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CCNA Exploration 4.0.5.0

Routing Protocols and Concepts
Student Lab Manual

Lab 1.5.1: Cabling a Network and Basic Router Configuration

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
PC1	N/A	192.168.1.10	255.255.255.0	192.168.1.1
PC2	N/A	192.168.3.10	255.255.255.0	192.168.3.1

Learning Objectives

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

- Cable devices and establish console connections.
- Erase and reload the routers.
- Perform basic IOS command line interface operations.
- Perform basic router configuration.
- Verify and test configurations using show commands, ping and traceroute.
- Create a startup configuration file.
- Reload a startup configuration file.
- Install a terminal emulation program.

Scenario

In this lab activity, you will review previously learned skills including cabling devices, establishing a console connection, and basic IOS command line interface operation and configuration commands. You will also learn to save configuration files and capture your configurations to a text file. The skills presented in this lab are essential to completing the rest of the labs in this course. However, you may substitute the shorter version, **Lab 1.5.2: Basic Router Configuration**, if your instructor determines that you are proficient in the essential skills reviewed in this lab.

Task 1: Cable the Ethernet Links of the Network.

Cable the Ethernet links for a network that is similar to the one in the Topology Diagram. The output used in this lab is from Cisco 1841 routers. But you can use any current router in your lab as long as it has the required interfaces as shown in the topology. A simple way to identify the available interfaces on a router is by entering the **show ip interface brief** command.

Which of the devices in the Topology Diagram require an Ethernet cable between them?

_____

Step 1: Connect the R1 Router to the S1 Switch.

Use a straight-through Ethernet cable to connect the FastEthernet 0/0 interface of the R1 router to the FastEthernet 0/1 interface on the S1 switch.

What color is the link status light next to the FastEthernet 0/0 interface on R1? _____

What color is the link status light next to the FastEthernet 0/1 interface on S1? _____

Step 2: Connect PC1 to the S1 Switch.

Use a straight-through Ethernet cable to connect the network interface card (NIC) of PC1 to the FastEthernet 0/2 Interface of the S1 switch.

What color is the link status light next to the NIC interface on PC1? _____

What color is the link status light next to the FastEthernet 0/2 interface on S1? _____

If the link status lights are not green, wait a few moments for the link between the two devices to become established. If the lights do not turn green after a few moments, check that you are using a straight-through Ethernet cable and that the power is on for the S1 switch and PC1.

Step 3: Connect PC2 to the R2 Router.

Use a crossover Ethernet cable to connect the FastEthernet 0/0 interface of the R2 router to the NIC of PC2. Because there is no switch between PC2 and the R2 router, a crossover cable is required for a direct link between the PC and the router.

What color is the link status light next to the NIC interface on PC2? _____

What color is the link status light next to the FastEthernet 0/0 interface on R2? _____

Task 2: Cable the Serial Link between the R1 and R2 Routers.

In a real-world WAN connection, the customer premises equipment (CPE), which is often a router, is the data terminal equipment (DTE). This equipment is connected to the service provider through a data circuit-terminating equipment (DCE) device, which is commonly a modem or channel service unit (CSU)/ data service unit (DSU). This device is used to convert the data from the DTE into a form acceptable to the WAN service provider.

Unlike the cables in the academy lab setup, the serial cables in the real world are not connected back to back. In a real-world situation, one router might be in New York, while another router might be in Sydney, Australia. An administrator located in Sydney would have to connect to the router in New York through the WAN cloud in order to troubleshoot the New York router.

In the academy labs, devices that make up the WAN cloud are simulated by the connection between the back-to-back DTE-DCE cables. The connection from one router serial interface to another router serial interface simulates the whole circuit cloud.

Step 1: Create a null serial cable to connect the R1 router to the R2 router.

In the academy labs, the WAN connection between routers uses one DCE cable and one DTE cable. The DCE-DTE connection between routers is referred to as a null serial cable. The labs will use one V.35 DCE cable and one V.35 DTE cable to simulate the WAN connection. The V.35 DCE connector is usually a female V.35 (34-pin) connector. The DTE cable has a male V.35 connector. The cables are also labeled as DCE or DTE on the router end of the cable.

