Chapter 2 — Static Routing

2.0.1.2 Class Activity – Which Way Should We Go?

Objectives

Explain the benefits of using static routes.

Scenario

A huge sporting event is about to take place in your city. To attend the event, you make concise plans to arrive at the sports arena on time to see the entire game.

There are two routes you can take to drive to the event:

- Highway route - It is easy to follow and fast driving speeds are allowed.
- Alternative, direct route - You found this route using a city map. Depending on conditions, such as the amount of traffic or congestion, this just may be the way to get to the arena on time!

With a partner, discuss these options. Choose a preferred route to arrive at the arena in time to see every second of the huge sporting event.

Compare your optional preferences to network traffic, which route would you choose to deliver data communications for your small- to medium-sized business? Would it be the fastest, easiest route or the alternative, direct route? Justify your choice.

Complete the modeling activity .pdf and be prepared to justify your answers to the class or with another group.

Required Resources

None

Reflection

1. Which route did you choose as your first preference? On what criteria did you base your decision?

2. If traffic congestion were to occur on either route, would this change the path you would take to the arena? Explain your answer.

3. A popular phrase that can be argued is “the shortest distance between two points is a straight line.” Is this always true with delivery of network data? How do you compare your answer to this modeling activity scenario?
2.2.2.5 Lab – Configuring IPv4 Static and Default Routes

Topology

Addressing Table

<table>
<thead>
<tr>
<th>Device</th>
<th>Interface</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Default Gateway</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>G0/1</td>
<td>192.168.0.1</td>
<td>255.255.255.0</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/1</td>
<td>10.1.1.1</td>
<td>255.255.255.252</td>
<td>N/A</td>
</tr>
<tr>
<td>R3</td>
<td>G0/1</td>
<td>192.168.1.1</td>
<td>255.255.255.0</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0 (DCE)</td>
<td>10.1.1.2</td>
<td>255.255.255.252</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Lo0</td>
<td>209.165.200.225</td>
<td>255.255.255.224</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Lo1</td>
<td>198.133.219.1</td>
<td>255.255.255.0</td>
<td>N/A</td>
</tr>
<tr>
<td>PC-A</td>
<td>NIC</td>
<td>192.168.0.10</td>
<td>255.255.255.0</td>
<td>192.168.0.1</td>
</tr>
<tr>
<td>PC-C</td>
<td>NIC</td>
<td>192.168.1.10</td>
<td>255.255.255.0</td>
<td>192.168.1.1</td>
</tr>
</tbody>
</table>

Objectives

Part 1: Set Up the Topology and Initialize Devices

Part 2: Configure Basic Device Settings and Verify Connectivity
Part 3: Configure Static Routes

- Configure a recursive static route.
- Configure a directly connected static route.
- Configure and remove static routes.

Part 4: Configure and Verify a Default Route

Background / Scenario

A router uses a routing table to determine where to send packets. The routing table contains a set of routes that describe which gateway or interface the router uses to reach a specified network. Initially, the routing table contains only directly connected networks. To communicate with distant networks, routes must be specified and added to the routing table.

In this lab, you will manually configure a static route to a specified distant network based on a next-hop IP address or exit interface. You will also configure a static default route. A default route is a type of static route that specifies a gateway to use when the routing table does not contain a path for the destination network.

Note: This lab provides minimal assistance with the actual commands necessary to configure static routing. However, the required commands are provided in Appendix A. Test your knowledge by trying to configure the devices without referring to the appendix.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). The switches used are Cisco Catalyst 2960s with Cisco IOS Release 15.0(2) (lanbasek9 image). Other routers, switches, and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

Note: Make sure that the routers and switches have been erased and have no startup configurations. If you are unsure, contact your instructor.

Required Resources

- 2 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 2 Switches (Cisco 2960 with Cisco IOS Release 15.0(2) lanbasek9 image or comparable)
- 2 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet and serial cables as shown in the topology

Part 1: Set Up the Topology and Initialize Devices

Step 1: Cable the network as shown in the topology.

Step 2: Initialize and reload the router and switch.

Part 2: Configure Basic Device Settings and Verify Connectivity

In Part 2, you will configure basic settings, such as the interface IP addresses, device access, and passwords. You will verify LAN connectivity and identify routes listed in the routing tables for R1 and R3.
Step 1: Configure the PC interfaces.

Step 2: Configure basic settings on the routers.
   a. Configure device names, as shown in the Topology and Addressing Table.
   b. Disable DNS lookup.
   c. Assign `class` as the enable password and assign `cisco` as the console and vty password.
   d. Save the running configuration to the startup configuration file.

Step 3: Configure IP settings on the routers.
   a. Configure the R1 and R3 interfaces with IP addresses according to the Addressing Table.
   b. The S0/0/0 connection is the DCE connection and requires the `clock rate` command. The R3 S0/0/0 configuration is displayed below.

   ```
   R3(config)# interface s0/0/0
   R3(config-if)# ip address 10.1.1.2 255.255.255.252
   R3(config-if)# clock rate 128000
   R3(config-if)# no shutdown
   ```

Step 4: Verify connectivity of the LANs.
   a. Test connectivity by pinging from each PC to the default gateway that has been configured for that host.

   From PC-A, is it possible to ping the default gateway? __________
   From PC-C, is it possible to ping the default gateway? __________

   b. Test connectivity by pinging between the directly connected routers.

   From R1, is it possible to ping the S0/0/0 interface of R3? __________
   If the answer is no to any of these questions, troubleshoot the configurations and correct the error.

c. Test connectivity between devices that are not directly connected.

   From PC-A, is it possible to ping PC-C? __________
   From PC-A, is it possible to ping Lo0? __________
   From PC-A, is it possible to ping Lo1? __________

   Were these pings successful? Why or why not?

---

Note: It may be necessary to disable the PC firewall to ping between PCs.
Step 5: **Gather information.**

a. Check the status of the interfaces on R1 with the **show ip interface brief** command.

   How many interfaces are activated on R1? ________

b. Check the status of the interfaces on R3.

   How many interfaces are activated on R3? ________

c. View the routing table information for R1 using the **show ip route** command.

   What networks are present in the Addressing Table of this lab, but not in the routing table for R1?

   __________________________

d. View the routing table information for R3.
What networks are present in the Addressing Table in this lab, but not in the routing table for R3?

Why are all the networks not in the routing tables for each of the routers?

Part 3: **Configure Static Routes**

In Part 3, you will employ multiple ways to implement static and default routes, you will confirm that the routes have been added to the routing tables of R1 and R3, and you will verify connectivity based on the introduced routes.

**Note:** This lab provides minimal assistance with the actual commands necessary to configure static routing. However, the required commands are provided in Appendix A. Test your knowledge by trying to configure the devices without referring to the appendix.

**Step 1:** **Configure a recursive static route.**

With a recursive static route, the next-hop IP address is specified. Because only the next-hop IP is specified, the router must perform multiple lookups in the routing table before forwarding packets. To configure recursive static routes, use the following syntax:

```
Router(config)# ip route network-address subnet-mask ip-address
```

a. On the R1 router, configure a static route to the 192.168.1.0 network using the IP address of the Serial 0/0/0 interface of R3 as the next-hop address. Write the command you used in the space provided.

b. View the routing table to verify the new static route entry.
How is this new route listed in the routing table?

From host PC-A, is it possible to ping the host PC-C? No

These pings should fail. If the recursive static route is correctly configured, the ping arrives at PC-C. PC-C sends a ping reply back to PC-A. However, the ping reply is discarded at R3 because R3 does not have a return route to the 192.168.0.0 network in the routing table.

Step 2: **Configure a directly connected static route.**

With a directly connected static route, the `exit-interface` parameter is specified, which allows the router to resolve a forwarding decision in one lookup. A directly connected static route is typically used with a point-to-point serial interface. To configure directly connected static routes with an exit interface specified, use the following syntax:

```
Router(config)# ip route network-address subnet-mask exit-intf
```

a. On the R3 router, configure a static route to the 192.168.0.0 network using S0/0/0 as the exit interface. Write the command you used in the space provided.

b. View the routing table to verify the new static route entry.
How is this new route listed in the routing table?

---

c. From host PC-A, is it possible to ping the host PC-C? 

This ping should be successful.

Note: It may be necessary to disable the PC firewall to ping between PCs.

Step 3:  **Configure a static route.**

a. On the R1 router, configure a static route to the 198.133.219.0 network using one of the static route configuration options from the previous steps. Write the command you used in the space provided.

