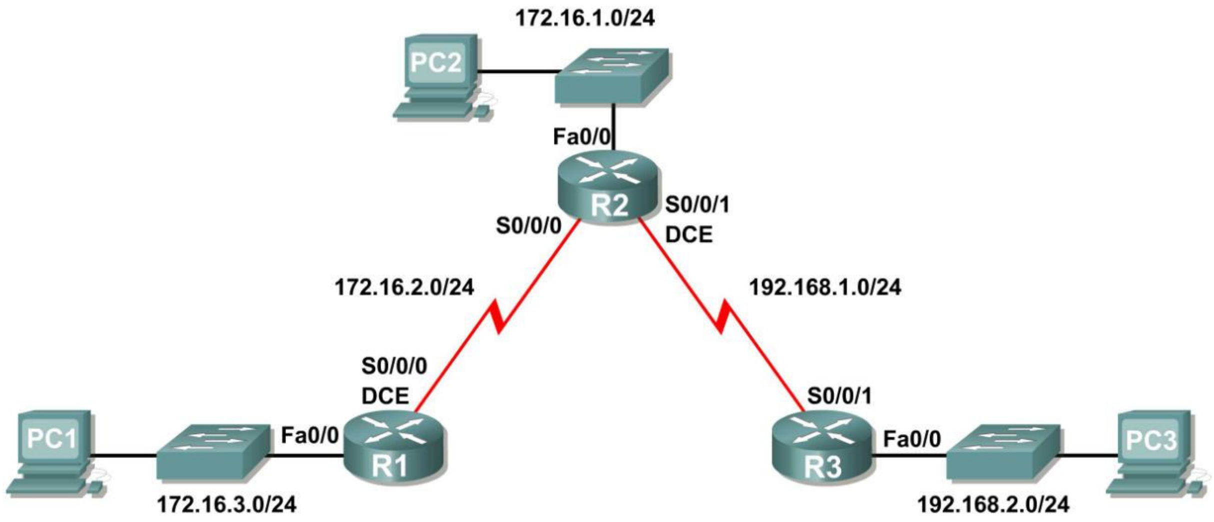
# Lab 2.8.1: Basic Static Route Configuration

## Topology Diagram




## Addressing Table

| Device | Interface | IP Address | Subnet Mask | Default Gateway |
|---|---|---|---|---|
| R1 | Fa0/0 | 172.16.3.1 | 255.255.255.0 | N/A |
| | S0/0/0 | 172.16.2.1 | 255.255.255.0 | N/A |
| R2 | Fa0/0 | 172.16.1.1 | 255.255.255.0 | N/A |
| | S0/0/0 | 172.16.2.2 | 255.255.255.0 | N/A |
| | S0/0/1 | 192.168.1.2 | 255.255.255.0 | N/A |
| R3 | FA0/0 | 192.168.2.1 | 255.255.255.0 | N/A |
| | S0/0/1 | 192.168.1.1 | 255.255.255.0 | N/A |
| PC1 | NIC | 172.16.3.10 | 255.255.255.0 | 172.16.3.1 |
| PC2 | NIC | 172.16.1.10 | 255.255.255.0 | 172.16.1.1 |
| PC3 | NIC | 192.168.2.10 | 255.255.255.0 | 192.168.2.1 |

## Learning Objectives

Upon completion of this lab, you will be able to:

- Cable a network according to the Topology Diagram.
- Erase the startup configuration and reload a router to the default state.
- Perform basic configuration tasks on a router.

- Interpret **`debug ip routing`** output.
- Configure and activate Serial and Ethernet interfaces.
- Test connectivity.
- Gather information to discover causes for lack of connectivity between devices.
- Configure a static route using an intermediate address.
- Configure a static route using an exit interface.
- Compare a static route with intermediate address to a static route with exit interface.
- Configure a default static route.
- Configure a summary static route.
- Document the network implementation.

## Scenario

In this lab activity, you will create a network that is similar to the one shown in the Topology Diagram. Begin by cabling the network as shown in the Topology Diagram. You will then perform the initial router configurations required for connectivity. Use the IP addresses that are provided in the Addressing Table to apply an addressing scheme to the network devices. After completing the basic configuration, test connectivity between the devices on the network. First test the connections between directly connected devices, and then test connectivity between devices that are not directly connected. Static routes must be configured on the routers for end-to-end communication to take place between the network hosts. You will configure the static routes that are needed to allow communication between the hosts. View the routing table after each static route is added to observe how the routing table has changed.

## Task 1: Cable, Erase, and Reload the Routers.

### Step 1: Cable a network that is similar to the one in the Topology Diagram.

### Step 2: Clear the configuration on each router.

Clear the configuration on each of the routers using the **`erase startup-config`** command and then **`reload`** the routers. Answer **no** if asked to save changes.

## Task 2: Perform Basic Router Configuration.

**Note:** If you have difficulty with any of the commands in this task, see **Lab 1.5.1: Cabling a Network and Basic Router Configuration**.

### Step 1: Use global configuration commands.

On the routers, enter global configuration mode and configure the basic global configuration commands including:

- **`hostname`**
- **`no ip domain-lookup`**
- **`enable secret`**

### Step 2: Configure the console and virtual terminal line passwords on each of the routers.

- **`password`**
- **`login`**

**Step 3: Add the `logging synchronous` command to the console and virtual terminal lines.**

This command is very helpful in both lab and production environments and uses the following syntax:

```
Router(config-line)#logging synchronous
```

To synchronize unsolicited messages and debug output with solicited Cisco IOS software output and prompts for a specific console port line, auxiliary port line, or virtual terminal line, we can use the **`logging synchronous`** line configuration command. In other words, the **`logging synchronous`** command prevents IOS messages delivered to the console or Telnet lines from interrupting your keyboard input.

For example, you may have already experienced something similar to the following example:

**Note:** *Do not* configure R1 interfaces yet.

```
R1(config)#interface fastethernet 0/0
R1(config-if)#ip address 172.16.3.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#descri
*Mar  1 01:16:08.212: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed
state to up
*Mar  1 01:16:09.214: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/0, changed state to upption
R1(config-if)#
```

The IOS sends unsolicited messages to the console when you activate an interface with the **`no shutdown`** command. However, the next command you enter (in this case, **`description`**) is interrupted by these messages. The **`logging synchronous`** command solves this problem by copying the command entered up to that point down to the next router prompt.

```
R1(config)#interface fastethernet 0/0
R1(config-if)#ip address 172.16.3.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#description
*Mar  1 01:28:04.242: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed
state to up
*Mar  1 01:28:05.243: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/0, changed state to up
R1(config-if)#description  <-- Keyboard input copied after message
```

R1 is shown here as an example. Add **`logging synchronous`** to the console and virtual terminal lines on all routers.

```
R1(config)#line console 0
R1(config-line)#logging synchronous
R1(config-line)#line vty 0 4
R1(config-line)#logging synchronous
```

### Step 4: Add the `exec-timeout` command to the console and virtual terminal lines.

To set the interval that the EXEC command interpreter waits until user input is detected, we can use the **`exec-timeout`** line configuration command. If no input is detected during the interval, the EXEC facility resumes the current connection. If no connections exist, the EXEC facility returns the terminal to the idle state and disconnects the incoming session. This command allows you to control the amount of time a console or virtual terminal line can be idle before the session is terminated. The syntax follows:

```
Router(config-line)#exec-timeout minutes [seconds]
```

Syntax description:

*minutes*—Integer that specifies the number of minutes.

*seconds*—(Optional) Additional time intervals in seconds.

In a lab environment, you can specify "no timeout" by entering the **`exec-timeout 0 0`** command. This command is very helpful because the default timeout for lines is 10 minutes. However, for security purposes, you would not normally set lines to "no timeout" in a production environment.

R1 is shown here as an example.

Add **`exec-timeout 0 0`** to console and virtual terminal lines on all routers.

```
R1(config)#line console 0
R1(config-line)#exec-timeout 0 0
R1(config-line)#line vty 0 4
R1(config-line)#exec-timeout 0 0
```

## Task 3: Interpreting Debug Output.

**Note:** If you already configured IP addressing on R1, please remove all `interface` commands now before proceeding. R1, R2 and R3 should be configured through the end of Task 2 without any interface configurations.

### Step 1: On R1 from privileged EXEC mode, enter the `debug ip routing` command.

```
R1#debug ip routing
IP routing debugging is on
```

The **`debug ip routing`** command shows when routes are added, modified, and deleted from the routing table. For example, every time you successfully configure and activate an interface, Cisco IOS adds a route to the routing table. We can verify this by observing output from the **`debug ip routing`** command.

### Step 2: Enter interface configuration mode for R1's LAN interface.

```
R1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface fastethernet 0/0
```

Configure the IP address as specified in the Topology Diagram.

```
R1(config-if)#ip address 172.16.3.1 255.255.255.0
is_up: 0 state: 6 sub state: 1 line: 1 has_route: False
```

As soon as you press the **Enter** key, Cisco IOS debug output informs you that there is now a route, but its state is `False`. In other words, the route has not yet been added to the routing table. Why did this occur and what steps should be taken to ensure that the route is entered into the routing table?

______________________________________________________________________________

______________________________________________________________________________

**Step 3: Enter the command necessary to install the route in the routing table.**

If you are not sure what the correct command is, review the discussion in "Examining Router Interfaces" which is discussed in Section 2.2, "Router Configuration Review."

After you enter the correct command, you should see debug output. Your output may be slightly different from the example below.

```
is_up: 1 state: 4 sub state: 1 line: 1 has_route: False
RT: add 172.16.3.0/24 via 0.0.0.0, connected metric [0/0]
RT: NET-RED 172.16.3.0/24
RT: NET-RED queued, Queue size 1
RT: interface FastEthernet0/0 added to routing table
%LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
is_up: 1 state: 4 sub state: 1 line: 1 has_route: True
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, chan
ged state to up
is_up: 1 state: 4 sub state: 1 line: 1 has_route: True
is_up: 1 state: 4 sub state: 1 line: 1 has_route: True
```

The new network you configured on the LAN interface is now added to the routing table, as shown in the highlighted output.

If you do not see the route added to the routing table, the interface did not come up. Use the following systematic process to troubleshoot your connection:

1. Check your physical connections to the LAN interface.
   Is the correct interface attached? ________
   Your router may have more than one LAN interface. Did you connect the correct LAN interface? ________
   An interface will not come up unless it detects a carrier detect signal at the Physical layer from another device. Is the interface connected to another device such as a hub, switch, or PC? ________
2. Check link lights. Are all link lights blinking? ________
3. Check the cabling. Are the correct cables connected to the devices? ________
4. Has the interface been activated or enabled? ________

If you can answer **yes** to all the proceeding questions, the interface should come up.