The DTE and DCE V.35 cables must be joined together. Holding one of the V.35 ends in each hand, examine the pins and sockets as well as the threaded connectors. Note that there is only one proper way for the cables to fit together. Align the pins on the male cable with the sockets on the female cable and gently couple them. Very little effort should be required to accomplish this. When they are joined, turn the thumbscrews clockwise and secure the connectors.

Step 2: Connect the DCE end of the null serial cable to the Serial 0/0/0 interface of the R1 router, and the DTE end of the null serial cable to the Serial 0/0/0 interface of the R2 router.

Review the information provided below before making these connections.

Before making the connection to one of the routers, examine the connector on the router and the cable. Note that the connectors are tapered to help prevent improper connection. Holding the connector in one hand, orient the cable and router connecters so that the tapers match. Now push the cable connector partially into the router connector. It probably will not go in all the way because the threaded connectors need to be tightened in order for the cable to be inserted completely. While holding the cable in one hand and gently pushing the cable toward the router, turn one of the thumb screws clockwise, 3 or 4 rounds, to start the screws. Now turn the other thumbscrew clockwise, 3 or 4 rounds, to get it started. At this point the cable should be attached sufficiently to free both hands to advance each thumbscrew at the same rate until the cable is fully inserted. Do not over-tighten these connectors.

Task 3: Establish a Console connection to the R1 Router.

The console port is a management port used to provide out-of-band access to a router. It is used to set up the initial configuration of a router and to monitor it.

A rollover cable and an RJ-45 to DB-9 adapter are used to connect a PC to the console port. As you know from your previous studies, terminal emulation software is used to configure the router over the console connection. The Cisco Networking Academy Program recommends using Tera Term. However, you can also use HyperTerminal, which is part of the Windows operating system.

At the end of this lab, the following three appendices are available for your reference concerning these two terminal emulation programs:

- Appendix 1: Installing and Configuring Tera Term for use on Windows XP
- Appendix 2: Configuring Tera Term as the Default Telnet Client in Windows XP
- Appendix 3: Accessing and Configuring HyperTerminal

Step 1: Examine the router and locate the RJ-45 connector labeled Console.

Step 2: Examine PC1 and locate a 9-pin male connector serial port.

It may—or may not—be labeled as COM1 or COM2.

Step 3: Locate the console cable.

Some console cables have an RJ-45 to DB-9 adapter built into one end. Others do not. Locate either a console cable with a built-in adapter or a console cable with a separate RJ-45 to DB-9 adapter attached to one end.

Step 4: Connect the console cable to the router and PC.

First, connect the console cable to the router console port, an RJ-45 connector. Next, connect the DB-9 end of the console cable to the serial port of PC1.

Step 5: Test router connection.

1. Open your terminal emulation software (HyperTerminal, Tera Term, or other software specified by your instructor).

2. Configure the software parameters specific to your applications (see appendices for help).

3. Once the terminal window is open, press the **Enter** key. There should be a response from the router. If there is, then the connection has been successfully completed. If there is no connection, troubleshoot as necessary. For example, verify that the router has power. Check the connection to the serial port on the PC and the console port on the router.

Task 4: Erase and Reload the Routers.

Step 1: Using the HyperTerminal session established in Task 3, enter privileged EXEC mode on R1.

```
Router>enable
Router#
```

Step 2: Erase the configuration.

To clear the configuration, issue the **erase startup-config** command. Confirm the objective when prompted, and answer **no** if asked to save changes. The result should look something like this:

```
Router#erase startup-config
Erasing the nvram filesystem will remove all files! Continue? [confirm]
[OK]
Erase of nvram: complete
Router#
```

Step 3: Reload the configuration.

When the prompt returns, issue the **reload** command. Confirm the objective when prompted. After the router finishes the boot process, choose not to use the AutoInstall facility, as shown:

```
Would you like to enter the initial configuration dialog? [yes/no]: no
Would you like to terminate autoinstall? [yes]:
Press Enter to accept default.
Press RETURN to get started!
```

Step 4: Establish a HyperTerminal Session to R2.

Repeat Steps 1 through 3 to remove any startup configuration file that may be present.