---

b. On the R1 router, configure a static route to the 209.165.200.224 network on R3 using the other static route configuration option from the previous steps. Write the command you used in the space provided.

---

c. View the routing table to verify the new static route entry.
How is this new route listed in the routing table?

_________________________________________________________________________________

d. From host PC-A, is it possible to ping the R1 address 198.133.219.1? __________

This ping should be successful.

Step 4: **Remove static routes for loopback addresses.**

a. On R1, use the **no** command to remove the static routes for the two loopback addresses from the routing table. Write the commands you used in the space provided.

_________________________________________________________________________________

b. View the routing table to verify the routes have been removed.

How many network routes are listed in the routing table on R1? __________

Is the Gateway of last resort set? __________
Part 4: Configure and Verify a Default Route

In Part 4, you will implement a default route, confirm that the route has been added to the routing table, and verify connectivity based on the introduced route.

A default route identifies the gateway to which the router sends all IP packets for which it does not have a learned or static route. A default static route is a static route with 0.0.0.0 as the destination IP address and subnet mask. This is commonly referred to as a "quad zero" route.

In a default route, either the next-hop IP address or exit interface can be specified. To configure a default static route, use the following syntax:

```
Router(config)# ip route 0.0.0.0 0.0.0.0 [ip-address or exit-intf]
```

a. Configure the R1 router with a default route using the exit interface of S0/0/1. Write the command you used in the space provided.

How is this new route listed in the routing table?

What is the Gateway of last resort?

c. From host PC-A, is it possible to ping the 209.165.200.225? 

d. From host PC-A, is it possible to ping the 198.133.219.1? 

These pings should be successful.
Reflection

1. A new network 192.168.3.0/24 is connected to interface G0/0 on R1. What commands could be used to configure a static route to that network from R3?

2. Is there a benefit to configuring a directly connected static route instead of a recursive static route?

3. Why is it important to configure a default route on a router?

Router Interface Summary Table

<table>
<thead>
<tr>
<th>Router Model</th>
<th>Ethernet Interface #1</th>
<th>Ethernet Interface #2</th>
<th>Serial Interface #1</th>
<th>Serial Interface #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
<tr>
<td>1900</td>
<td>Gigabit Ethernet 0/0 (G0/0)</td>
<td>Gigabit Ethernet 0/1 (G0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
<tr>
<td>2801</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/1/0 (S0/1/0)</td>
<td>Serial 0/1/1 (S0/1/1)</td>
</tr>
<tr>
<td>2811</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
<tr>
<td>2900</td>
<td>Gigabit Ethernet 0/0 (G0/0)</td>
<td>Gigabit Ethernet 0/1 (G0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
</tbody>
</table>

Note: To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.
Appendix A: Configuration Commands for Parts 2, 3, and 4

The commands listed in Appendix A are for reference only. This Appendix does not include all the specific commands necessary to complete this lab.

Basic Device Settings

Configure IP settings on the router.

R3(config)# interface s0/0/0
R3(config-if)# ip address 10.1.1.2 255.255.255.252
R3(config-if)# clock rate 128000
R3(config-if)# no shutdown

Static Route Configurations

Configure a recursive static route.

R1(config)# ip route 192.168.1.0 255.255.255.0 10.1.1.2

Configure a directly connected static route.

R3(config)# ip route 192.168.0.0 255.255.255.0 s0/0/0

Remove static routes.

R1(config)# no ip route 209.165.200.224 255.255.255.224 serial0/0/1

or

R1(config)# no ip route 209.165.200.224 255.255.255.224 10.1.1.2

or

R1(config)# no ip route 209.165.200.224 255.255.255.224

Default Route Configuration

R1(config)# ip route 0.0.0.0 0.0.0.0 s0/0/1
2.2.4.5 Lab – Configuring IPv6 Static and Default Routes

Topology

Addressing Table

<table>
<thead>
<tr>
<th>Device</th>
<th>Interface</th>
<th>IPv6 Address / Prefix Length</th>
<th>Default Gateway</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>G0/1</td>
<td>2001:DB8:ACAD:A::/64 eui-64</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/1</td>
<td>FC00::1/64</td>
<td>N/A</td>
</tr>
<tr>
<td>R3</td>
<td>G0/1</td>
<td>2001:DB8:ACAD:B::/64 eui-64</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0</td>
<td>FC00::2/64</td>
<td>N/A</td>
</tr>
<tr>
<td>PC-A</td>
<td>NIC</td>
<td>SLAAC</td>
<td>SLAAC</td>
</tr>
<tr>
<td>PC-C</td>
<td>NIC</td>
<td>SLAAC</td>
<td>SLAAC</td>
</tr>
</tbody>
</table>

Objectives

Part 1: Build the Network and Configure Basic Device Settings

- Enable IPv6 unicast routing and configure IPv6 addressing on the routers.
- Disable IPv4 addressing and enable IPv6 SLAAC for the PC network interfaces.
- Use `ipconfig` and `ping` to verify LAN connectivity.
- Use `show` commands to verify IPv6 settings.

Part 2: Configure IPv6 Static and Default Routes

- Configure a directly attached IPv6 static route.
- Configure a recursive IPv6 static route.
- Configure a default IPv6 static route.
Background / Scenario

In this lab, you will configure the entire network to communicate using only IPv6 addressing, including configuring the routers and PCs. You will use stateless address auto-configuration (SLAAC) for configuring the IPv6 addresses for the hosts. You will also configure IPv6 static and default routes on the routers to enable communication to remote networks that are not directly connected.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). The switches used are Cisco Catalyst 2960s with Cisco IOS Release 15.0(2) (lanbasek9 image). Other routers, switches, and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

Note: Make sure that the routers and switches have been erased and have no startup configurations. If you are unsure, contact your instructor.

Required Resources

- 2 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 2 Switches (Cisco 2960 with Cisco IOS Release 15.0(2) lanbasek9 image or comparable)
- 2 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet and serial cables as shown in the topology

Part 1: Build the Network and Configure Basic Device Settings

In Part 1, you will cable and configure the network to communicate using IPv6 addressing.

Step 1: Cable the network as shown in the topology diagram.

Step 2: Initialize and reload the routers and switches.

Step 3: Enable IPv6 unicast routing and configure IPv6 addressing on the routers.

a. Using Tera Term, console into the router labeled R1 in the topology diagram and assign the router the name R1.

b. Within global configuration mode, enable IPv6 routing on R1.

   R1(config)# ipv6 unicast-routing

   c. Configure the network interfaces on R1 with IPv6 addresses. Notice that IPv6 is enabled on each interface. The G0/1 interface has a globally routable unicast address and EUI-64 is used to create the interface identifier portion of the address. The S0/0/1 interface has a privately routable, unique-local address, which is recommended for point-to-point serial connections.

   R1(config)# interface g0/1

   R1(config-if)# ipv6 address 2001:DB8:ACAD::/64 eui-64

   R1(config-if)# no shutdown

   R1(config-if)# interface serial 0/0/1

   R1(config-if)# ipv6 address FC00:1/64

   R1(config-if)# no shutdown

   R1(config-if)# exit
d. Assign a device name to router R3.

e. Within global configuration mode, enable IPv6 routing on R3.

   R3(config)# ipv6 unicast-routing

f. Configure the network interfaces on R3 with IPv6 addresses. Notice that IPv6 is enabled on each interface. The G0/1 interface has a globally routable unicast address and EUI-64 is used to create the interface identifier portion of the address. The S0/0/0 interface has a privately routable, unique-local address, which is recommended for point-to-point serial connections. The clock rate is set because it is the DCE end of the serial cable.

   R3(config)# interface gigabit 0/1
   R3(config-if)# ipv6 address 2001:DB8:ACAD:B::/64 eui-64
   R3(config-if)# no shutdown
   R3(config-if)# interface serial 0/0/0
   R3(config-if)# ipv6 address FC00::2/64
   R3(config-if)# clock rate 128000
   R3(config-if)# no shutdown
   R3(config-if)# exit

Step 4: Disable IPv4 addressing and enable IPv6 SLAAC for the PC network interfaces.

a. On both PC-A and PC-C, navigate to the Start menu > Control Panel. Click the Network and Sharing Center link while viewing with icons. In the Network and Sharing Center window, click the Change adapter settings link on the left side of the window to open the Network Connections window.

b. In the Network Connections window, you see the icons for your network interface adapters. Double-click the Local Area Connection icon for the PC network interface that is connected to the switch. Click the Properties to open the Local Area Connection Properties dialogue window.

c. With the Local Area Connection Properties window open, scroll down through the items and uncheck the item Internet Protocol Version 4 (TCP/IPv4) check box to disable the IPv4 protocol on the network interface.

d. With the Local Area Connection Properties window still open, click the Internet Protocol Version 6 (TCP/IPv6) check box, and then click Properties.

e. With the Internet Protocol Version 6 (TCP/IPv6) Properties window open, check to see if the radio buttons for Obtain an IPv6 address automatically and Obtain DNS server address automatically are selected. If not, select them.

f. With the PCs configured to obtain an IPv6 address automatically, they will contact the routers to obtain the network subnet and gateway information, and auto-configure their IPv6 address information. In the next step, you will verify the settings.