**Step 4: Enter the command to verify that the new route is now in the routing table.**

Your output should look similar to the following output. There should now be one route in the table for R1. What command did you use?

```
R1#______________________________________
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.3.0 is directly connected, FastEthernet0/0
```

**Step 5: Enter interface configuration mode for R1's WAN interface connected to R2.**

```
R1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface Serial 0/0/0
```

Configure the IP address as specified in the Topology Diagram.

```
R1(config-if)#ip address 172.16.2.1 255.255.255.0
is_up: 0 state: 0 sub state: 1 line: 0 has_route: False
```

As soon as you press the **Enter** key, Cisco IOS debug output informs you that there is now a route, but its state is `False`. Because R1 is the DCE side of our lab environment, we must specify how fast the bits will be clocked between R1 and R2.

**Step 6: Enter the `clock rate` command on R1.**

You can specify any valid clocking speed. Use the **?** to find the valid rates. Here, we used 64000 bps.

```
R1(config-if)#clock rate 64000
is_up: 0 state: 0 sub state: 1 line: 0 has_route: False
```

Some IOS versions display the output shown above every 30 seconds. Why is the state of the route still `False`? What step must you now take to make sure that the interface is fully configured?

_______________________________________________________________________________

**Step 7: Enter the command necessary to ensure that the interface is fully configured.**

If you are not sure what the correct command is, review the discussion in "Examining Router Interfaces," which is discussed in Section 2.2, "Router Configuration Review."

```
R1(config-if)#_____________________________
```

After you enter the correct command, you should see debug output similar to the following example:

```
is_up: 0 state: 0 sub state: 1 line: 0 has_route: False
%LINK-3-UPDOWN: Interface Serial0/0/0, changed state to down
```

Unlike configuring the LAN interface, fully configuring the WAN interface does not always guarantee that the route will be entered in the routing table, even if your cable connections are correct. The other side of the WAN link must also be configured.

**Step 8:** If possible, establish a separate terminal session by consoling into R2 from another workstation. Doing this allows you to observe the debug output on R1 when you make changes on R2. You can also turn on **debug ip routing** on R2.

```
R2#debug ip routing
IP routing debugging is on
```

Enter interface configuration mode for R2's WAN interface connected to R1.

```
R2#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#interface serial 0/0/0
```

Configure the IP address as specified in the Topology Diagram.

```
R2(config-if)#ip address 172.16.2.2 255.255.255.0
is_up: 0 state: 6 sub state: 1 line: 0
```

**Step 9: Enter the command necessary to ensure that the interface is fully configured.**

If you are not sure what the correct command is, review the discussion in "Examining Router Interfaces," which is discussed in Section 2.2, "Router Configuration Review."

```
R2(config-if)#______________________________
```

After you enter the correct command, you should see debug output similar to the following example:

```
is_up: 0 state: 4 sub state: 1 line: 0
%LINK-3-UPDOWN: Interface Serial0/0/0, changed state to up
is_up: 1 state: 4 sub state: 1 line: 0
RT: add 172.16.2.0/24 via 0.0.0.0, connected metric [0/0]
RT: interface Serial0/0/0 added to routing table
is_up: 1 state: 4 sub state: 1 line: 0
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to
up
is_up: 1 state: 4 sub state: 1 line: 0
```

The new network that you configured on the WAN interface is now added to the routing table, as shown in the highlighted output.

If you do not see the route added to the routing table, the interface did not come up. Use the following systematic process to troubleshoot your connection:

1. Check your physical connections between the two WAN interfaces for R1 and R2.
   Is the correct interface attached? ________
   Your router has more than one WAN interface. Did you connect the correct WAN interface?
   ________
   An interface will not come up unless it detects a link beat at the Physical layer from another device. Is the interface connected to the other router's interface? ________
2. Check link lights. Are all link lights blinking? ________
3. Check the cabling. R1 must have the DCE side of the cable attached and R2 must have the DTE side of the cable attached. Are the correct cables connected to the routers? ________
4. Has the interface been activated or enabled? ________

If you can answer **yes** to all the proceeding questions, the interface should come up.

**Step 10: Enter the command to verify that the new route is now in the routing table for R1 and R2.**

Your output should look similar to the following output. There should now be two routes in the routing table for R1 and one route in the table for R2. What command did you use?

```
R1#_________________________________
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0

R2#_________________________________
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.2.0 is directly connected, Serial0/0/0
```

**Step 11: Turn off debugging on both routers using either `no debug ip routing` or simply, `undebug all`.**

```
R1(config-if)#end
R1#no debug ip routing
IP routing debugging is off
```

## Task 4: Finish Configuring Router Interfaces

### Step 1: Configure Remaining R2 Interfaces

Finish configuring the remaining interfaces on R2 according to the Topology Diagram and Addressing Table.

### Step 2: Configure R3 Interfaces

Console into R3 and configure the necessary interfaces according to the Topology Diagram and Addressing Table.

## Task 5: Configure IP Addressing on the Host PCs.

### Step 1: Configure the host PC1.

Configure the host PC1 with an IP address of 172.16.3.10/24 and a default gateway of 172.16.3.1.

### Step 2: Configure the host PC2.

Configure the host PC2 with an IP address of 172.16.1.10/24 and a default gateway of 172.16.1.1.

### Step 3: Configure the host PC3.

Configure the host PC3 with an IP address of 192.168.2.10/24 and a default gateway of 192.168.2.1.

## Task 6: Test and Verify the Configurations.

### Step 1: Test connectivity.

Test connectivity by pinging from each host to the default gateway that has been configured for that host.

From the host PC1, is it possible to ping the default gateway? ________

From the host PC2, is it possible to ping the default gateway? ________

From the host PC3, is it possible to ping the default gateway? ________

If the answer is **no** for any of these questions, troubleshoot the configurations to find the error using the following systematic process:

1. Check the cabling.
   Are the PCs physically connected to the correct router? ________
   (Connection could be through a switch or directly)
   Are link lights blinking on all relevant ports? ________
2. Check the PC configurations. Do they match the Topology Diagram? ________
3. Check the router interfaces using the **`show ip interface brief`** command.
   Are all relevant interfaces **up** and **up**? ________

If your answer to all three steps is **yes**, you should be able to successfully ping the default gateway.

### Step 2: Use the `ping` command to test connectivity between directly connected routers.

From the router R2, is it possible to ping R1 at 172.16.2.1? ________

From the router R2, is it possible to ping R3 at 192.168.1.1? ________

If the answer is **no** for any of these questions, troubleshoot the configurations to find the error using the following systematic process:

1. Check the cabling.
   Are the routers physically connected? ________
   Are link lights blinking on all relevant ports? ________
2. Check the router configurations.
   Do they match the Topology Diagram? ________
   Did you configure the **`clock rate`** command on the DCE side of the link? ________
3. Has the interface been activated or enabled? ________
4. Check the router interfaces using the **`show ip interface brief`** command.
   Are the interfaces **up** and **up**? ________

If your answer to all three steps is **yes**, you should be able to successfully ping from R2 to R1 and from R2 to R3.

### Step 3: Use `ping` to check connectivity between devices that are not directly connected.

From the host PC3, is it possible to ping the host PC1? ________

From the host PC3, is it possible to ping the host PC2? ________

From the host PC2, is it possible to ping the host PC1? ________

From the router R1, is it possible to ping router R3? ________

These pings should all fail. Why?

_______________________________________________________________________________

_______________________________________________________________________________

_______________________________________________________________________________

## Task 7: Gather Information.

### Step 1: Check status of interfaces.

Check the status of the interfaces on each router with the command **`show ip interface brief`**. The following output is for R2.

```
R2#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        172.16.1.1      YES manual up                    up
FastEthernet0/1        unassigned      YES unset  administratively down down
Serial0/0/0            172.16.2.2      YES manual up                    up
Serial0/0/1            192.168.1.2     YES manual up                    up
Vlan1                  unassigned      YES manual administratively down down
```

Are all of the relevant interfaces on each router activated (that is, in the **up** and **up** state)? ________

How many interfaces are activated on R1 and R3? _______

Why are there three activated interfaces on R2? ____________________________________________

_______________________________________________________________________________

### Step 2: View the routing table information for all three routers.

```
R1#________________________________
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
```

What networks are present in the Topology Diagram but not in the routing table for R1?

_______________________________________________________________

```
R2#________________________________
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
C       172.16.2.0 is directly connected, Serial0/0/0
C    192.168.1.0/24 is directly connected, Serial0/0/1
```

What networks are present in the Topology Diagram but not in the routing table for R2?

_______________________________________________________________

```
R3#________________________________
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, Serial0/0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```

What networks are present in the Topology Diagram but not in the routing table for R3?

_______________________________________________________________

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

______________________________________________________________________________

______________________________________________________________________________

What can be added to the network so that devices that are not directly connected can ping each other?

______________________________________________________________________________

## Task 8: Configure a Static Route Using a Next-Hop Address.

### Step 1: To configure static routes with a next-hop specified, use the following syntax:

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

- *network-address*:—Destination network address of the remote network to be added to the routing table.
- *subnet-mask*—Subnet mask of the remote network to be added to the routing table. The subnet mask can be modified to summarize a group of networks.
- *ip-address*—Commonly referred to as the next-hop router's IP address.

On the R3 router, configure a static route to the 172.16.1.0 network using the Serial 0/0/1 interface of R2 as the next-hop address.

```
R3(config)#ip route 172.16.1.0 255.255.255.0 192.168.1.2
R3(config)#
```

### Step 2: View the routing table to verify the new static route entry.

Notice that the route is coded with an **S**, which means that the route is a **static** route.

```
R3#_________________________________

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.1.0 [1/0] via 192.168.1.2
C    192.168.1.0/24 is directly connected, Serial0/0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
R3#
```

With this route entered in the routing table, any packet that matches the first 24 left-most bits of 172.16.1.0/24 will be forwarded to the next-hop router at 192.168.1.2.

What interface will R3 use to forward packets to the 172.16.1.0/24 network? ____________

Assume that the following packets have arrived at R3 with the indicated destination addresses. Will R3 discard the packet or forward the packet? If R3 forwards the packet, with what interface will R3 send the packet?

| Packet | Destination IP | Discard or Forward? | Interface |
|---|---|---|---|
| 1 | 172.16.2.1 | __________ | __________ |
| 2 | 172.16.1.10 | __________ | __________ |
| 3 | 192.168.1.2 | __________ | __________ |
| 4 | 172.16.3.10 | __________ | __________ |
| 5 | 192.16.2.10 | __________ | __________ |

Although R3 will forward packets to destinations for which there is a route, this does not mean that a packet will arrive safely at the final destination.

**Step 3: Use `ping` to check connectivity between the host PC3 and the host PC2.**

From the host PC3, is it possible to ping the host PC2? ________

These pings should fail. The pings will arrive at PC2 if you have configured and verified all devices through Task 7, "Gather Information." PC2 will send a ping reply back to PC3. However, the ping reply will be discarded at R2 because the R2 does not have a return route to the 192.168.2.0 network in the routing table.

**Step 4: On the R2 router, configure a static route to reach the 192.168.2.0 network.**

What is the next-hop address to which R2 would send a packet destined for the 192.168.2.0/24 network?