Task 5: Understand Command Line Basics.

Step 1: Establish a HyperTerminal session to router R1.

Step 2: Enter privileged EXEC mode.

```
Router>enable
Router#
```

Step 3: Enter an incorrect command and observe the router response.

```
Router#comfigure terminal
                 ^
% Invalid input detected at '^' marker.

Router#
```

Command line errors occur primarily from typing mistakes. If a command keyword is incorrectly typed, the user interface uses the caret symbol (^) to identify and isolate the error. The ^ appears at or near the point in the command string where an incorrect command, keyword, or argument was entered.

Step 4: Correct the previous command.

If a command is entered incorrectly, and the **Enter** key is pressed, the **Up Arrow** key on the keyboard can be pressed to repeat the last command. Use the **Right Arrow** and **Left Arrow** keys to move the cursor to the location where the mistake was made. Then make the correction. If something needs to be deleted, use the **Backspace** key. Use the directional keys and the **Backspace** key to correct the command to **configure terminal**, and then press **Enter**.

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

Step 5: Return to privileged EXEC mode with the `exit` command.

```
Router(config)#exit
%SYS-5-CONFIG_I: Configured from console by console
Router#
```

Step 6: Examine the commands that are available for privileged EXEC mode.

A question mark, **?**, can be entered at the prompt to display a list of available commands.

```
Router#?
Exec commands:
  <1-99>      Session number to resume
  clear       Reset functions
  clock       Manage the system clock
  configure   Enter configuration mode
  connect     Open a terminal connection
  copy        Copy from one file to another
  debug       Debugging functions (see also 'undebug')
  delete      Delete a file
  dir         List files on a filesystem
  disable     Turn off privileged commands
  disconnect  Disconnect an existing network connection
  enable      Turn on privileged commands
  erase       Erase a filesystem
  exit        Exit from the EXEC
  logout      Exit from the EXEC
  no          Disable debugging informations
  ping        Send echo messages
  reload      Halt and perform a cold restart
  resume      Resume an active network connection
  setup       Run the SETUP command facility
  show        Show running system information
 --More--
```

Notice the `--More--` at the bottom of the command output. The `--More--` prompt indicates that there are multiple screens of output. When a `--More--` prompt appears, press the **Spacebar** to view the next available screen. To display only the next line, press the **Enter** key. Press any other key to return to the prompt.

Step 7: View output.

View the rest of the command output by pressing the **Spacebar**. The remainder of the output will appear where the `--More--` prompt appeared previously.

```
telnet      Open a telnet connection
traceroute  Trace route to destination
undebug     Disable debugging functions (see also 'debug')
vlan        Configure VLAN parameters
write       Write running configuration to memory, network, or terminal
```

Step 8: Exit privileged EXEC mode with the `exit` command.

```
Router#exit
```

The following output should be displayed:

```
Router con0 is now available


Press RETURN to get started.
```

Step 9: Press the Enter key to enter user EXEC mode.

The `Router>` prompt should be visible.

Step 10: Type an abbreviated IOS command.

IOS commands can be abbreviated, as long as enough characters are typed for the IOS to recognize the unique command.

Enter only the character **e** at the command prompt and observe the results.

```
Router>e
% Ambiguous command: "e"
Router>
```

Enter **en** at the command prompt and observe the results.

```
Router>en
Router#
```

The abbreviated command **en** contains enough characters for the IOS to distinguish the **enable** command from the **exit** command.

Step 11: Press the Tab key after an abbreviated command to use auto-complete.

Typing an abbreviated command, such as **conf**, followed by the **Tab** key completes a partial command name. This functionality of the IOS is called auto-complete. Type the abbreviated command **conf**, press the **Tab** key, and observe the results.

```
Router#conf
Router#configure
```

This auto-complete feature can be used as long as enough characters are typed for the IOS to recognize the unique command.

Step 12: Enter IOS commands in the correct mode.

IOS commands must be entered in the correct mode. For example, configuration changes cannot be made while in privileged EXEC mode. Attempt to enter the command hostname **R1** at the privileged EXEC prompt and observe the results.

```
Router#hostname R1
                ^
% Invalid input detected at '^' marker.

Router#
```

Task 6: Perform Basic Configuration of Router R1.

