**

S1(config)# **sdm prefer dual-ipv4-and-ipv6 default**

S1(config)# **end**

S1# **reload**

# Required Resources

* 2 Switches (Cisco 3650 with Cisco IOS XE release 16.9.4 universal image or comparable)
* 1 Switch (Cisco 2960 with Cisco IOS Release 15.2(2) lanbasek9 image or comparable)
* 1 PC (Choice of operating system with a terminal emulation program installed)
* Console cables to configure the Cisco IOS devices via the console ports
* Ethernet cables as shown in the topology

# Instructions

## Build the Network and Configure Basic Device Settings and Interface Addressing

In Part 1, you will set up the network topology and configure basic settings and interface addressing.

### Cable the network as shown in the topology.

Attach the devices as shown in the topology diagram, and cable as necessary.

### Configure basic settings for each switch.

* + - 1. Console into each switch, enter global configuration mode, and apply the basic settings. A command list for each switch is provided below for initial configurations.

Open configuration window

Switch D1

hostname D1

ip routing

ipv6 unicast-routing

no ip domain lookup

banner motd # D1, Implement HSRP #

line con 0

exec-timeout 0 0

logging synchronous

exit

line vty 0 4

privilege level 15

password cisco123

exec-timeout 0 0

logging synchronous

login

exit

interface range g1/0/1-24, g1/1/1-4, g0/0

shutdown

exit

interface range g1/0/1-6

switchport mode trunk

no shutdown

exit

interface range g1/0/1-4

channel-group 12 mode active

exit

interface range g1/0/5-6

channel-group 1 mode active

exit

vlan 11

name FIRST\_VLAN

exit

vlan 21

name SECOND\_VLAN

exit

interface vlan 11

ip address 10.11.0.1 255.255.255.0

ipv6 address fe80::d1:1 link-local

ipv6 address 2001:db8:acad:11::1/64

no shutdown

exit

interface vlan 21

ip address 10.21.0.1 255.255.255.0

ipv6 address fe80::d1:2 link-local

ipv6 address 2001:db8:acad:21::1/64

no shutdown

exit

interface loopback 0

ip address 192.168.1.1 255.255.255.0

ipv6 address fe80::d1:3 link-local

ipv6 address 2001:db8:acad:1000::1/64

no shutdown

exit

Switch D2

hostname D2

ip routing

ipv6 unicast-routing

no ip domain lookup

banner motd # D2, Implement HSRP #

line con 0

exec-timeout 0 0

logging synchronous

exit

line vty 0 4

privilege level 15

password cisco123

exec-timeout 0 0

logging synchronous

login

exit

interface range g1/0/1-24, g1/1/1-4, g0/0

shutdown

exit

interface range g1/0/1-6

switchport mode trunk

no shutdown

exit

interface range g1/0/1-4

channel-group 12 mode active

exit

interface range g1/0/5-6

channel-group 2 mode active

exit

vlan 11

name FIRST\_VLAN

exit

vlan 21

name SECOND\_VLAN

exit

interface vlan 11

ip address 10.11.0.2 255.255.255.0

ipv6 address fe80::d2:1 link-local

ipv6 address 2001:db8:acad:11::2/64

no shutdown

exit

interface vlan 21

ip address 10.21.0.2 255.255.255.0

ipv6 address fe80::d2:2 link-local

ipv6 address 2001:db8:acad:21::2/64

no shutdown

exit

interface loopback 0

ip address 192.168.1.1 255.255.255.0

ipv6 address fe80::d2:3 link-local

ipv6 address 2001:db8:acad:1000::1/64

no shutdown

exit

Switch A1

hostname A1

banner motd # A1, Implement HSRP #

line con 0

exec-timeout 0 0

logging synchronous

exit

line vty 0 4

privilege level 15

password cisco123

exec-timeout 0 0

logging synchronous

login

exit

interface range g1/0/1-24, g1/1/1-4

shutdown

exit

interface range g1/0/1-4

switchport mode trunk

no shutdown

exit

interface range g1/0/1-2

channel-group 1 mode active

exit

interface range g1/0/3-4

channel-group 2 mode active

exit

vlan 11

name FIRST\_VLAN

exit

vlan 21

name SECOND\_VLAN

exit

interface g1/0/23

switchport mode access

switchport access vlan 11

spanning-tree portfast

no shutdown

exit

interface g1/0/24

switchport mode access

switchport access vlan 21

spanning-tree portfast

no shutdown

exit

interface vlan 11

ip address 10.11.0.3 255.255.255.0

ipv6 address fe80::a1:1 link-local

ipv6 address 2001:db8:acad:11::3/64

no shutdown

exit

ip default-gateway 10.11.0.254

* + - 1. Set the clock on each switch to UTC time.
      2. Close configuration window