```
R2(config)#ip route 192.168.2.0 255.255.255.0 ________________
R2(config)#
```

**Step 5: View the routing table to verify the new static route entry.**

Notice that the route is coded with an **S**, which means the route is a **static** route.

```
R2#_________________________________

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
C       172.16.2.0 is directly connected, Serial0/0/0
C    192.168.1.0/24 is directly connected, Serial0/0/1
S    192.168.2.0/24 [1/0] via 192.168.1.1
R2#
```

**Step 6: Use `ping` to check connectivity between the host PC3 and the host PC2.**

From the host PC3, is it possible to ping the host PC2? ________

This ping should be successful.

## Task 9: Configure a Static Route Using an Exit Interface.

To configure static routes with an exit interface specified, use the following syntax:

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

- *network-address*—Destination network address of the remote network to be added to the routing table.
- *subnet-mask*—Subnet mask of the remote network to be added to the routing table. The subnet mask can be modified to summarize a group of networks.
- *exit-interface*—Outgoing interface that would be used in forwarding packets to the destination network.

### Step 1: On the R3 router, configure a static route.

On the R3 router, configure a static route to the 172.16.2.0 network using the Serial 0/0/1 interface of the R3 router as the exit interface.

```
R3(config)# ip route 172.16.2.0 255.255.255.0 Serial0/0/1
R3(config)#
```

### Step 2: View the routing table to verify the new static route entry.

```
R3#________________________________
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
S       172.16.1.0 [1/0] via 192.168.1.2
S       172.16.2.0 is directly connected, Serial0/0/1
C    192.168.1.0/24 is directly connected, Serial0/0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
R3#
```

Use the **show running-config** command to verify the static routes that are currently configured on R3.

```
R3#show running-config
Building configuration...

<output omitted>
!
hostname R3
!
interface FastEthernet0/0
ip address 192.168.2.1 255.255.255.0
!
interface Serial0/0/0
 no ip address
 shutdown
```

```
!
interface Serial0/0/1
 ip address 192.168.1.1 255.255.255.0
!
ip route 172.16.1.0 255.255.255.0 192.168.1.2
ip route 172.16.2.0 255.255.255.0 Serial0/0/1
!
end
```

How would you remove either of these routes from the configuration?

_______________________________________________________________________________

### Step 3: On the R2 router, configure a static route.

On the R2 router, configure a static route to the 172.16.3.0 network using the Serial 0/0/0 interface of the R2 router as the exit interface.

```
R2(config)#ip route 172.16.3.0 255.255.255.0 Serial0/0/0
R2(config)#
```

### Step 4: View the routing table to verify the new static route entry.

```
R2#_________________________________

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 3 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
C       172.16.2.0 is directly connected, Serial0/0/0
S       172.16.3.0 is directly connected, Serial0/0/0
C    192.168.1.0/24 is directly connected, Serial0/0/1
S    192.168.2.0/24 [1/0] via 192.168.1.1
R2#
```

At this point, R2 has a complete routing table with valid routes to all five networks shown in the Topology Diagram.

Does this mean that R2 can receive ping replies from all destinations shown in the Topology Diagram?

________

Why or why not?

_________________________________________________________________________

_________________________________________________________________________

### Step 5: Use `ping` to check connectivity between the host PC2 and PC1.

This ping should fail because the R1 router does not have a return route to the 172.16.1.0 network in the routing table.

## Task 10: Configure a Default Static Route.

In the previous steps, you configured the router for specific destination routes. But could you do this for every route on the Internet? No. The router and you would be overwhelmed. To minimize the size of the routing tables, add a default static route. A router uses the default static route when there is not a better, more specific route to a destination.

Instead of filling the routing table of R1 with static routes, we could assume that R1 is a *stub router*. This means that R2 is the default gateway for R1. If R1 has packets to route that do not belong to any of R1 directly connected networks, R1 should send the packet to R2. However, we must explicitly configure R1 with a default route before it will send packets with unknown destinations to R2. Otherwise, R1 discards packets with unknown destinations.

To configure a default static route, use the following syntax:

```
Router(config)#ip route 0.0.0.0 0.0.0.0 { ip-address | interface }
```

### Step 1: Configure the R1 router with a default route.

Configure the R1 router with a default route using the interface option on Serial 0/0/0 of R1 as the next-hop interface.

```
R1(config)#ip route 0.0.0.0 0.0.0.0 172.16.2.2
R1(config)#
```

### Step 2: View the routing table to verify the new static route entry.

```
R1#________________________________
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is 172.16.2.2 to network 0.0.0.0

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
S*   0.0.0.0/0 [1/0] via 172.16.2.2
R1#
```

Note that the R1 router now has a default route, the *gateway of last resort*, and will send all unknown traffic out Serial 0/0/0, which is connected to R2.

### Step 3: Use `ping` to check connectivity between the host PC2 and PC1.

From the host PC2, is it possible to ping PC1? ________

This ping should be successful this time because the R1 router can return the packet using the default route.

From the host PC3, is it possible to ping the host PC1? ________

Is there a route to the 172.16.3.0 network in the routing table on the R3 router? ________

## Task 11: Configure a Summary Static Route.

We could configure another static route on R3 for the 172.16.3.0 network. However, we already have two static routes to 172.16.2.0/24 and 172.16.1.0/24. Because these networks are so close together, we can summarize them into one route. Again, doing this helps reduce the size of routing tables, which makes the route lookup process more efficient.

Looking at the three networks at the binary level, we can a common boundary at the 22nd bit from the left.

```
172.16.1.0      10101100.00010000.00000001.00000000
172.16.2.0      10101100.00010000.00000010.00000000
172.16.3.0      10101100.00010000.00000011.00000000
```

The prefix portion will include 172.16.0.0, because this would be the prefix if we turned off all the bits to the right of the 22nd bit.

```
Prefix   172.16.0.0
```

To mask the first 22 left-most bits, we use a mask with 22 bits turned on from left to right:

```
Bit Mask 11111111.11111111.11111100.00000000
```

This mask, in dotted-decimal format, is...

```
Mask     255.255.252.0
```

### Step 1: Configure the summary static route on the R3 router.

The network to be used in the summary route is 172.16.0.0/22.

```
R3(config)#ip route 172.16.0.0 255.255.252.0 192.168.1.2
```

### Step 2: Verify that the summary route is installed in the routing table.

```
R3#________________________________
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
S       172.16.0.0/22 [1/0] via 192.168.1.2
S       172.16.1.0/24 [1/0] via 192.168.1.2
S       172.16.2.0/24 is directly connected, Serial0/0/1
C    192.168.1.0/24 is directly connected, Serial0/0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```

Configuring a summary route on R3 did not remove the static routes configured earlier because these routes are more specific routes. They both use **/24** mask, whereas the new summary will be using a **/22** mask. To reduce the size of the routing table, we can now remove the more specific **/24** routes.

### Step 3: Remove static routes on R3.

Remove the two static routes that are currently configured on R3 by using the **no** form of the command.

```
R3(config)#no ip route 172.16.1.0 255.255.255.0 192.168.1.2
R3(config)#no ip route 172.16.2.0 255.255.255.0 Serial0/0/1
```