Step 5: Use ipconfig and ping to verify LAN connectivity.

a. From PC-A, open a command prompt, type ipconfig /all and press Enter. The output should look similar to that shown below. In the output, you should see that the PC now has an IPv6 global unicast address, a link-local IPv6 address, and a link-local IPv6 default gateway address. You may also see a temporary IPv6 address and under the DNS server addresses, three site-local addresses that start with FEC0. Site-local addresses are private addresses that were meant to be backwards compatible with NAT. However, they are not supported in IPv6 and are replaced by unique-local addresses.
C:\Users\User1> **ipconfig /all**

Windows IP Configuration

<Output omitted>

Ethernet adapter Local Area Connection:

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection-specific DNS Suffix.</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Intel(R) 82577LC Gigabit Network Connection</td>
</tr>
<tr>
<td>Physical Address</td>
<td>1C-Cl-DE-91-C3-5D</td>
</tr>
<tr>
<td>DHCP Enabled</td>
<td>No</td>
</tr>
<tr>
<td>Autoconfiguration Enabled</td>
<td>Yes</td>
</tr>
<tr>
<td>Temporary IPv6 Address</td>
<td>2001:db8:acad:a:bc40:133a:54e7:d497(Preferred)</td>
</tr>
<tr>
<td>Link-local IPv6 Address</td>
<td>fe80::7c0c:7493:218d:2f6c%13(Preferred)</td>
</tr>
<tr>
<td>Default Gateway</td>
<td>fe80::6273:5c00:fe0d:1a61%13</td>
</tr>
<tr>
<td>DNS Servers</td>
<td>fec0::0:0:ffff:1%1</td>
</tr>
<tr>
<td></td>
<td>fec0::0:0:ffff:2%1</td>
</tr>
<tr>
<td></td>
<td>fec0::0:0:ffff:3%1</td>
</tr>
<tr>
<td>NetBIOS over Tcpip</td>
<td>Disabled</td>
</tr>
</tbody>
</table>

Based on your network implementation and the output of the **ipconfig /all** command, did PC-A receive IPv6 addressing information from R1?

b. What is the PC-A global unicast IPv6 address?

c. What is the PC-A link-local IPv6 address?

d. What is the PC-A default gateway IPv6 address?
e. From PC-A, use the **ping -6** command to issue an IPv6 ping to the link-local default gateway address. You should see replies from the R1 router.

   C:\Users\User1> **ping -6 <default-gateway-address>**

Did PC-A receive replies to the ping from PC-A to R1?

f. Repeat Step 5a from PC-C.

   Did PC-C receive IPv6 addressing information from R3?


g. What is the PC-C global unicast IPv6 address?


h. What is the PC-C link-local IPv6 address?


i. What is the PC-C default gateway IPv6 address?


j. From PC-C, use the **ping -6** command to ping the PC-C default gateway.

   Did PC-C receive replies to the pings from PC-C to R3?
k. Attempt an IPv6 **ping -6** from PC-A to the PC-C IPv6 address.

   C:\Users\User1> **ping -6** PC-C-IPv6-address

   Was the ping successful? Why or why not?

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

   **Step 6:** **Use show commands to verify IPv6 settings.**

   a. Check the status of the interfaces on R1 with the **show ipv6 interface brief** command.

   What are the two IPv6 addresses for the G0/1 interface and what kind of IPv6 addresses are they?

   ____________________________________________________________

   What are the two IPv6 addresses for the S0/0/1 interface and what kind of IPv6 addresses are they?

   ____________________________________________________________

   b. To see more detailed information on the IPv6 interfaces, type a **show ipv6 interface** command on R1 and press Enter.
What are the multicast group addresses for the Gigabit Ethernet 0/1 interface?

What are the multicast group addresses for the S0/0/1 interface?

What is an FF02::1 multicast address used for?

What is an FF02::2 multicast address used for?

What kind of multicast addresses are FF02::1:FF00:1 and FF02::1:FF0D:1A60, and what are they used for?

c. View the IPv6 routing table information for R1 using the `show ipv6 route` command. The IPv6 routing table should have two connected routes, one for each interface, and three local routes, one for each interface and one for multicast traffic to a Null0 interface.
Part 2: **Configure IPv6 Static and Default Routes**

In Part 2, you will configure IPv6 static and default routes three different ways. You will confirm that the routes have been added to the routing tables, and you will verify successful connectivity between PC-A and PC-C.

You will configure three types of IPv6 static routes:

- **Directly Connected IPv6 Static Route** – A directly connected static route is created when specifying the outgoing interface.

- **Recursive IPv6 Static Route** – A recursive static route is created when specifying the next-hop IP address. This method requires the router to execute a recursive lookup in the routing table in order to identify the outgoing interface.

- **Default IPv6 Static Route** – Similar to a quad zero IPv4 route, a default IPv6 static route is created by making the destination IPv6 prefix and prefix length all zeros, ::/0.

**Step 1: Configure a directly connected IPv6 static route.**

In a directly connected IPv6 static route, the route entry specifies the router outgoing interface. A directly connected static route is typically used with a point-to-point serial interface. To configure a directly attached IPv6 static route, use the following command format:

```
Router(config)# ipv6 route <ipv6-prefix/prefix-length> <outgoing-interface-type> <outgoing-interface-number>
```

a. On router R1, configure an IPv6 static route to the 2001:DB8:ACAD:B::/64 network on R3, using the R1 outgoing S0/0/1 interface.

```
R1(config)# ipv6 route 2001:DB8:ACAD:B::/64 serial 0/0/1
```

b. View the IPv6 routing table to verify the new static route entry.
What is the code letter and routing table entry for the newly added route in the routing table?

c. Now that the static route has been configured on R1, is it now possible to ping the host PC-C from PC-A?

These pings should fail. If the recursive static route is correctly configured, the ping arrives at PC-C. PC-C sends a ping reply back to PC-A. However, the ping reply is discarded at R3 because R3 does not have a return route to the 2001:DB8:ACAD:A::/64 network in the routing table. To successfully ping across the network, you must also create a static route on R3.

d. On router R3, configure an IPv6 static route to the 2001:DB8:ACAD:A::/64 network, using the R3 outgoing S0/0/0 interface.

R3 (config) # ipv6 route 2001:DB8:ACAD:A::/64 serial 0/0/0

R3 (config) #

e. Now that both routers have static routes, attempt an IPv6 ping -6 from PC-A to the PC-C global unicast IPv6 address.

Was the ping successful? Why?

---

Step 2: **Configure a recursive IPv6 static route.**

In a recursive IPv6 static route, the route entry has the next-hop router IPv6 address. To configure a recursive IPv6 static route, use the following command format:
Router(config)# ipv6 route <ipv6-prefix/prefix-length> <next-hop-ipv6-address>

a. On router R1, delete the directly attached static route and add a recursive static route.

R1(config)# no ipv6 route 2001:DB8:ACAD:B::/64 serial 0/0/1
R1(config)# ipv6 route 2001:DB8:ACAD:B::/64 FC00::2
R1(config)# exit

b. On router R3, delete the directly attached static route and add a recursive static route.

R3(config)# no ipv6 route 2001:DB8:ACAD:A::/64 serial 0/0/0
R3(config)# ipv6 route 2001:DB8:ACAD:A::/64 FC00::1
R3(config)# exit

c. View the IPv6 routing table on R1 to verify the new static route entry.

What is the code letter and routing table entry for the newly added route in the routing table?

--------------------
d. Verify connectivity by issuing a **ping -6** command from PC-A to PC-C.

Was the ping successful? _______________

**Note:** It may be necessary to disable the PC firewall to ping between PCs.

**Step 3:** **Configure a default IPv6 static route.**

In a default static route, the destination IPv6 prefix and prefix length are all zeros.