### Configure the PCs for network connectivity.

Configure PC1 and PC2 with the IPv4 address, subnet mask, and default gateway specified in the topology diagram. The IPv6 address and default gateway information for each PC will come from SLAAC.

## Configure and Observe HSRP for IPv4 and IPv6.

In Part 2, you will configure and test HSRPv2 in support of IPv4 and IPv6.

HSRP provides redundancy in the network. The traffic can be load-balanced by using the **standby** *group* **priority** *priority* command.

IP routing is enabled on D1 and D2. Each route processor can route between the SVIs configured on its switch. In addition to the real IP address assigned to each switch SVI, assign a third IP address in each subnet to be used as a virtual gateway address. HSRP negotiates and determines which switch accepts information forwarded to the virtual gateway IP address.

The **standby** command configures the IP address of the virtual gateway, sets the priority for each group, and configures the router for preemption. Preemption allows the router with the higher priority to become the active router after a network failure has been resolved. Notice that the abbreviation HSRP is not used in the command syntax to implement HSRP. HSRP version 2 must be implemented to support IPv6. This is accomplished by using the **standby version 2** command on every interface required.

The **standby x ipv6 autoconfig** command, where x is the assigned HSRP group number, is used to assign the group an automatically generated virtual ipv6 address. Note that the group number used for IPv6 on an interface must be different than the group used for IPv4.

In this lab, the group numbers will be 11 and 21 for IPv4, and 116 and 216 for IPv6.

In the following configurations, the priority for VLAN 11 on D1 is set to 150, making it the active router for VLAN 11. VLAN 21 has the default priority of 100 on D1, making D1 the standby router for VLAN 21. D2 is configured to be the active router for VLAN 21 with a priority of 150, and the standby router for VLAN 11 with a default priority of 100.

**Note**: It is recommended that the HSRP group number be mapped to VLAN number.

### Configure HSRPv2 on Switch D1.

* + - 1. Configure standby group 11 on interface VLAN 11 for HSRP version 2, a standby IP address of 10.11.0.254, a priority of 150, and preemption.

Open configuration window

D1(config)# **interface vlan 11**

D1(config-if)# **standby version 2**

D1(config-if)# **standby 11 ip 10.11.0.254**

D1(config-if)# **standby 11 priority 150**

D1(config-if)# **standby 11 preempt**

* + - 1. Configure standby group 116 on interface vlan 11 for ipv6 autoconfig command, a priority of 150, and preemption.

D1(config-if)# **standby 116 ipv6 autoconfig**

D1(config-if)# **standby 116 priority 150**

D1(config-if)# **standby 116 preempt**

* + - 1. Configure standby group 21 on interface VLAN 21 for HSRP version 2, a standby IP address of 10.21.0.254, and preemption.

D1(config)# **interface vlan 21**

D1(config-if)# **standby version 2**

D1(config-if)# **standby 21 ip 10.21.0.254**

D1(config-if)# **standby 21 preempt**

* + - 1. Configure standby group 216 on interface vlan 21 for ipv6 autoconfig command and preemption.

D1(config-if)# **standby 216 ipv6 autoconfig**

D1(config-if)# **standby 216 preempt**

### Verify HSRPv2 is operational on Switch D1.

* + - 1. Verify that HSRP is active and operating on Switch D1 with the **show standby brief** command.

D1# **show standby brief**

P indicates configured to preempt.

|

Interface Grp Pri P State Active Standby Virtual IP

Vl11 11 150 P Active local unknown 10.11.0.254

Vl11 116 150 P Active local unknown FE80::5:73FF:FEA0:74

Vl21 21 100 P Active local unknown 10.21.0.254

Vl21 216 100 P Active local unknown FE80::5:73FF:FEA0:D8

Close configuration window

* + - 1. Interface Loopback0 on D1 and D2 represent a destination on the internet. From PC1 and PC2, ping the IPv4 and IPv6 address of interface Loopack0 on D1. A successful ping verifies that the gateway router is working.