**Step 4: Verify that the routes are no longer in the routing table.**

```
R3#_________________________________
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/22 is subnetted, 1 subnets
S       172.16.0.0 [1/0] via 192.168.1.2
C    192.168.1.0/24 is directly connected, Serial0/0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```

R3 now only has one route to any host belonging to networks 172.16.0.0/24, 172.16.1.0/24, 172.16.2.0/24, and 172.16.3.0/24. Traffic destined for these networks will be sent to R2 at 192.168.1.2.

**Step 5: Use `ping` to check connectivity between the host PC3 and PC1.**

From the host PC3, is it possible to ping the host PC1? ________

This ping should be successful this time because there is a route to the 172.16.3.0 network on the R3 router, and the R1 router can return the packet using the default route.

## Task 12: Summary, Reflection, and Documentation

With the completion of this lab, you have:

- Configured your first network with a combination of static and default routing to provide full connectivity to all networks
- Observed how a route is installed in the routing table when you correctly configure and activate the interface
- Learned how to statically configure routes to destinations that are not directly connected
- Learned how to configure a default route that is used to forward packets to unknown destinations
- Learned how to summarize a group of networks into one static route to reduce the size of a routing table

Along the way, you have also probably encountered some problems either in your physical lab setup or in your configurations. Hopefully, you have learned to systematically troubleshoot such problems. At this point, record any comments or notes that may help you in future labs.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Finally, you should document your network implementation. On each router, capture the following command output to a text (.txt) file and save for future reference.

- **`show running-config`**
- **`show ip route`**
- **`show ip interface brief`**

If you need to review the procedures for capturing command output, see Lab 1.5.1.

## Task 13: Clean Up

Erase the configurations and reload the routers. Disconnect and store the cabling. For PC hosts that are normally connected to other networks (such as the school LAN or to the Internet), reconnect the appropriate cabling and restore the TCP/IP settings.

## Task 14: Challenge

In the following exercise, fill in the blanks to document the process as the ping travels from source to destination. If you need help with this exercise see Section 1.4, "Path Determination and Switching Function."

1. The ICMP process on PC3 formulates a ping request to PC2 and sends the request to the IP process.
2. The IP process on PC3 encapsulates the ping packet with a source IP address of ________________ and destination IP address of ________________.
3. PC3 then frames the packet with the source MAC address of (indicate device name) ___ _____ and the destination MAC address of (indicate device name) ______ ________.
4. Next, PC3 sends the frame out on the media as an encoded bit stream.
5. R3 receives the bit stream on its _____________ interface. Because the destination MAC address matches the receiving interface's MAC address, R3 strips off the Ethernet header.
6. R3 looks up the destination network address _______________ in its routing table. This destination has a next-hop IP address of ________________. The next-hop IP address is reachable out interface _____________.
7. R3 encapsulates the packet in an HDLC frame and forwards the frame out the correct interface. (Because this is a point-to-point link, no address is needed. However, the address field in the HDLC packet contains the value 0x8F.)
8. R2 receives the frame on the ____________ interface. Because the frame is HDLC, R2 strips off the header and looks up the network address __________________ in its routing table. This destination address is directly connected to the ___________ interface.
9. R2 encapsulates the ping request in a frame with the source MAC address of (indicated device name) ____ _____ and the destination MAC address of (indicate device name) ________.
10. R2 then sends the frame out on the media as an encoded bit stream.
11. PC2 receives the bit stream on its ___________ interface. Because the destination MAC address matches the MAC address of PC2, PC2 strips off the Ethernet header.
12. The IP process on PC2 examines the ___________ IP address to make sure that it matches its own IP address. Then PC2 passes the data to the ICMP process.
13. The ICMP process on PC2 formulates a ping reply to PC3 and sends the reply to the IP process.
14. The IP process on PC2 encapsulates the ping packet with a source IP address of ________________ and destination IP address of _______________.

15. PC2 then frames the packet with the source MAC address of (indicate device name) ________ and the destination MAC address of (indicate device name) _________.
16. PC2 then sends the frame out on the media as an encoded bit stream.
17. R2 receives the bit stream on its _____________ interface. Because the destination MAC address matches the receiving interface's MAC address, R2 strips off the Ethernet header.
18. R2 looks up the destination network address _______________ in its routing table. This destination has a next-hop IP address of _____________. The next-hop IP address is reachable out interface ____________.
19. R2 encapsulates the packet in an HDLC frame and forwards the frame out the correct interface. (Because this is a point-to-point link, no address is needed. However, the address field in the HDLC packet contains the value 0x8F.)
20. R3 receives the frame on the ___________ interface. Because the frame is HDLC, R3 strips off the header and looks up the destination network address ____________ in its routing table. This destination address is directly connected to the ______________ interface.
21. R3 encapsulates the ping request in a frame with the source MAC address of (indicated device name) ________ and the destination MAC address of (indicate device name) ________.
22. R3 then sends the frame out on the media as an encoded bit stream.
23. PC3 receives the bit stream on its ______________ interface. Because the destination MAC address matches the MAC address of PC3, PC3 strips off the Ethernet header.
24. The IP process on PC3 examines the _______ IP address to make sure that it matches its own IP address. Then PC3 passes the data to the ICMP process.
25. ICMP sends a "success" message to the requesting application.

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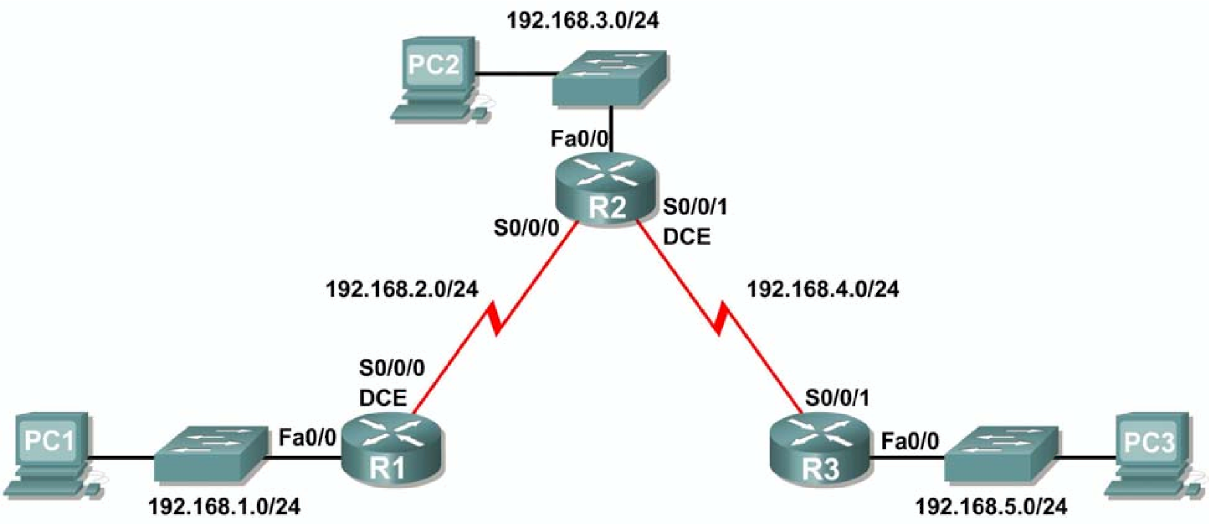
# Lab 5.6.1: Basic RIP Configuration

## Topology Diagram




## Learning Objectives

Upon completion of this lab, you will be able to:

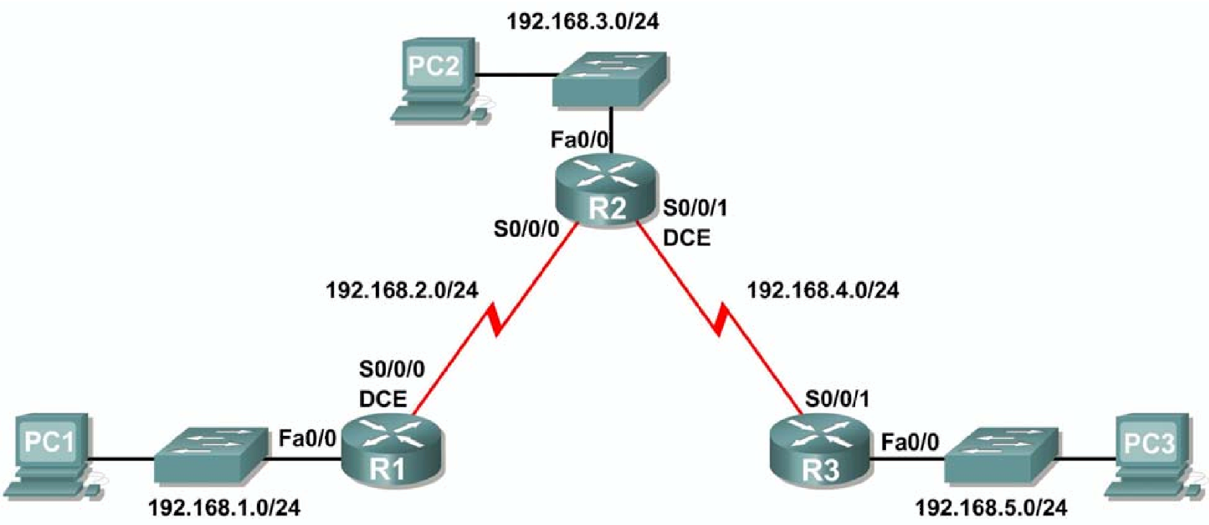
- Cable a network according to the Topology Diagram.
- Erase the startup configuration and reload a router to the default state.
- Perform basic configuration tasks on a router.
- Configure and activate interfaces.
- Configure RIP routing on all routers.
- Verify RIP routing using **`show`** and **`debug`** commands.
- Reconfigure the network to make it contiguous.
- Observe automatic summarization at boundary router.
- Gather information about RIP processing using the **`debug ip rip`** command.
- Configure a static default route.
- Propagate default routes to RIP neighbors.
- Document the RIP configuration.

## Scenarios

- Scenario A: Running RIPv1 on Classful Networks
- Scenario B: Running RIPv1 with Subnets and Between Classful Networks
- Scenario C: Running RIPv1 on a Stub Network.

## Scenario A: Running RIPv1 on Classful Networks

## Topology Diagram




## Addressing Table

| Device | Interface | IP Address | Subnet Mask | Default Gateway |
|---|---|---|---|---|
| R1 | Fa0/0 | 192.168.1.1 | 255.255.255.0 | N/A |
| | S0/0/0 | 192.168.2.1 | 255.255.255.0 | N/A |
| R2 | Fa0/0 | 192.168.3.1 | 255.255.255.0 | N/A |
| | S0/0/0 | 192.168.2.2 | 255.255.255.0 | N/A |
| | S0/0/1 | 192.168.4.2 | 255.255.255.0 | N/A |
| R3 | Fa0/0 | 192.168.5.1 | 255.255.255.0 | N/A |
| | S0/0/1 | 192.168.4.1 | 255.255.255.0 | N/A |
| PC1 | NIC | 192.168.1.10 | 255.255.255.0 | 192.168.1.1 |
| PC2 | NIC | 192.168.3.10 | 255.255.255.0 | 192.168.3.1 |
| PC3 | NIC | 192.168.5.10 | 255.255.255.0 | 192.168.5.1 |

## Task 1: Prepare the Network.

### Step 1: Cable a network that is similar to the one in the Topology Diagram.

You can use any current router in your lab as long as it has the required interfaces shown in the topology.

**Note:** If you use 1700, 2500, or 2600 routers, the router outputs and interface descriptions will appear different.

### Step 2: Clear any existing configurations on the routers.

## Task 2: Perform Basic Router Configurations.

Perform basic configuration of the R1, R2, and R3 routers according to the following guidelines:

1. Configure the router hostname.
2. Disable DNS lookup.
3. Configure an EXEC mode password.
4. Configure a message-of-the-day banner.
5. Configure a password for console connections.
6. Configure a password for VTY connections.

## Task 3: Configure and Activate Serial and Ethernet Addresses.

### Step 1: Configure interfaces on R1, R2, and R3.

Configure the interfaces on the R1, R2, and R3 routers with the IP addresses from the table under the Topology Diagram.

### Step 2: Verify IP addressing and interfaces.

Use the **`show ip interface brief`** command to verify that the IP addressing is correct and that the interfaces are active.

When you have finished, be sure to save the running configuration to the NVRAM of the router.

### Step 3: Configure Ethernet interfaces of PC1, PC2, and PC3.

Configure the Ethernet interfaces of PC1, PC2, and PC3 with the IP addresses and default gateways from the table under the Topology Diagram.

### Step 4: Test the PC configuration by pinging the default gateway from the PC.

## Task 4: Configure RIP.

### Step 1: Enable dynamic routing.

To enable a dynamic routing protocol, enter global configuration mode and use the **`router`** command.

Enter **`router ?`** at the global configuration prompt to a see a list of available routing protocols on your router.

To enable RIP, enter the command **`router rip`** in global configuration mode.

```
R1(config)#router rip
R1(config-router)#
```

### Step 2: Enter classful network addresses.

Once you are in routing configuration mode, enter the classful network address for each directly connected network, using the **`network`** command.

```
R1(config-router)#network 192.168.1.0
R1(config-router)#network 192.168.2.0
R1(config-router)#
```

The **network** command:

- Enables RIP on all interfaces that belong to this network. These interfaces will now both send and receive RIP updates.
- Advertises this network in RIP routing updates sent to other routers every 30 seconds.

When you are finished with the RIP configuration, return to privileged EXEC mode and save the current configuration to NVRAM.

```
R1(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R1#copy run start
```

**Step 3: Configure RIP on the R2 router using the `router rip` and `network` commands.**

```
R2(config)#router rip
R2(config-router)#network 192.168.2.0
R2(config-router)#network 192.168.3.0
R2(config-router)#network 192.168.4.0
R2(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#copy run start
```

When you are finished with the RIP configuration, return to privileged EXEC mode and save the current configuration to NVRAM.

**Step 4: Configure RIP on the R3 router using the `router rip` and `network` commands.**

```
R3(config)#router rip
R3(config-router)#network 192.168.4.0
R3(config-router)#network 192.168.5.0
R3(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R3# copy run start
```

When you are finished with the RIP configuration, return to privileged EXEC mode and save the current configuration to NVRAM.

## Task 5: Verify RIP Routing.

**Step 1: Use the `show ip route` command to verify that each router has all of the networks in the topology entered in the routing table.**

Routes learned through RIP are coded with an **R** in the routing table. If the tables are not converged as shown here, troubleshoot your configuration. Did you verify that the configured interfaces are active? Did you configure RIP correctly? Return to Task 3 and Task 4 to review the steps necessary to achieve convergence.