Step 1: Establish a HyperTerminal session to router R1.

Step 2: Enter privileged EXEC mode.

```
Router>enable
Router#
```

Step 3: Enter global configuration mode.

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

Step 4: Configure the router name as R1.

Enter the command **hostname R1** at the prompt.

```
Router(config)#hostname R1
R1(config)#
```

Step 5: Disable DNS lookup with the no ip domain-lookup command.

```
R1(config)#no ip domain-lookup
R1(config)#
```

Why would you want to disable DNS lookup in a lab environment?

_____

_____

What would happen if you disabled DNS lookup in a production environment?

_____

_____

Step 6: Configure an EXEC mode password.

Configure an EXEC mode password using the **enable secret** *password* command. Use **class** for the *password*.

```
R1(config)#enable secret class
R1(config)#
```

The **enable secret** command is used to provide an additional layer of security over the **enable password** command. The **enable secret** command provides better security by storing the **enable secret** password using a non-reversible cryptographic function. The added layer of security encryption provides is useful in environments where the password crosses the network or is stored on a TFTP server. When both the **enable password** and **enable secret** passwords are configured, the router expects the password as defined in the **enable secret** command. In this case, the router ignores the password defined in the **enable password** command.

Step 7: Remove the enable password.

Because the **enable secret** is configured, the **enable password** is no longer necessary. IOS commands can be removed from the configuration using the **no** form of the command.

```
R1(config)#no enable password
R1(config)#
```

Step 8: Configure a message-of-the-day banner using the banner motd command.

```
R1(config)#banner motd &
Enter TEXT message.  End with the character '&'.
*******************************
  !!!AUTHORIZED ACCESS ONLY!!!
*******************************
&
R1(config)#
```

When does this banner display?

_____

_____

Why should every router have a message-of-the-day banner?

_____

_____

Step 9: Configure the console password on the router.

Use **cisco** as the password. When you are finished, exit from line configuration mode.
```
R1(config)#line console 0
R1(config-line)#password cisco
R1(config-line)#login
R1(config-line)#exit
R1(config)#
```

Step 10: Configure the password for the virtual terminal lines.

Use `cisco` as the password. When you are finished, exit from line configuration mode.

```
R1(config)#line vty 0 4
R1(config-line)#password cisco
R1(config-line)#login
R1(config-line)#exit
R1(config)#
```

Step 11: Configure the FastEthernet 0/0 interface with the IP address 192.168.1.1/24.

```
R1(config)#interface fastethernet 0/0
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed
state to up
R1(config-if)#
```

Step 12: Use the `description` command to provide a description for this interface.

```
R1(config-if)#description R1 LAN
R1(config-if)#
```

Step 13: Configure the Serial0/0/0 interface with the IP address 192.168.2.1/24.

Set the clock rate to 64000.

Note: Because the routers in the labs will not be connected to a live leased line, one of the routers will need to provide the clocking for the circuit. This is normally provided to each of the routers by the service provider. To provide this clocking signal in the lab, one of the routers will need to act as the DCE on the connection. This function is achieved by applying the `clock rate 64000` command on the serial 0/0/0 interface, where the DCE end of the null modem cable has been connected. The purpose of the `clock rate` command is discussed further in Chapter 2, "Static Routes."

```
R1(config-if)#interface serial 0/0/0
R1(config-if)#ip address 192.168.2.1 255.255.255.0
R1(config-if)#clock rate 64000
R1(config-if)#no shutdown
R1(config-if)#
```

Note: The interface will not be activated until the serial interface on R2 is configured and activated.

Step 14: Use the `description` command to provide a description for this interface.

```
R1(config-if)#description Link to R2
R1(config-if)#
```

Step 15: Use the `end` command to return to privileged EXEC mode.

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

Step 16: Save the R1 configuration.

Save the R1 configuration using the `copy running-config startup-config` command.

```
R1#copy running-config startup-config
Building configuration...
[OK]
R1#
```

Task 7: Perform Basic Configuration of Router R2.

Step 1: For R2, repeat Steps 1 through 10 from Task 6.