### Configure HSRPv2 on Switch D2.

* + - 1. Configure standby group 11 on interface VLAN 11 for HSRP version 2, a standby IP address of 10.11.0.254, and preemption.

Open configuration window

D2(config)# **interface vlan 11**

D2(config-if)# **standby version 2**

D2(config-if)# **standby 11 ip 10.11.0.254**

D2(config-if)# **standby 11 preempt**

* + - 1. Configure standby group 116 on interface vlan 11 for ipv6 autoconfig command, and preemption.

D2(config-if)# **standby 116 ipv6 autoconfig**

D2(config-if)# **standby 116 preempt**

* + - 1. Configure standby group 21 on interface VLAN 21 for HSRP version 2, a standby IP address of 10.21.0.254, a priority of 150, and preemption.

D2(config)# **interface vlan 21**

D2(config-if)# **standby version 2**

D2(config-if)# **standby 21 ip 10.21.0.254**

D2(config-if)# **standby 21 priority 150**

D2(config-if)# **standby 21 preempt**

* + - 1. Configure standby group 216 on interface vlan 21 for ipv6 autoconfig command, a priority of 150, and preemption.

D2(config-if)# **standby 216 ipv6 autoconfig**

D2(config-if)# **standby 216 priority 150**

D2(config-if)# **standby 216 preempt**

### Verify HSRPv2 is operational on Switch D2.

* + - 1. Verify that HSRP is active and operating on Switch D2 with the **show standby brief** command. Based on the configuration, D2 should be the active switch for VLAN 21 only.

D2# **show standby brief**

P indicates configured to preempt.

|

Interface Grp Pri P State Active Standby Virtual IP

Vl11 11 100 P Standby 10.11.0.1 local 10.11.0.254

Vl11 116 100 P Standby FE80::D1:1 local FE80::5:73FF:FEA0:74

Vl21 21 150 P Active local 10.21.0.1 10.21.0.254

Vl21 216 150 P Active local FE80::D1:2 FE80::5:73FF:FEA0:D8

Close configuration window

* + - 1. Interface Loopback0 on D1 and D2 represent a destination on the internet. From PC1 and PC2, ping the IPv4 and IPv6 address of interface Loopack0 on D1. A successful ping verifies that the gateway router is working.

### Observe and validate HSRPv2 operation.

The whole point of HSRP is to help maintain gateway reachability in case of an outage. In this step, we will simulate an outage to show how HSRP achieves this objective.

* + - 1. On PC1, start a continuous ping to 192.168.1.1 and 2001:db8:acad:1000::1.
      2. On Switch D1, issue the **shutdown** command on interface VLAN 11. Note that D2 takes over the active role, and there is very little traffic loss in the running pings.
      3. On Switch D1, issue the **no shutdown** command on interface VLAN 11. Note that D1 takes back over as the active router, and once again there is very little traffic loss experienced.
      4. Stop the continuous ping running on PC1.

### Tune HSRPv2 operation.

We have validated the operation of HSRP for both IPv4 and IPv6, and our gateways are now redundant. But in some cases, the default amount of time taken to detect and react to an outage is too slow. By default, HSRP uses a 3-second hello timer and a 10-second hold timer. If 10 seconds is too slow for your organization or traffic scenario, you can tune the HSRP timers to speed things up. This should only be done on a stable network, and this will cause more HSRP traffic to be sent between the configured switches, so you should take those factors into account before changing the timers on a production network.

* + - 1. On both switches, issue the **shutdown** command on interface VLAN 11 and VLAN 21.
      2. On both switches, configure the timers for standby group 11 and standby group 21 so that the hello time is 250 milliseconds and the hold time is 750 milliseconds.

Open configuration window

D1(config)# **interface vlan 11**

D1(config-if)# **standby 11 timers msec 250 msec 750**

D1(config-if)# **exit**

D1(config)# **interface vlan 21**

D1(config-if)# **standby 21 timers msec 250 msec 750**

D1(config-if)# **exit**

* + - 1. On both switches, issue the **no** **shutdown** command on interface VLAN 11 and VLAN 21 and let HSRP initialize. Verify that it is operating as designed by issuing the **show standby brief** command on switch D1. You should see D1 as active for VLAN 11 and standby for VLAN 21.
      2. On PC1, start a continuous ping to 192.168.1.1 and 2001:db8:acad:1000::1
      3. On Switch D1, issue the **shutdown** command on interface VLAN 11. Note that that D2 takes over the active role almost immediately, and there is almost no traffic loss in the running pings.
      4. On Switch D1, issue the **no shutdown** command on interface VLAN 11. Note that D1 takes back over as the active router, and once again there is almost no traffic loss experienced.
      5. Stop the continuous ping running on PC1.