Router(config)# ipv6 route ::/0 <outgoing-interface-type> <outgoing-interface-number> {and/or} <next-hop-ipv6-address>

a. On router R1, delete the recursive static route and add a default static route.
R1(config)# no ipv6 route 2001:DB8:ACAD:B::/64 FC00::2
R1(config)# ipv6 route ::/0 serial 0/0/1
R1(config)#
b. Delete the recursive static route and add a default static route on R3.

c. View the IPv6 routing table on R1 to verify the new static route entry.

What is the code letter and routing table entry for the newly added default route in the routing table?

d. Verify connectivity by issuing a ping -6 command from PC-A to PC-C.

Was the ping successful? _________________

Note: It may be necessary to disable the PC firewall to ping between PCs.

Reflection

1. This lab focuses on configuring IPv6 static and default routes. Can you think of a situation where you would need to configure both IPv6 and IPv4 static and default routes on a router?

________________________________________________________________________

________________________________________________________________________

2. In practice, configuring an IPv6 static and default route is very similar to configuring an IPv4 static and default route. Aside from the obvious differences between the IPv6 and IPv4 addressing, what are some other differences when configuring and verifying an IPv6 static route as compared to an IPv4 static route?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
# Router Interface Summary Table

<table>
<thead>
<tr>
<th>Router Model</th>
<th>Ethernet Interface #1</th>
<th>Ethernet Interface #2</th>
<th>Serial Interface #1</th>
<th>Serial Interface #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
<tr>
<td>1900</td>
<td>Gigabit Ethernet 0/0 (G0/0)</td>
<td>Gigabit Ethernet 0/1 (G0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
<tr>
<td>2801</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/1/0 (S0/1/0)</td>
<td>Serial 0/1/1 (S0/1/1)</td>
</tr>
<tr>
<td>2811</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
<tr>
<td>2900</td>
<td>Gigabit Ethernet 0/0 (G0/0)</td>
<td>Gigabit Ethernet 0/1 (G0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
</tbody>
</table>

**Note:** To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.
2.3.3.7 Lab – Designing and Implementing IPv4 Addressing with VLSM

Topology

Objectives

Part 1: Examine the Network Requirements
Part 2: Design the VLSM Address Scheme
Part 3: Cable and Configure the IPv4 Network

Background / Scenario

The Variable Length Subnet Mask (VLSM) was designed to help conserve IP addresses. With VLSM, a network is subnetted and then subnetted again. This process can be repeated multiple times to create subnets of various sizes based on the number of hosts required in each subnet. Effective use of VLSM requires address planning.

In this lab, you are given the network address 172.16.128.0/17 to develop an address scheme for the network shown in the Topology diagram. VLSM will be used so that the addressing requirements can be met. After you have designed the VLSM address scheme, you will configure the interfaces on the routers with the appropriate IP address information.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

Note: Make sure that the routers have been erased and have no startup configurations. If you are unsure, contact your instructor.
Required Resources

- 3 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 1 PC (with terminal emulation program, such as Tera Term, to configure routers)
- Console cable to configure the Cisco IOS devices via the console ports
- Ethernet (optional) and serial cables as shown in the topology
- Windows Calculator (optional)

Part 1: Examine the Network Requirements

In Part 1, you will examine the network requirements to develop a VLSM address scheme for the network shown in the Topology diagram using the network address of 172.16.128.0/17.

**Note:** You may use the Windows Calculator application and the www.ipcalc.org IP subnet calculator to help with your calculations.

Step 1: **Determine how many host addresses are available and how many subnets are needed.**

- How many host addresses are available in a /17 network? ________
- What is the total number of host addresses needed in the topology diagram? ________
- How many subnets are needed in the network topology? ________

Step 2: **Determine the largest subnet needed.**

- Subnet description (e.g. BR1 G0/1 LAN or BR1-HQ WAN link) ______________________
- How many IP addresses are needed in the largest subnet? ________
- What is the smallest subnet that supports that many addresses? ________
- How many host addresses does that subnet support? ________
- Can the 172.16.128.0/17 network be subnetted to support this subnet? ______
- What are the two network addresses that would result from this subnetting? ______

Use the first network address for this subnet.

Step 3: **Determine the second largest subnet needed.**

- Subnet description ______________________
- How many IP addresses are needed for the second largest subnet? ______
What is the smallest subnet that supports that many hosts?

How many host addresses does that subnet support?

Can the remaining subnet be subnetted again and still support this subnet?

What are the two network addresses that would result from this subnetting?

Use the first network address for this subnet.

Step 4: **Determine the next largest subnet needed.**

Subnet description

How many IP addresses are needed for the next largest subnet?

What is the smallest subnet that supports that many hosts?

How many host addresses does that subnet support?

Can the remaining subnet be subnetted again and still support this subnet?

What are the two network addresses that would result from this subnetting?

Use the first network address for this subnet.

Step 5: **Determine the next largest subnet needed.**

Subnet description

How many IP addresses are needed for the next largest subnet?

What is the smallest subnet that supports that many hosts?

How many host addresses does that subnet support?

Can the remaining subnet be subnetted again and still support this subnet?
What are the two network addresses that would result from this subnetting?

____________________

____________________

Use the first network address for this subnet.

Step 6:  **Determine the next largest subnet needed.**

Subnet description __________________________

How many IP addresses are needed for the next largest subnet? ______

What is the smallest subnet that supports that many hosts?

____________________

How many host addresses does that subnet support? __________

Can the remaining subnet be subnetted again and still support this subnet? ______

What are the two network addresses that would result from this subnetting?

____________________

____________________

Use the first network address for this subnet.

Step 7:  **Determine the next largest subnet needed.**

Subnet description __________________________

How many IP addresses are needed for the next largest subnet? ______

What is the smallest subnet that supports that many hosts?

____________________

How many host addresses does that subnet support? __________

Can the remaining subnet be subnetted again and still support this subnet? ______

What are the two network addresses that would result from this subnetting?

____________________

____________________

Use the first network address for this subnet.
Step 8: **Determine the subnets needed to support the serial links.**

How many host addresses are needed for each serial subnet link? ______

What is the smallest subnet that supports that many host addresses?

____________________

a. Subnet the remaining subnet and write the network addresses that result from this subnetting below.

____________________

b. Continue subnetting the first subnet of each new subnet until you have four /30 subnets. Write the first three network addresses of these /30 subnets below.

____________________

____________________

____________________

c. Enter the subnet descriptions for these three subnets below.

____________________

____________________

____________________

**Part 2: Design the VLSM Address Scheme**

Step 1: **Calculate the subnet information.**

Use the information that you obtained in Part 1 to fill in the table below.

<table>
<thead>
<tr>
<th>Subnet Description</th>
<th>Number of Hosts Needed</th>
<th>Network Address /CIDR</th>
<th>First Host Address</th>
<th>Broadcast Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ G0/0</td>
<td>16,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HQ G0/1</td>
<td>8,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BR1 G0/1</td>
<td>4,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BR1 G0/0</td>
<td>2,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BR2 G0/1</td>
<td>1,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BR2 G0/0</td>
<td>500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HQ S0/0/0 – BR1 S0/0/0</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HQ S0/0/1 – BR2 S0/0/1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BR1 S0/0/1 – BR2 S0/0/0</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Step 2: **Complete the device interface address table.**

Assign the first host address in the subnet to the Ethernet interfaces. HQ should be given the first host address on the serial links to BR1 and BR2. BR1 should be given the first host address for the serial link to BR2.
<table>
<thead>
<tr>
<th>Device</th>
<th>Interface</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Device Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ</td>
<td>G0/0</td>
<td></td>
<td></td>
<td>16,000 Host LAN</td>
</tr>
<tr>
<td></td>
<td>G0/1</td>
<td></td>
<td></td>
<td>8,000 Host LAN</td>
</tr>
<tr>
<td></td>
<td>S0/0/0</td>
<td></td>
<td></td>
<td>BR1 S0/0/0</td>
</tr>
<tr>
<td></td>
<td>S0/0/1</td>
<td></td>
<td></td>
<td>BR2 S0/0/1</td>
</tr>
<tr>
<td>BR1</td>
<td>G0/0</td>
<td></td>
<td></td>
<td>2,000 Host LAN</td>
</tr>
<tr>
<td></td>
<td>G0/1</td>
<td></td>
<td></td>
<td>4,000 Host LAN</td>
</tr>
<tr>
<td></td>
<td>S0/0/0</td>
<td></td>
<td></td>
<td>HQ S0/0/0</td>
</tr>
<tr>
<td></td>
<td>S0/0/1</td>
<td></td>
<td></td>
<td>BR2 S0/0/0</td>
</tr>
<tr>
<td>BR2</td>
<td>G0/0</td>
<td></td>
<td></td>
<td>500 Host LAN</td>
</tr>
<tr>
<td></td>
<td>G0/1</td>
<td></td>
<td></td>
<td>1,000 Host LAN</td>
</tr>
<tr>
<td></td>
<td>S0/0/0</td>
<td></td>
<td></td>
<td>BR1 S0/0/1</td>
</tr>
<tr>
<td></td>
<td>S0/0/1</td>
<td></td>
<td></td>
<td>HQ S0/0/1</td>
</tr>
</tbody>
</table>

Part 3: **Cable and Configure the IPv4 Network**

In Part 3, you will cable the network topology and configure the three routers using the VLSM address scheme that you developed in Part 2.