Step 2: Configure the Serial 0/0/0 interface with the IP address 192.168.2.2/24.

```
R2(config)#interface serial 0/0/0
R2(config-if)#ip address 192.168.2.2 255.255.255.0
R2(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state
to up
R2(config-if)#
```

Step 3: Use the `description` command to provide a description for this interface.

```
R1(config-if)#description Link to R1
R1(config-if)#
```

Step 4: Configure the FastEthernet 0/0 interface with the IP address 192.168.3.1/24.

```
R2(config-if)#interface fastethernet 0/0
R2(config-if)#ip address 192.168.3.1 255.255.255.0
R2(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed
state to up
R2(config-if)#
```

Step 5: Use the `description` command to provide a description for this interface.

```
R1(config-if)#description R2 LAN
R1(config-if)#
```

Step 6: Use the `end` command to return to privileged EXEC mode.

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

Step 7: Save the R2 configuration.

Save the R2 configuration using the `copy running-config startup-config` command,

```
R2#copy running-config startup-config
Building configuration...
[OK]
R2#
```

Task 8: Configure IP Addressing on the Host PCs.

Step 1: Configure the host PC1.

Configure the host PC1 that is attached to R1 with an IP address of 192.168.1.10/24 and a default gateway of 192.168.1.1.

Step 2: Configure the host PC2.

Configure the host PC2 that is attached to R2 with an IP address of 192.168.3.10/24 and a default gateway of 192.168.3.1.

Task 9: Examine Router `show` Commands.

There are many `show` commands that can be used to examine the operation of the router. In both privileged EXEC and user EXEC modes, the command `show ?` provides a list of available `show` commands. The list is considerably longer in privileged EXEC mode than it is in user EXEC mode.

Step 1: Examine the `show running-config` command.

The `show running-config` command is used to display the contents of the currently running configuration file. From privileged EXEC mode on the R1 router, examine the output of the `show running-config` command. If the `--More--` prompt appears, press the **Spacebar** to view the remainder of the command output.

```
R1#show running-config
!
version 12.3
!
hostname R1
!
!
enable secret 5 $1$AFDd$0HCi0iYHkEWR4cegQdTQu/
!
no ip domain-lookup
!
interface FastEthernet0/0
 description R1 LAN
 mac-address 0007.eca7.1511
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 mac-address 0001.42dd.a220
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface Serial0/0/0
 description Link to R2
 ip address 192.168.2.1 255.255.255.0
 clock rate 64000
!
interface Serial0/0/1
 no ip address
```

```
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
ip classless
!
!
!
!
line con 0
 password cisco
line vty 0 4
 password cisco
 login
!
end
```

Step 2: Examine The `show startup-config` command.

The `show startup-config` command displays the startup configuration file contained in NVRAM.
From privileged EXEC mode on the R1 router, examine the output of the `show startup-config`
command. If the `--More--` prompt appears, press the **Spacebar** to view the remainder of the command
output.

```
R1#show startup-config
Using 583 bytes
!
version 12.3
!
hostname R1
!
!
no ip domain-lookup
!
interface FastEthernet0/0
 description R1 LAN
 mac-address 0007.eca7.1511
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 mac-address 0001.42dd.a220
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface Serial0/0/0
 description Link to R2
 ip address 192.168.2.1 255.255.255.0
 clock rate 64000
!
interface Serial0/0/1
 no ip address
```

```
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
ip classless
!
!
!
!
line con 0
 password cisco
line vty 0 4
 password cisco
 login
!
end
```

Step 3: Examine the `show interfaces` command.

The `show interfaces` command displays statistics for all interfaces configured on the router. A specific interface can be added to the end of this command to display the statistics for only that interface. From privileged EXEC mode on the R1 router, examine the output of the `show interfaces fastEthernet0/0` command. If the `--More--` prompt appears, press the **Spacebar** to view the remainder of the command output.

```
R1# show interfaces fastEthernet 0/0
FastEthernet0/0 is up, line protocol is up (connected)
  Hardware is Lance, address is 0007.eca7.1511 (bia 0002.1625.1bea)
  Description: R1 LAN
  Internet address is 192.168.1.1/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00,
  Last input 00:00:08, output 00:00:05, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue :0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 input packets with dribble condition detected
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
R1#
```

Step 4: Examine the `show version` command.