Close configuration window

## Configure and Observe HSRP Authentication

In this part of the lab, you will secure the HSRP communication between member devices. HSRP authentication prevents rogue routers on the network from joining the HSRP group. Without authentication, a rogue router could join the group and claim the active role. The attacker would then be able to capture all the traffic forwarded to attacker’s device. HSRP authentication can be configured using plaintext, an MD5-hashed key-string, or an MD5-hashed key chain. Using key chains offers more options and security because you can have lifetime parameters associated with the different keys. For simplicity, we will configure HSRP authentication using the key string option.

* + - 1. On D1, configure authentication for group 11 and group 21 using the key-string **Super53cret**.

Open configuration window

D1(config)# **interface vlan 11**

D1(config-if)# **standby 11 authentication md5 key-string Super53cret**

D1(config-if)# **exit**

D1(config)# **interface vlan 21**

D1(config-if)# **standby 21 authentication md5 key-string Super53cret**

D1(config-if)# **exit**

D1(config)# **end**

* + - 1. Notice as soon as this command was entered on D1 that we received a “bad authentication” message display to the console screen. HSRP authentication is not yet configured on D2 therefore we expect for the HSRP process to be disrupted. The output of the **show standby brief** command below confirms that D2 is no longer the standby router for group 11. The standby router shows *unknown*.

\*Jan 19 01:10:13.167: %HSRP-4-BADAUTH2: Bad authentication from 10.11.0.2

D1# **show standby brief**

P indicates configured to preempt.

|

Interface Grp Pri P State Active Standby Virtual IP

Vl11 11 150 P Active local unknown 10.11.0.254

Vl11 116 150 P Active local FE80::D2:1 FE80::5:73FF:FEA0:74

Vl21 21 100 P Active local unknown 10.21.0.254

Vl21 216 100 P Standby FE80::D2:2 local FE80::5:73FF:FEA0:D8

* + - 1. On D2, configure authentication for group 11 and group 21 using the key-string **Super53cret**.

D2(config)# **interface vlan 11**

D2(config-if)# **standby 11 authentication md5 key-string Super53cret**

D2(config-if)# **exit**

D2(config)# **interface vlan 21**

D2(config-if)# **standby 21 authentication md5 key-string Super53cret**

D2(config-if)# **exit**

D2(config)# **end**

* + - 1. As soon as the key string was entered, HSRP started working again. Verify this by examining the output of **show standby brief** on D1 and you will see that D2 is now listed as the standby router for group 11.

D1# **show standby brief**

P indicates configured to preempt.

|

Interface Grp Pri P State Active Standby Virtual IP

Vl11 11 150 P Active local 10.11.0.2 10.11.0.254

Vl11 116 150 P Active local FE80::D2:1 FE80::5:73FF:FEA0:74

Vl21 21 100 P Standby 10.21.0.2 local 10.21.0.254

Vl21 216 100 P Standby FE80::D2:2 local FE80::5:73FF:FEA0:D8

Close configuration window

## Configure and Observe HSRP Object Tracking

HSRP can perform object and interface tracking. Either of these tracking methods enables the priority of a standby group router to be automatically adjusted, based on the status of the tracked entity. When a tracked entity becomes unavailable, the HSRP priority of the router is decreased. With preemption configured on the HSRP group, this might cause another router to take over as the active router for a group based on its higher priority value. When properly configured, the HSRP tracking feature ensures that a router with an unavailable key interface will relinquish the active router role.

### Create a tracked object.

Create an object on Switch D1 and D2 that tracks the line-protocol of interface Loopback 0.

Open configuration window

D1(config)# **track 4 interface loopback 0 line-protocol**

D1(config-track)# **exit**

D2(config)# **track 4 interface loopback 0 line-protocol**

D2(config-track)# **exit**

### Configure HSRP to track the object status.

On D1, configure standby groups 11 and 116 to track the status of track 4. On D2, configure standby groups 21 and 216 to track the status of track 4. When the tracked object has failed, decrement the system priority by 60.