Step 1: **Cable the network as shown in the topology.**

Step 2: **Configure basic settings on each router.**

a. Assign the device name to the router.

b. Disable DNS lookup to prevent the router from attempting to translate incorrectly entered commands as though they were hostnames.

c. Assign `class` as the privileged EXEC encrypted password.

d. Assign `cisco` as the console password and enable login.

e. Assign `cisco` as the vty password and enable login.

f. Encrypt the clear text passwords.

g. Create a banner that warns anyone accessing the device that unauthorized access is prohibited.

Step 3: **Configure the interfaces on each router.**

a. Assign an IP address and subnet mask to each interface using the table that you completed in Part 2.

b. Configure an interface description for each interface.

c. Set the clocking rate on all DCE serial interfaces to 128000.

```
HQ(config-if)# clock rate 128000
```

d. Activate the interfaces.

Step 4: **Save the configuration on all devices.**
Step 5: **Test Connectivity.**

a. From HQ, ping BR1's S0/0/0 interface address.

b. From HQ, ping BR2's S0/0/1 interface address.

c. From BR1, ping BR2's S0/0/0 interface address.

d. Troubleshoot connectivity issues if pings were not successful.

**Note:** Pings to the GigabitEthernet interfaces on other routers are unsuccessful. The LANs defined for the GigabitEthernet interfaces are simulated. Because no devices are attached to these LANs, they are in a down/down state. A routing protocol must be in place for other devices to be aware of those subnets. The GigabitEthernet interfaces must also be in an up/up state before a routing protocol can add the subnets to the routing table. These interfaces remain in a down/down state until a device is connected to the other end of the Ethernet interface cable. The focus of this lab is on VLSM and configuring the interfaces.

**Reflection**

Can you think of a shortcut for calculating the network addresses of consecutive /30 subnets?

<table>
<thead>
<tr>
<th>Router Model</th>
<th>Ethernet Interface #1</th>
<th>Ethernet Interface #2</th>
<th>Serial Interface #1</th>
<th>Serial Interface #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/0/0 (SO/0/0)</td>
<td>Serial 0/0/1 (SO/0/1)</td>
</tr>
<tr>
<td>1900</td>
<td>Gigabit Ethernet 0/0 (G0/0)</td>
<td>Gigabit Ethernet 0/1 (G0/1)</td>
<td>Serial 0/0/0 (SO/0/0)</td>
<td>Serial 0/0/1 (SO/0/1)</td>
</tr>
<tr>
<td>2801</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/1/0 (SO/1/0)</td>
<td>Serial 0/1/1 (SO/1/1)</td>
</tr>
<tr>
<td>2811</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/0/0 (SO/0/0)</td>
<td>Serial 0/0/1 (SO/0/1)</td>
</tr>
<tr>
<td>2900</td>
<td>Gigabit Ethernet 0/0 (G0/0)</td>
<td>Gigabit Ethernet 0/1 (G0/1)</td>
<td>Serial 0/0/0 (SO/0/0)</td>
<td>Serial 0/0/1 (SO/0/1)</td>
</tr>
</tbody>
</table>

**Note:** To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.
2.4.2.5 Lab – Calculating Summary Routes with IPv4 and IPv6

**Topology**

[Diagram showing network topology]

**Addressing Table**

<table>
<thead>
<tr>
<th>Subnet</th>
<th>IPv4 Address</th>
<th>IPv6 Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ LAN1</td>
<td>192.168.64.0/23</td>
<td>2001:DB8:ACAD:E::/64</td>
</tr>
<tr>
<td>HQ LAN2</td>
<td>192.168.66.0/23</td>
<td>2001:DB8:ACAD:F::/64</td>
</tr>
<tr>
<td>EAST LAN1</td>
<td>192.168.68.0/24</td>
<td>2001:DB8:ACAD:1::/64</td>
</tr>
<tr>
<td>EAST LAN2</td>
<td>192.168.69.0/24</td>
<td>2001:DB8:ACAD:2::/64</td>
</tr>
<tr>
<td>WEST LAN1</td>
<td>192.168.70.0/25</td>
<td>2001:DB8:ACAD:9::/64</td>
</tr>
<tr>
<td>WEST LAN2</td>
<td>192.168.70.128/25</td>
<td>2001:DB8:ACAD:A::/64</td>
</tr>
<tr>
<td>Link from HQ to EAST</td>
<td>192.168.71.4/30</td>
<td>2001:DB8:ACAD:1000::/64</td>
</tr>
<tr>
<td>Link from HQ to WEST</td>
<td>192.168.71.0/30</td>
<td>2001:DB8:ACAD:2000::/64</td>
</tr>
<tr>
<td>Link from HQ to ISP</td>
<td>209.165.201.0/30</td>
<td>2001:DB8:CC1E:1::/64</td>
</tr>
</tbody>
</table>

**Objectives**

**Part 1: Calculate IPv4 Summary Routes**

- Determine the summary route for the HQ LANs.
- Determine the summary route for the EAST LANs.
- Determine the summary route for the WEST LANs.
- Determine the summary route for the HQ, EAST, and WEST LANs.

**Part 2: Calculate IPv6 Summary Routes**

- Determine the summary route for the HQ LANs.
- Determine the summary route for the EAST LANs.
- Determine the summary route for the WEST LANs.
- Determine the summary route for the HQ, EAST, and WEST LANs.
Background / Scenario

Summary routes reduce the number of entries in routing tables and make the routing table lookup process more efficient. This process also reduces the memory requirements for the router. A single static route can be used to represent a few routes or thousands of routes.

In this lab, you will determine the summary routes for different subnets of a network. You will then determine the summary route for the entire network. Summary routes will be determined for both IPv4 and IPv6 addresses. Because IPv6 uses hexadecimal (hex) values, you will be required to convert hex to binary.

Required Resources

- 1 PC (Windows 7, Vista, or XP with Internet access)
- Optional: calculator for converting hex and decimal to binary

Part 1: Calculate IPv4 Summary Routes

In Part 1, you will determine summarized routes that can be used to reduce the size of routing tables. Fill in the tables, after each set of steps, with the appropriate IPv4 addressing information.

Step 1: List the HQ LAN1 and HQ LAN2 IP subnet mask in decimal form.

Step 2: List the HQ LAN1 and HQ LAN2 IP address in binary form.

Step 3: Count the number of far left matching bits to determine the subnet mask for the summary route.

   a. How many far left matching bits are present in the two networks?

   b. List the subnet mask for the summary route in decimal form.

Step 4: Copy the matching binary bits and then add all zeros to determine the summarized network address.

   a. List the matching binary bits for HQ LAN1 and HQ LAN2 subnets.

   b. Add zeros to comprise the remainder of the network address in binary form.

   c. List the summarized network address in decimal form.

<table>
<thead>
<tr>
<th>Subnet</th>
<th>IPv4 Address</th>
<th>Subnet Mask</th>
<th>Subnet IP Address in Binary Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ LAN1</td>
<td>192.168.64.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HQ LAN2</td>
<td>192.168.66.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HQ LANs Summary Address</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Step 5: List the EAST LAN1 and EAST LAN2 IP subnet mask in decimal form.
Step 6: List the EAST LAN1 and EAST LAN2 IP address in binary form.

Step 7: Count the number of far left matching bits to determine the subnet mask for the summary route.
   a. How many far left matching bits are present in the two networks? ____________
   b. List the subnet mask for the summary route in decimal form.