```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
C    192.168.2.0/24 is directly connected, Serial0/0/0
R    192.168.3.0/24 [120/1] via 192.168.2.2, 00:00:04, Serial0/0/0
R    192.168.4.0/24 [120/1] via 192.168.2.2, 00:00:04, Serial0/0/0
R    192.168.5.0/24 [120/2] via 192.168.2.2, 00:00:04, Serial0/0/0
R1#
```

```
R2#show ip route

<Output omitted>

R    192.168.1.0/24 [120/1] via 192.168.2.1, 00:00:22, Serial0/0/0
C    192.168.2.0/24 is directly connected, Serial0/0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
C    192.168.4.0/24 is directly connected, Serial0/0/1
R    192.168.5.0/24 [120/1] via 192.168.4.1, 00:00:23, Serial0/0/1
R2#
```

```
R3#show ip route

<Output omitted>

R    192.168.1.0/24 [120/2] via 192.168.4.2, 00:00:18, Serial0/0/1
R    192.168.2.0/24 [120/1] via 192.168.4.2, 00:00:18, Serial0/0/1
R    192.168.3.0/24 [120/1] via 192.168.4.2, 00:00:18, Serial0/0/1
C    192.168.4.0/24 is directly connected, Serial0/0/1
C    192.168.5.0/24 is directly connected, FastEthernet0/0
R3#
```

### Step 2: Use the `show ip protocols` command to view information about the routing processes.

The **`show ip protocols`** command can be used to view information about the routing processes that are occurring on the router. This output can be used to verify most RIP parameters to confirm that:

- RIP routing is configured
- The correct interfaces send and receive RIP updates
- The router advertises the correct networks
- RIP neighbors are sending updates

```
R1#show ip protocols
Routing Protocol is "rip"
Sending updates every 30 seconds, next due in 16 seconds
Invalid after 180 seconds, hold down 180, flushed after 240
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Redistributing: rip
Default version control: send version 1, receive any version
  Interface             Send  Recv  Triggered RIP  Key-chain
  FastEthernet0/0       1     2 1
  Serial0/0/0           1     2 1
Automatic network summarization is in effect
Maximum path: 4
Routing for Networks:
      192.168.1.0
      192.168.2.0
Passive Interface(s):
Routing Information Sources:
      Gateway         Distance      Last Update
      192.168.2.2          120
Distance: (default is 120)
R1#
```

R1 is indeed configured with RIP. R1 is sending and receiving RIP updates on FastEthernet0/0 and Serial0/0/0. R1 is advertising networks 192.168.1.0 and 192.168.2.0. R1 has one routing information source. R2 is sending R1 updates.

**Step 3: Use the `debug ip rip` command to view the RIP messages being sent and received.**

Rip updates are sent every 30 seconds so you may have to wait for debug information to be displayed.

```
R1#debug ip rip
R1#RIP: received v1 update from 192.168.2.2 on Serial0/0/0
      192.168.3.0 in 1 hops
      192.168.4.0 in 1 hops
      192.168.5.0 in 2 hops
RIP: sending  v1 update to 255.255.255.255 via FastEthernet0/0 (192.168.1.1)
RIP: build update entries
      network 192.168.2.0 metric 1
      network 192.168.3.0 metric 2
      network 192.168.4.0 metric 2
      network 192.168.5.0 metric 3
RIP: sending  v1 update to 255.255.255.255 via Serial0/0/0 (192.168.2.1)
RIP: build update entries
      network 192.168.1.0 metric 1
```

The debug output shows that R1 receives an update from R2. Notice how this update includes all the networks that R1 does not already have in its routing table. Because the FastEthernet0/0 interface belongs to the 192.168.1.0 network configured under RIP, R1 builds an update to send out that interface. The update includes all networks known to R1 except the network of the interface. Finally, R1 builds an update to send to R2. Because of split horizon, R1 only includes the 192.168.1.0 network in the update.

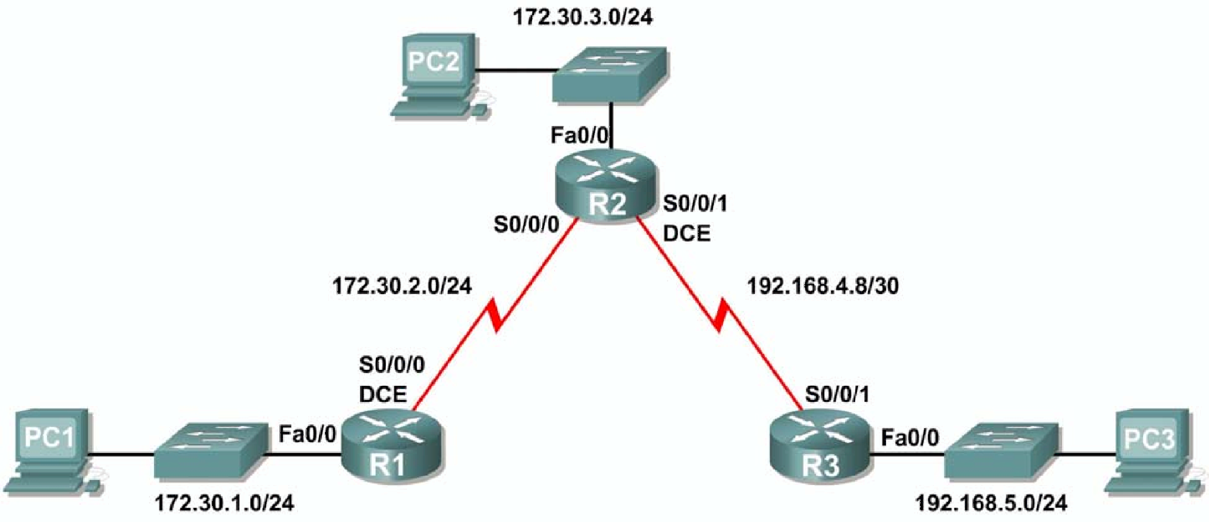
**Step 4: Discontinue the debug output with the `undebug all` command.**

```
R1#undebug all
All possible debugging has been turned off
```

## Scenario B: Running RIPv1 with Subnets and Between Classful Networks

## Topology Diagram




## Addressing Table

| Device | Interface | IP Address | Subnet Mask | Default Gateway |
|---|---|---|---|---|
| R1 | Fa0/0 | 172.30.1.1 | 255.255.255.0 | N/A |
| | S0/0/0 | 172.30.2.1 | 255.255.255.0 | N/A |
| R2 | Fa0/0 | 172.30.3.1 | 255.255.255.0 | N/A |
| | S0/0/0 | 172.30.2.2 | 255.255.255.0 | N/A |
| | S0/0/1 | 192.168.4.9 | 255.255.255.252 | N/A |
| R3 | Fa0/0 | 192.168.5.1 | 255.255.255.0 | N/A |
| | S0/0/1 | 192.168.4.10 | 255.255.255.252 | N/A |
| PC1 | NIC | 172.30.1.10 | 255.255.255.0 | 172.30.1.1 |
| PC2 | NIC | 172.30.3.10 | 255.255.255.0 | 172.30.3.1 |
| PC3 | NIC | 192.168.5.10 | 255.255.255.0 | 192.168.5.1 |

### Task 1: Make Changes between Scenario A and Scenario B

#### Step 1: Change the IP addressing on the interfaces as shown in the Topology Diagram and the Addressing Table.

Sometimes when changing the IP address on a serial interface, you may need to reset that interface by using the **`shutdown`** command, waiting for the `LINK-5-CHANGED` message, and then using the **`no shutdown`** command. This process will force the IOS to starting using the new IP address.

```
R1(config)#int s0/0/0
R1(config-if)#ip add 172.30.2.1 255.255.255.0
R1(config-if)#shutdown

%LINK-5-CHANGED: Interface Serial0/0/0, changed state to administratively
down
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to
down
R1(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up
R1(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to
up
```

**Step 2: Verify that routers are active.**

After reconfiguring all the interfaces on all three routers, verify that all necessary interfaces are active with the **`show ip interface brief`** command.

**Step 3: Remove the RIP configurations from each router.**

Although you can remove the old **`network`** commands with the **`no`** version of the command, it is more efficient to simply remove RIP and start over. Remove the RIP configurations from each router with the **`no router rip`** global configuration command. This will remove all the RIP configuration commands including the **`network`** commands.

```
R1(config)#no router rip

R2(config)#no router rip

R3(config)#no router rip
```

## Task 2: Configure RIP

**Step 1: Configure RIP routing on R1 as shown below.**

```
R1(config)#router rip
R1(config-router)#network 172.30.0.0
```

Notice that only a single network statement is needed for R1. This statement includes both interfaces on different subnets of the 172.30.0.0 major network.

**Step 2: Configure R1 to stop sending updates out the FastEthernet0/0 interface.**

Sending updates out this interface wastes the bandwidth and processing resources of all devices on the LAN. In addition, advertising updates on a broadcast network is a security risk. RIP updates can be intercepted with packet sniffing software. Routing updates can be modified and sent back to the router, corrupting the router table with false metrics that misdirects traffic.

The **`passive-interface fastethernet 0/0`** command is used to disable sending RIPv1 updates out that interface. When you are finished with the RIP configuration, return to privileged EXEC mode and save the current configuration to NVRAM.

```
R1(config-router)#passive-interface fastethernet 0/0
R1(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R1#copy run start
```

**Step 3: Configure RIP routing on R2 as shown below.**

```
R2(config)#router rip
R2(config-router)#network 172.30.0.0
R2(config-router)#network 192.168.4.0
R2(config-router)#passive-interface fastethernet 0/0
R2(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#copy run start
```

Again notice that only a single network statement is needed for the two subnets of 172.30.0.0. This statement includes both interfaces, on different subnets, of the 172.30.0.0 major network. The network for the WAN link between R2 and R3 is also configured.

When you are finished with the RIP configuration, return to privileged EXEC mode and save the current configuration to NVRAM.

**Step 4: Configure RIP routing on R3 as shown below.**

```
R3(config)#router rip
R3(config-router)#network 192.168.4.0
R3(config-router)#network 192.168.5.0
R3(config-router)#passive-interface fastethernet 0/0
R3(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R3#copy run start
```

When you are finished with the RIP configuration, return to privileged EXEC mode and save the current configuration to NVRAM.

## Task 3: Verify RIP Routing

**Step 1: Use the `show ip route` command to verify that each router has all of the networks in the topology in the routing table.**

```
R1#show ip route

<Output omitted>

     172.30.0.0/24 is subnetted, 3 subnets
C       172.30.1.0 is directly connected, FastEthernet0/0
C       172.30.2.0 is directly connected, Serial0/0/0
R       172.30.3.0 [120/1] via 172.30.2.2, 00:00:22, Serial0/0/0
R    192.168.4.0/24 [120/1] via 172.30.2.2, 00:00:22, Serial0/0/0
R    192.168.5.0/24 [120/2] via 172.30.2.2, 00:00:22, Serial0/0/0
R1#
```

**Note:** RIPv1 is a classful routing protocol. Classful routing protocols do not send the subnet mask with network in routing updates. For example, 172.30.1.0 is sent by R2 to R1 without any subnet mask information.