D1(config)# **interface vlan 11**

D1(config-if)# **standby 11 track 4 decrement 60**

D1(config-if)# **standby 116 track 4 decrement 60**

D1(config-if)# **exit**

D2(config)# **interface vlan 21**

D2(config-if)# **standby 21 track 4 decrement 60**

D2(config-if)# **standby 216 track 4 decrement 60**

D2(config-if)# **exit**

### Verify the HSRP configuration.

Issue the command **show standby** on Switch D1. This is the full version of the command, and in the output, you can see all the adjustments that have been made to this point.

D1# **show standby**

Vlan11 - Group 11 (version 2)

State is Active

5 state changes, last state change 00:07:30

Virtual IP address is 10.11.0.254

Active virtual MAC address is 0000.0c9f.f00b (MAC In Use)

Local virtual MAC address is 0000.0c9f.f00b (v2 default)

Hello time 250 msec, hold time 750 msec

Next hello sent in 0.240 secs

Authentication MD5, key-string

Preemption enabled

Active router is local

Standby router is 10.11.0.2, priority 100 (expires in 0.816 sec)

Priority 150 (configured 150)

Track object 4 state Up decrement 60

Group name is "hsrp-Vl11-11" (default)

Vlan11 - Group 116 (version 2)

State is Active

1 state change, last state change 00:04:53

Link-Local Virtual IPv6 address is FE80::5:73FF:FEA0:74 (conf auto EUI64)

Active virtual MAC address is 0005.73a0.0074 (MAC In Use)

Local virtual MAC address is 0005.73a0.0074 (v2 IPv6 default)

Hello time 3 sec, hold time 10 sec

Next hello sent in 1.216 secs

Preemption enabled

Active router is local

Standby router is FE80::D2:1, priority 100 (expires in 11.024 sec)

Priority 150 (configured 150)

Track object 4 state Up decrement 60

Group name is "hsrp-Vl11-116" (default)

<output omitted>

### Verify HSRP complies with the configuration.

* + - 1. On D1, shut down interface Loopback 1. Switch D2 should take over as active for group 11. Verify D1’s current priority value and D2’s status with the **show standby brief** command.

D1(config)# **interface loopback 0**

D1(config-if)# **shutdown**

D1(config-if)#

\*Jan 19 16:10:52.041: %TRACK-6-STATE: 4 interface Lo0 line-protocol Up -> Down

D1(config-if)#

\*Jan 19 16:10:52.168: %HSRP-5-STATECHANGE: Vlan11 Grp 11 state Active -> Speak

\*Jan 19 16:10:53.035: %HSRP-5-STATECHANGE: Vlan11 Grp 11 state Speak -> Standby

D1(config-if)#

\*Jan 19 16:10:53.037: %HSRP-5-STATECHANGE: Vlan11 Grp 116 state Active -> Speak

D1(config-if)#

\*Jan 19 16:10:54.040: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to down

D1(config-if)#

\*Jan 19 16:10:54.041: %LINK-5-CHANGED: Interface Loopback0, changed state to administratively down

\*Jan 19 16:10:59.047: %HSRP-5-STATECHANGE: Vlan11 Grp 116 state Speak -> Standby

D1(config-if)# **end**

D1#

D1# **show standby brief**

P indicates configured to preempt.

|

Interface Grp Pri P State Active Standby Virtual IP

Vl11 11 90 P Standby 10.11.0.2 local 10.11.0.254

Vl11 116 90 P Standby FE80::D2:1 local FE80::5:73FF:FEA0:74

Vl21 21 100 P Standby 10.21.0.2 local 10.21.0.254

Vl21 216 100 P Standby FE80::D2:2 local FE80::5:73FF:FEA0:D8

* + - 1. Examine the priority information in detail in the output of the **show standby** command.

D1# **show standby**

Vlan11 - Group 11 (version 2)

State is Standby

<output omitted>

Active router is 10.11.0.2, priority 100 (expires in 0.720 sec)

MAC address is 7069.5a9f.5654

Standby router is local

Priority 90 (configured 150)

Track object 4 state Down decrement 60

Group name is "hsrp-Vl11-11" (default)

Close configuration window

End of document