Step 8: Copy the matching binary bits and then add all zeros to determine the summarized network address.
   a. List the matching binary bits for EAST LAN1 and EAST LAN2 subnets.
   b. Add zeros to comprise the remainder of the network address in binary form.
   c. List the summarized network address in decimal form.

<table>
<thead>
<tr>
<th>Subnet</th>
<th>IPv4 Address</th>
<th>Subnet Mask</th>
<th>Subnet Address in Binary Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAST LAN1</td>
<td>192.168.68.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAST LAN2</td>
<td>192.168.69.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAST LANs Summary Address</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Step 9: List the WEST LAN1 and WEST LAN2 IP subnet mask in decimal form.

Step 10: List the WEST LAN1 and WEST LAN2 IP address in binary form.

Step 11: Count the number of far left matching bits to determine the subnet mask for the summary route.
   a. How many far left matching bits are present in the two networks? ____________
   b. List the subnet mask for the summary route in decimal form.

Step 12: Copy the matching binary bits and then add all zeros to determine the summarized network address.
   a. List the matching binary bits for WEST LAN1 and WEST LAN2 subnets.
   b. Add zeros to comprise the remainder of the network address in binary form.
   c. List the summarized network address in decimal form.
### Subnet Summary Routes

<table>
<thead>
<tr>
<th>Subnet</th>
<th>IPv4 Address</th>
<th>Subnet Mask</th>
<th>Subnet IP Address in Binary Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEST LAN1</td>
<td>192.168.70.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEST LAN2</td>
<td>192.168.70.128</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEST LANs Summary Address</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Step 13:** List the HQ, EAST, and WEST summary route IP address and subnet mask in decimal form.

**Step 14:** List the HQ, EAST, and WEST summary route IP address in binary form.

**Step 15:** Count the number of far left matching bits to determine the subnet mask for the summary route.
   a. How many far left matching bits are present in the three networks? ____________
   b. List the subnet mask for the summary route in decimal form.

**Step 16:** Copy the matching binary bits and then add all zeros to determine the summarized network address.
   a. List the matching binary bits for HQ, EAST, and WEST subnets.
   b. Add zeros to comprise the remainder of the network address in binary form.
   c. List the summarized network address in decimal form.

<table>
<thead>
<tr>
<th>Subnet</th>
<th>IPv4 Address</th>
<th>Subnet Mask</th>
<th>Subnet IP Address in Binary Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network Address Summary Route</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Part 2: Calculate IPv6 Summary Routes

In Part 2, you will determine summarized routes that can be used to reduce the size of routing tables. Complete the tables after each set of steps, with the appropriate IPv6 addressing information.
Step 1: List the first 64 bits of the HQ LAN1 and HQ LAN2 IP subnet mask in hexadecimal form.

Step 2: List the HQ LAN1 and HQ LAN2 subnet ID (bits 48-64) in binary form.

Step 3: Count the number of far left matching bits to determine the subnet mask for the summary route.

a. How many far left matching bits are present in the two subnet IDs? ______

b. List the subnet mask for the first 64 bits of the summary route in decimal form.

Step 4: Copy the matching binary bits and then add all zeros to determine the summarized network address.

a. List the matching subnet ID binary bits for HQ LAN1 and HQ LAN2 subnets.
b. Add zeros to comprise the remainder of the subnet ID address in binary form.

c. List the summarized network address in decimal form.

<table>
<thead>
<tr>
<th>Subnet</th>
<th>IPv6 Address</th>
<th>Subnet Mask for First 64 bits</th>
<th>Subnet ID in Binary Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ LAN1</td>
<td>2001:DB8:ACAD:E::/64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HQ LAN2</td>
<td>2001:DB8:ACAD:F::/64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HQ LANs Summary Address</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Step 5: List the first 64 bits of the EAST LAN1 and EAST LAN2 IP subnet mask in hexadecimal form.

Step 6: List the EAST LAN1 and EAST LAN2 subnet ID (bits 48-64) in binary form.

Step 7: Count the number of far left matching bits to determine the subnet mask for the summary route.

   a. How many far left matching bits are present in the two subnet IDs? ________________

   b. List the subnet mask for the first 64 bits of the summary route in decimal form.

Step 8: Copy the matching binary bits and then add all zeros to determine the summarized network address.

   a. List the matching binary bits for EAST LAN1 and EAST LAN2 subnets.

   b. Add zeros to comprise the remainder of the subnet ID address in binary form.

   c. List the summarized network address in decimal form.

<table>
<thead>
<tr>
<th>Subnet</th>
<th>IPv6 Address</th>
<th>Subnet Mask for First 64 bits</th>
<th>Subnet ID in Binary Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAST LAN1</td>
<td>2001:DB8:ACAD:1::/64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAST LAN2</td>
<td>2001:DB8:ACAD:2::/64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAST LANs Summary Address</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Step 9: List the first 64 bits of the WEST LAN1 and WEST LAN2 IP subnet mask in decimal form.

Step 10: List the WEST LAN1 and WEST LAN2 subnet ID (bits 48-64) in binary form.

Step 11: Count the number of far left matching bits to determine the subnet mask for the summary route.

   a. How many far left matching bits are present in the two subnet IDs? ________________

   b. List the subnet mask for the first 64 bits of the summary route in decimal form.
Step 12: **Copy the matching binary bits and then add all zeros to determine the summarized network address.**

a. List the matching binary bits for WEST LAN1 and WEST LAN2 subnets.

b. Add zeros to comprise the remainder of the subnet ID address in binary form.

c. List the summarized network address in decimal form.

<table>
<thead>
<tr>
<th>Subnet</th>
<th>IPv6 Address</th>
<th>Subnet Mask for First 64 bits</th>
<th>Subnet ID in Binary Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEST LAN1</td>
<td>2001:DB8:ACAD:9::/64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEST LAN2</td>
<td>2001:DB8:ACAD:A::/64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEST LANs Summary Address</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Step 13: **List the HQ, EAST, and WEST summary route IP address and the first 64 bits of the subnet mask in decimal form.**

Step 14: **List the HQ, EAST, and WEST summary route subnet ID in binary form.**

Step 15: **Count the number of far left matching bits to determine the subnet mask for the summary route.**

a. How many far left matching bits are present in the three subnet IDs? ______________

b. List the subnet mask for the first 64 bits of the summary route in decimal form.

Step 16: **Copy the matching binary bits and then add all zeros to determine the summarized network address.**

a. List the matching binary bits for HQ, EAST, and WEST subnets.

b. Add zeros to comprise the remainder of the subnet ID address in binary form.

c. List the summarized network address in decimal form.

<table>
<thead>
<tr>
<th>Subnet</th>
<th>IPv6 Address</th>
<th>Subnet Mask for first 64 bits</th>
<th>Subnet ID in Binary Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network Address</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary Route</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Reflection

1. How is determining the summary route for IPv4 different from IPv6?

2. Why are summary routes beneficial to a network?
2.5.2.5 Lab – Troubleshooting IPv4 and IPv6 Static Routes

Topology
### Addressing Table

<table>
<thead>
<tr>
<th>Device</th>
<th>Interface</th>
<th>IP Address</th>
<th>Default Gateway</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ</td>
<td>G0/1</td>
<td>192.168.0.1/25</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::1/64</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>FE80::1 link-local</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0 (DCE)</td>
<td>10.1.1.2/30</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::20:2/64</td>
<td>N/A</td>
</tr>
<tr>
<td>ISP</td>
<td>G0/0</td>
<td>192.168.0.253/30</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::2::1/30</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0</td>
<td>172.16.3.1/24</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::30::1/64</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FE80::1 link-local</td>
<td>N/A</td>
</tr>
<tr>
<td>BRANCH</td>
<td>G0/1</td>
<td>10.1.1.1/30</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::20::64</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0 (DCE)</td>
<td>192.168.1.1/24</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::1::1/64</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FE80::1 link-local</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0</td>
<td>192.168.0.254/30</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::2::2/64</td>
<td>N/A</td>
</tr>
<tr>
<td>S1</td>
<td>VLAN 1</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>S3</td>
<td>VLAN 1</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>PC-A</td>
<td>NIC</td>
<td>192.168.0.3/25</td>
<td>192.168.0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::3/64</td>
<td>FE80::1</td>
</tr>
<tr>
<td>Web Server</td>
<td>NIC</td>
<td>172.16.3.3/24</td>
<td>172.16.3.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::30::3/64</td>
<td>FE80::1</td>
</tr>
<tr>
<td>PC-C</td>
<td>NIC</td>
<td>192.168.1.3/24</td>
<td>192.168.1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2001:DB8:ACAD::1::3/64</td>
<td>FE80::1</td>
</tr>
</tbody>
</table>

### Objectives

**Part 1: Build the Network and Configure Basic Device Settings**

**Part 2: Troubleshoot Static Routes in an IPv4 Network**

**Part 3: Troubleshoot Static Routes in an IPv6 Network**

### Background / Scenario

As a network administrator, you must be able to configure routing of traffic using static routes. Understanding how to configure and troubleshoot static routing is a requirement. Static routes are commonly used for stub networks and default routes. Your company's ISP has hired you to troubleshoot connectivity issues on the network. You will have access to the HQ, BRANCH, and the ISP routers.