```
R2#show ip route

<Output omitted>

     172.30.0.0/24 is subnetted, 3 subnets
R       172.30.1.0 [120/1] via 172.30.2.1, 00:00:04, Serial0/0/0
C       172.30.2.0 is directly connected, Serial0/0/0
C       172.30.3.0 is directly connected, FastEthernet0/0
     192.168.4.0/30 is subnetted, 1 subnets
C       192.168.4.8 is directly connected, Serial0/0/1
R    192.168.5.0/24 [120/1] via 192.168.4.10, 00:00:19, Serial0/0/1
R2#
```

```
R3#show ip route

<Output omitted>

R    172.30.0.0/16 [120/1] via 192.168.4.9, 00:00:22, Serial0/0/1
     192.168.4.0/30 is subnetted, 1 subnets
C       192.168.4.8 is directly connected, Serial0/0/1
C    192.168.5.0/24 is directly connected, FastEthernet0/0
```

**Step 2: Verify that all necessary interfaces are active.**

If one or more routing tables does not have a converged routing table, first make sure that all necessary interfaces are active with **`show ip interface brief`**.

Then use **`show ip protocols`** to verify the RIP configuration. Notice in the output from this command that the FastEthernet0/0 interface is no longer listed under **Interface** but is now listed under a new section of the output: **Passive Interface(s)**.

```
R1#show ip protocols
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 20 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Redistributing: rip
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    Serial0/1/0           2     2
  Automatic network summarization is in effect
  Maximum path: 4
  Routing for Networks:
    172.30.0.0
    209.165.200.0
Passive Interface(s):
       FastEthernet0/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    209.165.200.229      120      00:00:15
  Distance: (default is 120)
```

**Step 3: View the RIP messages being sent and received.**

To view the RIP messages being sent and received use the **`debug ip rip`** command. Notice that RIP updates are not sent out of the fa0/0 interface because of the **`passive-interface fastethernet 0/0`** command.

```
R1#debug ip rip
R1#RIP: sending  v1 update to 255.255.255.255 via Serial0/0/0 (172.30.2.1)
RIP: build update entries
      network 172.30.1.0 metric 1
RIP: received v1 update from 172.30.2.2 on Serial0/0/0
      172.30.3.0 in 1 hops
```

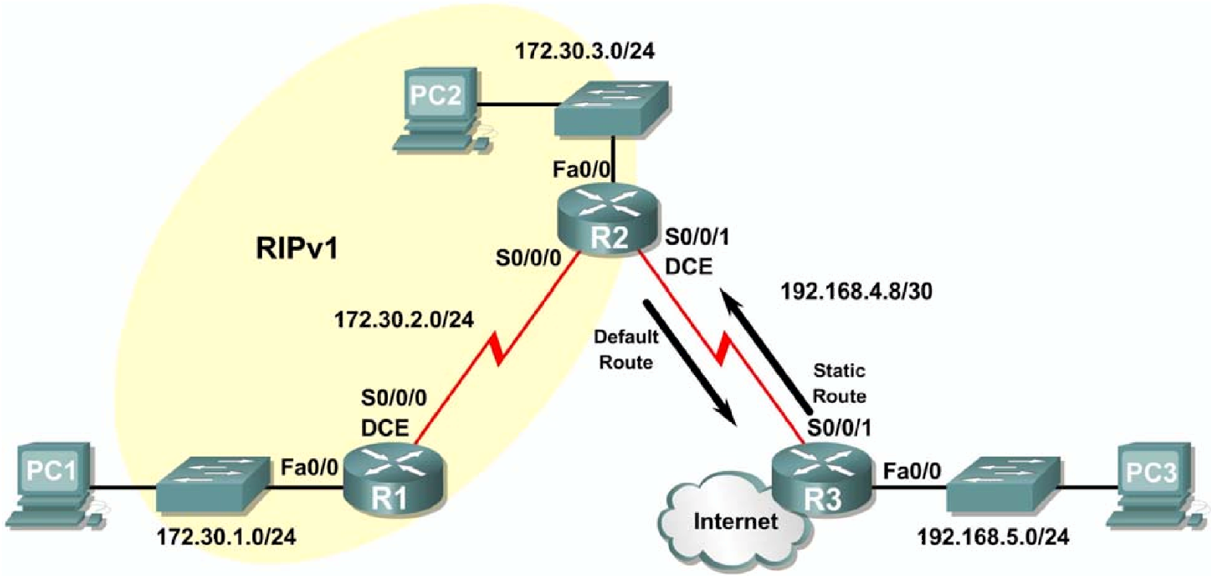
**Step 4: Discontinue the debug output with the `undebug all` command.**

```
R1#undebug all
All possible debugging has been turned off
```

## Scenario C: Running RIPv1 on a Stub Network

## Topology Diagram




## Background

In this scenario we will modify Scenario B to only run RIP between R1 and R2. Scenario C is a typical configuration for most companies connecting a stub network to a central headquarters router or an ISP. Typically, a company runs a dynamic routing protocol (RIPv1 in our case) within the local network but finds it unnecessary to run a dynamic routing protocol between the company's gateway router and the ISP. For example, colleges with multiple campuses often run a dynamic routing protocol between campuses but use default routing to the ISP for access to the Internet. In some cases, remote campuses may even use default routing to the main campus, choosing to use dynamic routing only locally.

To keep our example simple, for Scenario C, we left the addressing intact from Scenario B. Let's assume that R3 is the ISP for our Company XYZ, which consists of the R1 and R2 routers using the 172.30.0.0/16 major network, subnetted with a /24 mask. Company XYZ is a stub network, meaning that there is only one way in and one way out of the 172.30.0.0/16 network—in via R2 (the gateway router) and out via R3 (the ISP). It doesn't make sense for R2 to send R3 RIP updates for the 172.30.0.0 network every 30 seconds, because R3 has no other way to get to 172.30.0.0 except through R2. It makes more sense for R3 to have a static route configured for the 172.30.0.0/16 network pointing to R2.

How about traffic from Company XYZ toward the Internet? It makes no sense for R3 to send over 120,000 summarized Internet routes to R2. All R2 needs to know is that if a packet is not destined for a host on the 172.30.0.0 network, then it should send the packet to the ISP, R3. This is the same for all other Company XYZ routers (only R1 in our case). They should send all traffic not destined for the 172.30.0.0 network to R2. R2 would then forward the traffic to R3.

### Task 1: Make Changes between Scenario B and Scenario C.

#### Step 1: Remove network 192.168.4.0 from the RIP configuration for R2.

Remove network 192.168.4.0 from the RIP configuration for R2, because no updates will be sent between R2 and R3 and we don't want to advertise the 192.168.4.0 network to R1.

```
R2(config)#router rip
R2(config-router)#no network 192.168.4.0
```

### Step 2: Completely remove RIP routing from R3.

```
R3(config)#no router rip
```

## Task 2: Configure the Static Route on R3 for the 172.30.0.0/16 network.

Because R3 and R2 are not exchanging RIP updates, we need to configure a static route on R3 for the 172.30.0.0/16 network. This will send all 172.30.0.0/16 traffic to R2.

```
R3(config)#ip route 172.30.0.0 255.255.252.0 serial0/0/1
```

## Task 3: Configure a Default Static Route on R2.

### Step 1: Configure R2 to send default traffic to R3.

Configure a default static route on R2 that will send all default traffic—packets with destination IP addresses that do not match a specific route in the routing table—to R3.

```
R2(config)# ip route 0.0.0.0 0.0.0.0 serial 0/0/1
```

### Step 2: Configure R2 to send default static route information to R1.

The **`default-information originate`** command is used to configure R2 to include the default static route with its RIP updates. Configure this command on R2 so that the default static route information is sent to R1.

```
R2(config)#router rip
R2(config-router)#default-information originate
R2(config-router)#
```

**Note:** Sometimes it is necessary to clear the RIP routing process before the **`default-information originate`** command will work. First, try the command **`clear ip route *`** on both R1 and R2. This command will cause the routers to immediately flush routes in the routing table and request updates from each other. Sometimes this does not work with RIP. If the default route information is still not sent to R1, save the configuration on R1 and R2 and then reload both routers. Doing this will reset the hardware and both routers will restart the RIP routing process.

## Task 4: Verify RIP Routing.

### Step 1: Use the `show ip route` command to view the routing table on R2 and R1.

```
R2#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     172.30.0.0/24 is subnetted, 3 subnets
C       172.30.2.0 is directly connected, Serial0/0/0
C       172.30.3.0 is directly connected, FastEthernet0/0
R       172.30.1.0 [120/1] via 172.30.2.1, 00:00:16, Serial0/0/0
```

```
     192.168.4.0/30 is subnetted, 1 subnets
C       192.168.4.8 is directly connected, Serial0/0/1
S*   0.0.0.0/0 is directly connected, Serial0/0/1
```

Notice that R2 now has a static route tagged as a **candidate default**.

```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 172.30.2.2 to network 0.0.0.0

     172.30.0.0/24 is subnetted, 3 subnets
C       172.30.2.0 is directly connected, Serial0/0/0
R       172.30.3.0 [120/1] via 172.30.2.2, 00:00:05, Serial0/0/0
C       172.30.1.0 is directly connected, FastEthernet0/0
R*   0.0.0.0/0 [120/1] via 172.30.2.2, 00:00:19, Serial0/0/0
```

Notice that R1 now has a RIP route tagged as a **candidate default** route. The route is the "quad-zero" default route sent by R2. R1 will now send default traffic to the **Gateway of last resort** at 172.30.2.2, which is the IP address of R2.

**Step 2: View the RIP updates that are sent and received on R1 with the `debug ip rip` command.**

```
R1#debug ip rip
RIP protocol debugging is on
R1#RIP: sending  v1 update to 255.255.255.255 via Serial0/0/0 (172.30.2.1)
RIP: build update entries
      network 172.30.1.0 metric 1
RIP: received v1 update from 172.30.2.2 on Serial0/0/0
      0.0.0.0 in 1 hops
      172.30.3.0 in 1 hops
```

Notice that R1 is receiving the default route from R2.

**Step 3: Discontinue the debug output with the `undebug all` command.**

```
R1#undebug all
All possible debugging has been turned off
```

**Step 4: Use the `show ip route` command to view the routing table on R3.**