In this lab, you will begin by loading configuration scripts on each of the routers. These scripts contain errors that will prevent end-to-end communication across the network. You will need to troubleshoot each router to determine the configuration errors, and then use the appropriate commands to correct the configurations.
When you have corrected all of the configuration errors, the hosts on the network should be able to communicate with each other.

**Note:** The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). The switches used are Cisco Catalyst 2960s with Cisco IOS Release 15.0(2) (lanbasek9 image). Other routers, switches, and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

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

### Required Resources

- 3 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 2 Switches (Cisco 2960 with Cisco IOS Release 15.0(2) lanbasek9 image or comparable)
- 3 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet and serial cables as shown in the topology

### Part 1: Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and configure the routers and switches with some basic settings, such as passwords and IP addresses. Preset configurations are also provided for you for the initial router configurations. You will also configure the IP settings for the PCs in the topology.

**Step 1:** **Cable the network as shown in the topology.**

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

**Step 2:** **Initialize and reload the routers and switches.**

**Step 3:** **Configure basic settings for each router.**

a. Disable DNS lookup.

b. Configure device name as shown in the topology.

c. Assign **class** as the privileged EXEC mode password.

d. Assign **cisco** as the console and vty passwords.

e. Configure **logging synchronous** to prevent console messages from interrupting command entry.

**Step 4:** **Configure hosts and Web Server.**


b. Configure IPv4 default gateway.
Step 5: Load router configurations.

**Router HQ**

    hostname HQ
    ipv6 unicast-routing
    interface GigabitEthernet0/1
        ipv6 address 2001:DB8:ACAD::1/64
        ip address 192.168.0.1 255.255.255.128
        ipv6 address FE80::1 link-local

    interface Serial0/0/0
        ipv6 address 2001:DB8:ACAD:20::2/64
        ip address 10.1.1.2 255.255.255.252
        clock rate 800000
        no shutdown
    interface Serial0/0/1
        ipv6 address 2001:DB8:ACAD:2::3/64

        ip address 192.168.0.253 255.255.255.252
        no shutdown
    ip route 172.16.3.0 255.255.255.0 10.1.1.1
    ip route 192.168.1.0 255.255.255.0 192.16.0.254

    ipv6 route 2001:DB8:ACAD:1::/64 2001:DB8:ACAD:2::2
    ipv6 route 2001:DB8:ACAD:30::/64 2001:DB8:ACAD:20:1

**Router ISP**

    hostname ISP
    ipv6 unicast-routing
    interface GigabitEthernet0/0
        ipv6 address 2001:DB8:ACAD:30::1/64
        ip address 172.16.3.11 255.255.255.0

        ipv6 address FE80::1 link-local
        no shutdown
    interface Serial0/0/0
        ipv6 address 2001:DB8::ACAD:20:1/64

        ip address 10.1.1.1 255.255.255.252
        no shutdown
ip route 192.168.1.0 255.255.255.0 10.1.1.2

ipv6 route 2001:DB8:ACAD::/62 2001:DB8:ACAD:20::2

Router BRANCH

hostname BRANCH
ipv6 unicast-routing
interface GigabitEthernet0/1
ipv6 address 2001:DB8:ACAD:1::1/64
ip address 192.168.1.1 255.255.255.0
ipv6 address FE80::1 link-local
no shutdown
interface Serial0/0/0
ipv6 address 2001:DB8:ACAD:2::2/64
clock rate 128000
ip address 192.168.0.249 255.255.255.252

clock rate 128000
no shutdown
ip route 0.0.0.0 0.0.0.0 10.1.1.2

ipv6 route ::/0 2001:DB8:ACAD::1

Part 2: Troubleshoot Static Routes in an IPv4 Network

IPv4 Addressing Table

<table>
<thead>
<tr>
<th>Device</th>
<th>Interface</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Default Gateway</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ</td>
<td>G0/1</td>
<td>192.168.0.1</td>
<td>255.255.255.0</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0 (DCE)</td>
<td>10.1.1.2</td>
<td>255.255.255.252</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/1</td>
<td>192.168.0.253</td>
<td>255.255.255.252</td>
<td>N/A</td>
</tr>
<tr>
<td>ISP</td>
<td>G0/0</td>
<td>172.16.3.1</td>
<td>255.255.255.0</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0</td>
<td>10.1.1.1</td>
<td>255.255.255.252</td>
<td>N/A</td>
</tr>
<tr>
<td>BRANCH</td>
<td>G0/1</td>
<td>192.168.1.1</td>
<td>255.255.255.0</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0 (DCE)</td>
<td>192.168.0.254</td>
<td>255.255.255.252</td>
<td>N/A</td>
</tr>
<tr>
<td>S1</td>
<td>VLAN 1</td>
<td>192.168.0.11</td>
<td>255.255.255.128</td>
<td>192.168.0.1</td>
</tr>
<tr>
<td>S3</td>
<td>VLAN 1</td>
<td>192.168.1.11</td>
<td>255.255.255.0</td>
<td>192.168.1.1</td>
</tr>
<tr>
<td>PC-A</td>
<td>NIC</td>
<td>192.168.0.3</td>
<td>255.255.255.128</td>
<td>192.168.0.1</td>
</tr>
<tr>
<td>Web Server</td>
<td>NIC</td>
<td>172.16.3.3</td>
<td>255.255.255.0</td>
<td>172.16.3.1</td>
</tr>
<tr>
<td>PC-C</td>
<td>NIC</td>
<td>192.168.1.3</td>
<td>255.255.255.0</td>
<td>192.168.1.1</td>
</tr>
</tbody>
</table>
Step 1: Troubleshoot the HQ router.

The HQ router is the link between the ISP router and the BRANCH router. The ISP router represents the outside network while the BRANCH router represents the corporate network. The HQ router is configured with static routes to ISP and BRANCH networks.

a. Display the status of the interfaces on HQ. Enter `show ip interface brief`. Record and resolve any issues as necessary.

b. Ping from HQ router to BRANCH router (192.168.0.254). Were the pings successful? _________

c. Ping from HQ router to ISP router (10.1.1.1). Were the pings successful? _________

d. Ping from PC-A to the default gateway. Were the pings successful? _________

e. Ping from PC-A to PC-C. Were the pings successful? _________

f. Ping from PC-A to Web Server. Were the pings successful? _________

g. Display the routing table on HQ. What non-directly connected routes are shown in the routing table?

h. Based on the results of the pings, routing table output, and static routes in the running configuration, what can you conclude about network connectivity?

i. What commands (if any) need to be entered to resolve routing issues? Record the command(s).
j. Repeat any of the steps from b to f to verify whether the problems have been resolved. Record your observations and possible next steps in troubleshooting connectivity.

Step 2: **Troubleshoot the ISP router.**

For the ISP router, there should be a route to HQ and BRANCH routers. One static route is configured on ISP router to reach the 192.168.1.0/24, 192.168.0.0/25, and 192.168.0.252/30 networks.

a. Display the status of interfaces on ISP. Enter **show ip interface brief**. Record and resolve any issues as necessary.

b. Ping from the ISP router to the HQ router (10.1.1.2). Were the pings successful? __________

c. Ping from Web Server to the default gateway. Were the pings successful? __________

d. Ping from Web Server to PC-A. Were the pings successful? __________

e. Ping from Web Server to PC-C. Were the pings successful? __________

f. Display the routing table on ISP. What non-directly connected routes are shown in the routing table?

...
h. What commands (if any) need to be entered to resolve routing issues? Record the command(s).
   (Hint: ISP only requires one summarized route to the company’s networks 192.168.1.0/24, 192.168.0.0/25, and 192.168.0.252/32.)

i. Repeat any of the steps from b to e to verify whether the problems have been resolved. Record your observations and possible next steps in troubleshooting connectivity.

Step 3: Troubleshoot the BRANCH router.

For the BRANCH router, a default route is set to reach the rest of the network and ISP.

a. Display the status of the interfaces on BRANCH. Enter \texttt{show ip interface brief}. Record and resolve any issues, as necessary.

b. Ping from the BRANCH router to the HQ router (192.168.0.253). Were the pings successful? ________

c. Ping from PC-C to the default gateway. Were the pings successful? ________

d. Ping from PC-C to PC-A. Were the pings successful? ________

e. Ping from PC-C to Web Server. Were the pings successful? ________

f. Display the routing table on BRANCH. What non-directly connected routes are shown in the routing table?
g. Based on the results of the pings, routing table output, and static routes in the running configuration, what can you conclude about network connectivity?

h. What commands (if any) need to be entered to resolve routing issues? Record the command(s).

i. Repeat any of the steps from b to e to verify whether the problems have been resolved. Record your observations and possible next steps in troubleshooting connectivity.

Part 3: Troubleshoot Static Routes in an IPv6 Network

<table>
<thead>
<tr>
<th>Device</th>
<th>Interface</th>
<th>IPv6 Address</th>
<th>Prefix Length</th>
<th>Default Gateway</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ</td>
<td>G0/1</td>
<td>2001:DB8:ACAD::1</td>
<td>64</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0 (DCE)</td>
<td>2001:DB8:ACAD::20::2</td>
<td>64</td>
<td>N/A</td>
</tr>
<tr>
<td>ISP</td>
<td>G0/0</td>
<td>2001:DB8:ACAD::2::1</td>
<td>64</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0 (DCE)</td>
<td>2001:DB8:ACAD::30::1</td>
<td>64</td>
<td>N/A</td>
</tr>
<tr>
<td>BRANCH</td>
<td>G0/1</td>
<td>2001:DB8:ACAD::1::1</td>
<td>64</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>S0/0/0 (DCE)</td>
<td>2001:DB8:ACAD::2::2</td>
<td>64</td>
<td>N/A</td>
</tr>
<tr>
<td>PC-A</td>
<td>NIC</td>
<td>2001:DB8:ACAD::3</td>
<td>64</td>
<td>FE80::1</td>
</tr>
<tr>
<td>Web Server</td>
<td>NIC</td>
<td>2001:DB8:ACAD::30::3</td>
<td>64</td>
<td>FE80::1</td>
</tr>
<tr>
<td>PC-C</td>
<td>NIC</td>
<td>2001:DB8:ACAD::1::3</td>
<td>64</td>
<td>FE80::1</td>
</tr>
</tbody>
</table>

Step 1: Troubleshoot the HQ router.

The HQ router is the link between the ISP router and the BRANCH router. The ISP router represents the outside network while the BRANCH router represents the corporate network. The HQ router is configured with static routes to both the ISP and the BRANCH networks.
a. Display the status of the interfaces on HQ. Enter `show ipv6 interface brief`. Record and resolve any issues, as necessary.

b. Ping from the HQ router to the BRANCH router (2001:DB8:ACAD:2::2). Were the pings successful? 

c. Ping from the HQ router to the ISP router (2001:DB8:ACAD:20::1). Were the pings successful? 

d. Ping from PC-A to the default gateway. Were the pings successful? 

e. Ping from PC-A to Web Server. Were the pings successful? 

f. Ping from PC-A to PC-C. Were the pings successful? 

g. Display the routing table by issuing a `show ipv6 route` command. What non-directly connected routes are shown in the routing table? 

h. Based on the results of the pings, routing table output, and static routes in the running configuration, what can you conclude about network connectivity? 

i. What commands (if any) need to be entered to resolve routing issues? Record the command(s). 

Step 2: **Troubleshoot the ISP router.**

On the ISP router, one static route is configured to reach all the networks on HQ and BRANCH routers.

a. Display the status of the interfaces on ISP. Enter `show ipv6 interface brief`. Record and resolve any issues, as necessary.

b. Ping from the ISP router to the HQ router (2001:DB8:ACAD:20::2). Were the pings successful? 

c. Ping from Web Server to the default gateway. Were the pings successful? 

d. Ping from Web Server to PC-A. Were the pings successful? 

e. Ping from Web Server to PC-C. Were the pings successful? 

f. Display the routing table. What non-directly connected routes are shown in the routing table? 

g. Based on the results of the pings, routing table output, and static routes in the running configuration, what can you conclude about network connectivity?
h. What commands (if any) need to be entered to resolve routing issues? Record the command(s).

i. Repeat any of the steps from b to e to verify whether the problems have been resolved. Record your observations and possible next steps in troubleshooting connectivity.

Step 3: **Troubleshoot the BRANCH router.**

For the BRANCH routers, there is a default route to the HQ router. This default route allows the BRANCH network to the ISP router and Web Server.

a. Display the status of the interfaces on BRANCH. Enter `show ipv6 interface brief`. Record and resolve any issues, as necessary.

b. Ping from the BRANCH router to the HQ router (2001:DB8:ACAD:2::1). Were the pings successful? 

c. Ping from the BRANCH router to the ISP router (2001:DB8:ACAD:20::1). Were the pings successful? 

d. Ping from PC-C to the default gateway. Were the pings successful? 

e. Ping from PC-C to PC-A. Were the pings successful? 

f. Ping from PC-C to Web Server. Were the pings successful? 

g. Display the routing table. What non-directly connected routes are shown in the routing table?
h. Based on the results of the pings, routing table output, and static routes in the running configuration, what can you conclude about network connectivity?

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

i. What commands (if any) need to be entered to resolve routing issues? Record the command(s).

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

j. Repeat any of the steps from b to f to verify whether the problems have been resolved. Record your observations and possible next steps in troubleshooting connectivity.

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

Router Interface Summary Table

<table>
<thead>
<tr>
<th>Router Model</th>
<th>Ethernet Interface #1</th>
<th>Ethernet Interface #2</th>
<th>Serial Interface #1</th>
<th>Serial Interface #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
<tr>
<td>1900</td>
<td>Gigabit Ethernet 0/0 (G0/0)</td>
<td>Gigabit Ethernet 0/1 (G0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
<tr>
<td>2801</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/1/0 (S0/1/0)</td>
<td>Serial 0/1/1 (S0/1/1)</td>
</tr>
<tr>
<td>2811</td>
<td>Fast Ethernet 0/0 (F0/0)</td>
<td>Fast Ethernet 0/1 (F0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
<tr>
<td>2900</td>
<td>Gigabit Ethernet 0/0 (G0/0)</td>
<td>Gigabit Ethernet 0/1 (G0/1)</td>
<td>Serial 0/0/0 (S0/0/0)</td>
<td>Serial 0/0/1 (S0/0/1)</td>
</tr>
</tbody>
</table>

Note: To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.
2.6.1.1 Class Activity – Make It Static!

Objectives

Configure a static route.

As the use of IPv6 addressing becomes more prevalent, it is important for network administrators to be able to direct network traffic between routers.

To prove that you are able to direct IPv6 traffic correctly and review the IPv6 default static route curriculum concepts, use the topology as shown in the .pdf file provided, specifically for this activity. Work with a partner to write an IPv6 statement for each of the three scenarios. Try to write the route statements without the assistance of completed labs, Packet Tracer files, etc.

- **Scenario 1**
  IPv6 default static route from R2 directing all data through your S0/0/0 interface to the next hop address on R1.

- **Scenario 2**
  IPv6 default static route from R3 directing all data through your S0/0/1 interface to the next hop address on R2.

- **Scenario 3**
  IPv6 default static route from R2 directing all data through your S0/0/1 interface to the next hop address on R3.

When complete, get together with another group and compare your written answers. Discuss any differences found in your comparisons.

Resources

Topology Diagram
- **Scenario 1**
  IPv6 default static route from R2 directing all data to the next hop address on R1.

<table>
<thead>
<tr>
<th>Configuration Command</th>
<th>IPv6 Network to Route</th>
<th>Next Hop IPv6 Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2 (config) # ipv6 route</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Scenario 2**
  IPv6 default static route from R3 directing all data to the next hop address on R2.

<table>
<thead>
<tr>
<th>Configuration Command</th>
<th>IPv6 Network to Route</th>
<th>Next Hop IPv6 Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3 (config) # ipv6 route</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Scenario 3**
  IPv6 default static route from R2 directing all data to the next hop address on R3.

<table>
<thead>
<tr>
<th>Configuration Command</th>
<th>IPv6 Network to Route</th>
<th>Next Hop IPv6 Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2 (config) # ipv6 route</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>