```
R3#show ip route

<Output omitted>

S    172.30.0.0/16 is directly connected, Serial0/0/1
     192.168.4.0/30 is subnetted, 1 subnets
C       192.168.4.8 is directly connected, Serial0/0/1
C    192.168.5.0/24 is directly connected, FastEthernet0/0
```

Notice that RIP is not being used on R3. The only route that is not directly connected is the static route.

## Task 5: Document the Router Configurations

On each router, capture the following command output to a text file and save for future reference:

- Running configuration
- Routing table
- Interface summarization
- Output from **`show ip protocols`**

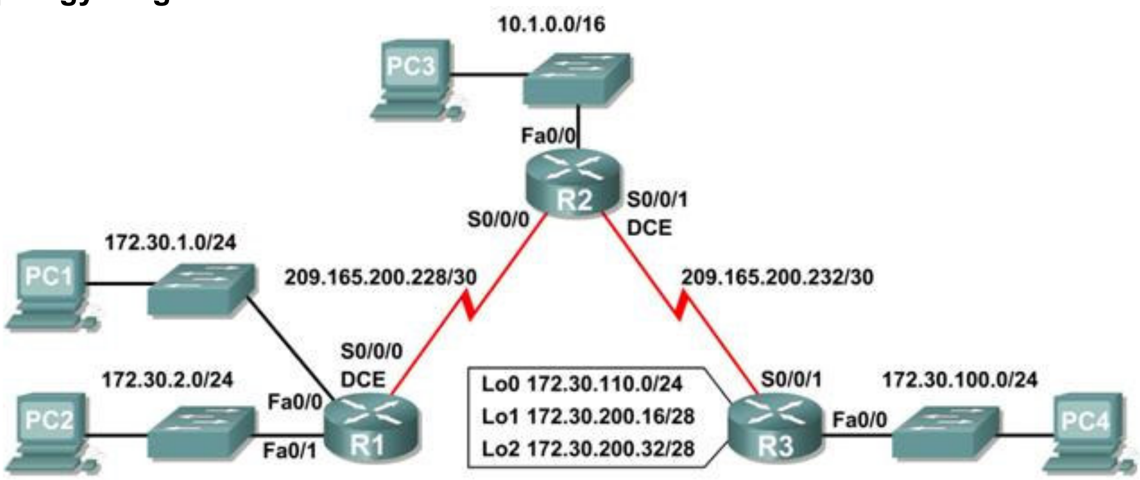
## Task 6: Clean Up

Erase the configurations and reload the routers. Disconnect and store the cabling. For PC hosts that are normally connected to other networks (such as the school LAN or to the Internet), reconnect the appropriate cabling and restore the TCP/IP settings.

# Lab 7.5.1: RIPv2 Basic Configuration Lab

## Topology Diagram




## Addressing Table

| Device | Interface | IP Address | Subnet Mask | Default Gateway |
|---|---|---|---|---|
| R1 | Fa0/0 | 172.30.1.1 | 255.255.255.0 | N/A |
| | Fa0/1 | 172.30.2.1 | 255.255.255.0 | N/A |
| | S0/0/0 | 209.165.200.230 | 255.255.255.252 | N/A |
| R2 | Fa0/0 | 10.1.0.1 | 255.255.0.0 | N/A |
| | S0/0/0 | 209.165.200.229 | 255.255.255.252 | N/A |
| | S0/0/1 | 209.165.200.233 | 255.255.255.252 | N/A |
| R3 | Fa0/0 | 172.30.100.1 | 255.255.255.0 | N/A |
| | S0/0/1 | 209.165.200.234 | 255.255.255.252 | N/A |
| | Lo0 | 172.30.110.1 | 255.255.255.0 | N/A |
| | Lo1 | 172.30.200.17 | 255.255.255.240 | N/A |
| | Lo2 | 172.30.200.33 | 255.255.255.240 | N/A |
| PC1 | NIC | 172.30.1.10 | 255.255.255.0 | 172.30.1.1 |
| PC2 | NIC | 172.30.2.10 | 255.255.255.0 | 172.30.2.1 |
| PC3 | NIC | 10.1.0.10 | 255.255.0.0 | 10.1.0.1 |
| PC4 | NIC | 172.30.100.10 | 255.255.255.0 | 172.30.100.1 |

## Learning Objectives

Upon completion of this lab, you will be able to:

- Cable a network according to the Topology Diagram.
- Load provided scripts onto the routers.
- Examine the current status of the network.
- Configure RIPv2 on all routers.
- Examine the automatic summarization of routes.
- Examine routing updates with **`debug ip rip`**.
- Disable automatic summarization.
- Examine the routing tables.
- Verify network connectivity.
- Document the RIPv2 configuration.

## Scenario

The network shown in the Topology Diagram contains a discontiguous network, 172.30.0.0. This network has been subnetted using VLSM. The 172.30.0.0 subnets are physically and logically divided by at least one other classful or major network, in this case the two serial networks 209.165.200.228/30 and 209.165.200.232/30. This can be an issue when the routing protocol used does not include enough information to distinguish the individual subnets. RIPv2 is a classless routing protocol that can be used to provide subnet mask information in the routing updates. This will allow VLSM subnet information to be propagated throughout the network.

### Task 1: Cable, Erase, and Reload the Routers.

#### Step 1: Cable a network.

Cable a network that is similar to the one in the Topology Diagram.

#### Step 2: Clear the configuration on each router.

Clear the configuration on each of routers using the **`erase startup-config`** command and then **`reload`** the routers. Answer **no** if asked to save changes.

### Task 2: Load Routers with the Supplied Scripts.

#### Step 1: Load the following script onto R1.

```
!
hostname R1
!
!
!
interface FastEthernet0/0
 ip address 172.30.1.1 255.255.255.0
 duplex auto
 speed auto
 no shutdown
!
interface FastEthernet0/1
 ip address 172.30.2.1 255.255.255.0
 duplex auto
```

```
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 209.165.200.230 255.255.255.252
 clock rate 64000
 no shutdown
!
router rip
 passive-interface FastEthernet0/0
 passive-interface FastEthernet0/1
 network 172.30.0.0
 network 209.165.200.0
!
line con 0
line vty 0 4
 login
!
end
```

**Step 2: Load the following script onto R2.**

```
hostname R2
!
!
!
interface FastEthernet0/0
 ip address 10.1.0.1 255.255.0.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 209.165.200.229 255.255.255.252
 no shutdown
!
interface Serial0/0/1
 ip address 209.165.200.233 255.255.255.252
 clock rate 64000
 no shutdown
!
router rip
 passive-interface FastEthernet0/0
 network 10.0.0.0
 network 209.165.200.0
!
line con 0
line vty 0 4
 login
!
end
```

**Step 3: Load the following script onto R3.**

```
hostname R3
!
!
!
interface FastEthernet0/0
 ip address 172.30.100.1 255.255.255.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/1
 ip address 209.165.200.234 255.255.255.252
 no shutdown
!
interface Loopback0
 ip address 172.30.110.1 255.255.255.0
!
interface Loopback1
 ip address 172.30.200.17 255.255.255.240
!
interface Loopback2
 ip address 172.30.200.33 255.255.255.240
!
router rip
 passive-interface FastEthernet0/0
 network 172.30.0.0
 network 209.165.200.0
!
line con 0
line vty 0 4
 login
!
end
```

## Task 3: Examine the Current Status of the Network.

### Step 1: Verify that both serial links are up.

The two serial links can quickly be verified using the **`show ip interface brief`** command on R2.

```
R2#show ip interface brief
Interface            IP-Address      OK? Method Status                Protocol
FastEthernet0/0      10.1.0.1        YES manual up                    up
FastEthernet0/1      unassigned      YES manual administratively down down
Serial0/0/0          209.165.200.229 YES manual up                    up
Serial0/0/1          209.165.200.233 YES manual up                    up
Vlan1                unassigned      YES manual administratively down down
```

### Step 2: Check the connectivity from R2 to the hosts on the R1 and R3 LANs.

Note: For the 1841 router, you will need to disable IP CEF to obtain the correct output from the **`ping`** command. Although a discussion of IP CEF is beyond the scope of this course, you may disable IP CEF by using the following command in global configuration mode:

```
R2(config)#no ip cef
```

From the R2 router, how many ICMP messages are successful when pinging PC1?

______________________________________________________________________

From the R2 router, how many ICMP messages are successful when pinging PC4?

______________________________________________________________________

**Step 3: Check the connectivity between the PCs.**

From the PC1, is it possible to ping PC2? __________

What is the success rate? __________

From the PC1, is it possible to ping PC3? __________

What is the success rate? __________

From the PC1, is it possible to ping PC4? __________

What is the success rate? __________

From the PC4, is it possible to ping PC2? __________

What is the success rate? __________

From the PC4, is it possible to ping PC3? __________

What is the success rate? __________

**Step 4: View the routing table on R2.**

Both the R1 and R3 are advertising routes to the 172.30.0.0/16 network; therefore, there are two entries for this network in the R2 routing table. The R2 routing table only shows the major classful network address of 172.30.0.0—it does not show any of the subnets for this network that are used on the LANs attached to R1 and R3. Because the routing metric is the same for both entries, the router alternates the routes that are used when forwarding packets that are destined for the 172.30.0.0/16 network.

```
R2#show ip route

Output omitted

     10.0.0.0/16 is subnetted, 1 subnets
C       10.1.0.0 is directly connected, FastEthernet0/0
R    172.30.0.0/16 [120/1] via 209.165.200.230, 00:00:24, Serial0/0/0
                   [120/1] via 209.165.200.234, 00:00:15, Serial0/0/1
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0/0
C       209.165.200.232 is directly connected, Serial0/0/1
```

**Step 5: Examine the routing table on the R1 router.**

Both R1 and R3 are configured with interfaces on a discontiguous network, 172.30.0.0. The 172.30.0.0 subnets are physically and logically divided by at least one other classful or major network—in this case, the two serial networks 209.165.200.228/30 and 209.165.200.232/30. Classful routing protocols like RIPv1 summarize networks at major network boundaries. Both R1 and R3 will be summarizing 172.30.0.0/24 subnets to 172.30.0.0/16. Because the route to 172.30.0.0/16 is directly connected, and because R1 does not have any specific routes for the 172.30.0.0 subnets on R3, packets destined for the R3 LANs will not be forwarded properly.

```
R1#show ip route
```

```
Output omitted

R    10.0.0.0/8 [120/1] via 209.165.200.229, 00:00:02, Serial0/0/0
     172.30.0.0/24 is subnetted, 2 subnets
C       172.30.1.0 is directly connected, FastEthernet0/0
C       172.30.2.0 is directly connected, FastEthernet0/1
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0/0
R       209.165.200.232 [120/1] via 209.165.200.229, 00:00:02, Serial0/0/0
```

**Step 6: Examine the routing table on the R3 router.**

R3 only shows its own subnets for 172.30.0.0 network: 172.30.100/24, 172.30.110/24, 172.30.200.16/28, and 172.30.200.32/28. R3 does not have any routes for the 172.30.0.0 subnets on R1.

```
R3#show ip route

Output omitted

R    10.0.0.0/8 [120/1] via 209.165.200.233, 00:00:19, Serial0/0/1
     172.30.0.0/16 is variably subnetted, 4 subnets, 2 masks
C       172.30.100.0/24 is directly connected, FastEthernet0/0
C       172.30.110.0/24 is directly connected, Loopback0
C       172.30.200.16/28 is directly connected, Loopback1
C       172.30.200.32/28 is directly connected, Loopback2
     209.165.200.0/30 is subnetted, 2 subnets
R       209.165.200.228 [120/1] via 209.165.200.233, 00:00:19, Serial0/0/1
C       209.165.200.232 is directly connected, Serial0/0/1
```

**Step 7: Examine the RIPv1 packets that are being received by R2.**

Use the **debug ip rip** command to display RIP routing updates.

R2 is receiving the route 172.30.0.0, with 1 hop, from both R1 and R3. Because these are equal cost metrics, both routes are added to the R2 routing table. Because RIPv1 is a classful routing protocol, no subnet mask information is sent in the update.

```
R2#debug ip rip
RIP protocol debugging is on
RIP: received v1 update from 209.165.200.234 on Serial0/0/1
      172.30.0.0 in 1 hops
RIP: received v1 update from 209.165.200.230 on Serial0/0/0
      172.30.0.0 in 1 hops
```

R2 is sending only the routes for the 10.0.0.0 LAN and the two serial connections to R1 and R3. R1 and R3 are not receiving any information about the 172.30.0.0 subnet routes.

```
RIP: sending  v1 update to 255.255.255.255 via Serial0/0/1
(209.165.200.233)
RIP: build update entries
      network 10.0.0.0 metric 1
      network 209.165.200.228 metric 1
RIP: sending  v1 update to 255.255.255.255 via Serial0/0/0
(209.165.200.229)
```

```
RIP: build update entries
      network 10.0.0.0 metric 1
      network 209.165.200.232 metric 1
```

When you are finished, turn off the debugging.

```
R2#undebug all
```

## Task 4: Configure RIP Version 2.

### Step 1: Use the `version 2` command to enable RIP version 2 on each of the routers.

```
R2(config)#router rip
R2(config-router)#version 2

R1(config)#router rip
R1(config-router)#version 2

R3(config)#router rip
R3(config-router)#version 2
```

RIPv2 messages include the subnet mask in a field in the routing updates. This allows subnets and their masks to be included in the routing updates. However, by default RIPv2 summarizes networks at major network boundaries, just like RIPv1, except that the subnet mask is included in the update.

### Step 2: Verify that RIPv2 is running on the routers.

The **`debug ip rip`**, **`show ip protocols`**, and **`show run`** commands can all be used to confirm that RIPv2 is running. The output of the **`show ip protocols`** command for R1 is shown below.

```
R1# show ip protocols
Routing Protocol is "rip"
Sending updates every 30 seconds, next due in 7 seconds
Invalid after 180 seconds, hold down 180, flushed after 240
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Redistributing: rip
Default version control: send version 2, receive 2
  Interface             Send  Recv  Triggered RIP  Key-chain
  FastEthernet0/0       2     2
  FastEthernet0/1       2     2
  Serial0/0/0           2     2
Automatic network summarization is in effect
Maximum path: 4
Routing for Networks:
   172.30.0.0
   209.165.200.0
Passive Interface(s):
   FastEthernet0/0
   FastEthernet0/1
Routing Information Sources:
   Gateway         Distance      Last Update
   209.165.200.229      120
Distance: (default is 120)
```

## Task 5: Examine the Automatic Summarization of Routes.

The LANs connected to R1 and R3 are still composed of discontiguous networks. R2 still shows two equal cost paths to the 172.30.0.0/16 network in the routing table. R2 still shows only the major classful network address of 172.30.0.0 and does not show any of the subnets for this network.

```
R2#show ip route

Output omitted

     10.0.0.0/16 is subnetted, 1 subnets
C       10.1.0.0 is directly connected, FastEthernet0/0
R    172.30.0.0/16 [120/1] via 209.165.200.230, 00:00:07, Serial0/0/0
                   [120/1] via 209.165.200.234, 00:00:08, Serial0/0/1
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0/0
C       209.165.200.232 is directly connected, Serial0/0/1
```

R1 still shows only its own subnets for the 172.30.0.0 network. R1 still does not have any routes for the 172.30.0.0 subnets on R3.

```
R1#show ip route

Output omitted

R    10.0.0.0/8 [120/1] via 209.165.200.229, 00:00:09, Serial0/0/0
     172.30.0.0/24 is subnetted, 2 subnets
C       172.30.1.0 is directly connected, FastEthernet0/0
C       172.30.2.0 is directly connected, FastEthernet0/1
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0/0
R       209.165.200.232 [120/1] via 209.165.200.229, 00:00:09, Serial0/0/0
```

R3 still only shows its own subnets for the 172.30.0.0 network. R3 still does not have any routes for the 172.30.0.0 subnets on R1.

```
R3#show ip route

Output omitted

R    10.0.0.0/8 [120/1] via 209.165.200.233, 00:00:16, Serial0/0/1
     172.30.0.0/16 is variably subnetted, 4 subnets, 2 masks
C       172.30.100.0/24 is directly connected, FastEthernet0/0
C       172.30.110.0/24 is directly connected, Loopback0
C       172.30.200.16/28 is directly connected, Loopback1
C       172.30.200.32/28 is directly connected, Loopback2
     209.165.200.0/30 is subnetted, 2 subnets
R       209.165.200.228 [120/1] via 209.165.200.233, 00:00:16, Serial0/0/1
C       209.165.200.232 is directly connected, Serial0/0/1
```

Use the output of the **debug ip rip** command to answer the following questions:

What entries are included in the RIP updates sent out from R3?

____________________________________

______________________________

______________________________

______________________________

______________________________

On R2, what routes are in the RIP updates that are received from R3?

___________________________________

_____________________________________________

_____________________________________________

R3 is not sending any of the 172.30.0.0 subnets—only the summarized route of 172.30.0.0/16, including the subnet mask. This is why R2 and R1 are not seeing the 172.30.0.0 subnets on R3.

### Task 6: Disable Automatic Summarization.

The **no auto-summary** command is used to turn off automatic summarization in RIPv2. Disable auto summarization on all routers. The routers will no longer summarize routes at major network boundaries.

```
R2(config)#router rip
R2(config-router)#no auto-summary

R1(config)#router rip
R1(config-router)#no auto-summary

R3(config)#router rip
R3(config-router)#no auto-summary
```

The **show ip route** and **ping** commands can be used to verify that automatic summarization is off.

### Task 7: Examine the Routing Tables.

The LANs connected to R1 and R3 should now be included in all three routing tables.

```
R2#show ip route

Output omitted

     10.0.0.0/16 is subnetted, 1 subnets
C       10.1.0.0 is directly connected, FastEthernet0/0
     172.30.0.0/16 is variably subnetted, 7 subnets, 3 masks
R       172.30.0.0/16 [120/1] via 209.165.200.230, 00:01:28, Serial0/0/0
                      [120/1] via 209.165.200.234, 00:01:56, Serial0/0/1
R       172.30.1.0/24 [120/1] via 209.165.200.230, 00:00:08, Serial0/0/0
```

```
R       172.30.2.0/24 [120/1] via 209.165.200.230, 00:00:08, Serial0/0/0
R       172.30.100.0/24 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/1
R       172.30.110.0/24 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/1
R       172.30.200.16/28 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/1
R       172.30.200.32/28 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/1
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0/0
C       209.165.200.232 is directly connected, Serial0/0/1

R1#show ip route

Output omitted

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
R       10.0.0.0/8 [120/1] via 209.165.200.229, 00:02:13, Serial0/0/0
R       10.1.0.0/16 [120/1] via 209.165.200.229, 00:00:21, Serial0/0/0
     172.30.0.0/16 is variably subnetted, 6 subnets, 2 masks
C       172.30.1.0/24 is directly connected, FastEthernet0/0
C       172.30.2.0/24 is directly connected, FastEthernet0/1
R       172.30.100.0/24 [120/2] via 209.165.200.229, 00:00:21, Serial0/0/0
R       172.30.110.0/24 [120/2] via 209.165.200.229, 00:00:21, Serial0/0/0
R       172.30.200.16/28 [120/2] via 209.165.200.229, 00:00:21, Serial0/0/0
R       172.30.200.32/28 [120/2] via 209.165.200.229, 00:00:21, Serial0/0/0
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0/0
R       209.165.200.232 [120/1] via 209.165.200.229, 00:00:21, Serial0/0/0

R3#show ip route

Output omitted

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
R       10.0.0.0/8 [120/1] via 209.165.200.233, 00:02:28, Serial0/0/1
R       10.1.0.0/16 [120/1] via 209.165.200.233, 00:00:08, Serial0/0/1
     172.30.0.0/16 is variably subnetted, 6 subnets, 2 masks
R       172.30.1.0/24 [120/2] via 209.165.200.233, 00:00:08, Serial0/0/1
R       172.30.2.0/24 [120/2] via 209.165.200.233, 00:00:08, Serial0/0/1
C       172.30.100.0/24 is directly connected, FastEthernet0/0
C       172.30.110.0/24 is directly connected, Loopback0
C       172.30.200.16/28 is directly connected, Loopback1
C       172.30.200.32/28 is directly connected, Loopback2
     209.165.200.0/30 is subnetted, 2 subnets
R       209.165.200.228 [120/1] via 209.165.200.233, 00:00:08, Serial0/0/1
C       209.165.200.232 is directly connected, Serial0/0/1
```

Use the output of the **`debug ip rip`** command to answer the following questions:

What entries are included in the RIP updates sent out from R1?

________________________________________

________________________________________

_____________________________________________________

On R2, what routes are in the RIP updates that are received from R1?

___________________________________

___________________________________

______________________________________________

Are the subnet masks now included in the routing updates? __________

## Task 8: Verify Network Connectivity.

**Step 1: Check connectivity between R2 router and PCs.**

From R2, how many ICMP messages are successful when pinging PC1?

______________________________________________________

From R2, how many ICMP messages are successful when pinging PC4?

_______________________________________________________

**Step 2: Check the connectivity between the PCs.**

From PC1, is it possible to ping PC2? __________

What is the success rate? __________

From PC1, is it possible to ping PC3? __________

What is the success rate? __________

From PC1, is it possible to ping PC4? __________

What is the success rate? __________

From PC4, is it possible to ping PC2? __________

What is the success rate? __________

From PC4, is it possible to ping PC3? __________

What is the success rate? __________

## Task 9: Documentation

On each router, capture the following command output to a text (.txt) file and save for future reference.

- **`show running-config`**
- **`show ip route`**
- **`show ip interface brief`**
- **`show ip protocols`**

If you need to review the procedures for capturing command output, refer to Lab 1.5.1.

## Task 10: Clean Up

Erase the configurations and reload the routers. Disconnect and store the cabling. For PC hosts that are normally connected to other networks (such as the school LAN or to the Internet), reconnect the appropriate cabling and restore the TCP/IP settings.