The `show version` command displays information about the currently loaded software version along with hardware and device information. From privileged EXEC mode on the R1 router, examine the output

of the `show version` command. If the `--More--` prompt appears, press the **Spacebar** to view the remainder of the command output.

```
R1#show version
Cisco IOS Software, 1841 Software (C1841-IPBASE-M), Version 12.3(14)T7,
RELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2006 by Cisco Systems, Inc.
Compiled Mon 15-May-06 14:54 by pt_team

ROM: System Bootstrap, Version 12.3(8r)T8, RELEASE SOFTWARE (fc1)

System returned to ROM by power-on
System image file is "flash:c1841-ipbase-mz.123-14.T7.bin"
This product contains cryptographic features and is subject to United
States and local country laws governing import, export, transfer and
use. Delivery of Cisco cryptographic products does not imply
third-party authority to import, export, distribute or use encryption.
Importers, exporters, distributors and users are responsible for
compliance with U.S. and local country laws. By using this product you
agree to comply with applicable laws and regulations. If you are unable
to comply with U.S. and local laws, return this product immediately.

A summary of U.S. laws governing Cisco cryptographic products may be found
at:
http://www.cisco.com/wwl/export/crypto/tool/stqrg.html

If you require further assistance please contact us by sending email to
export@cisco.com.

Cisco 1841 (revision 5.0) with 114688K/16384K bytes of memory.
Processor board ID FTX0947Z18E
M860 processor: part number 0, mask 49
2 FastEthernet/IEEE 802.3 interface(s)
2 Low-speed serial(sync/async) network interface(s)
191K bytes of NVRAM.
31360K bytes of ATA CompactFlash (Read/Write)

Configuration register is 0x2102

R1#
```

Step 5: Examine the `show ip interface brief` command.

The `show ip interface brief` command displays a summary of the usability status information for each interface. From privileged EXEC mode on the R1 router, examine the output of the `show ip interface brief` command. If the `--More--` prompt appears, press the **Spacebar** to view the remainder of the command output.

```
R1#show ip interface brief
Interface          IP-Address      OK? Method Status                 Protocol

FastEthernet0/0    192.168.1.1     YES manual up                     up

FastEthernet0/1    unassigned      YES manual administratively down down

Serial0/0/0        192.168.2.1     YES manual up                     up
```

```
    Serial0/0/1              unassigned     YES manual administratively down down

    Vlan1                    unassigned     YES manual administratively down down
    R1#
```

Task 10: Using `ping`.

The `ping` command is a useful tool for troubleshooting Layers 1 though 3 of the OSI model and diagnosing basic network connectivity. This operation can be performed at either the user or privileged EXEC modes. Using `ping` sends an Internet Control Message Protocol (ICMP) packet to the specified device and then waits for a reply. Pings can be sent from a router or a host PC.

Step 1: Use the `ping` command to test connectivity between the R1 router and PC1.

```
R1#ping 192.168.1.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.10, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 72/79/91 ms
```

Each exclamation point (!) indicates a successful echo. Each period (.) on the display indicates that the application on the router timed out while it waited for a packet echo from a target. The first ping packet failed because the router did not have an ARP table entry for the destination address of the IP packet. Because there is no ARP table entry, the packet is dropped. The router then sends an ARP request, receives a response, and adds the MAC address to the ARP table. When the next ping packet arrives, it will be forwarded and be successful.

Step 2: Repeat the ping from R1 to PC1.

```
R1#ping 192.168.1.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/83/93 ms

R1#
```

All of the pings are successful this time because the router has an entry for the destination IP address in the ARP table.

Step 3: Send an extended ping from R1 to PC1.

To accomplish this, type `ping` at the privileged EXEC prompt and press **Enter**. Fill out the rest of the prompts as shown:

```
R1#ping
Protocol [ip]:
Target IP address: 192.168.1.10
Repeat count [5]: 10
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]:
Sweep range of sizes [n]:
Type escape sequence to abort.
```

```
   Sending 10, 100-byte ICMP Echos to 192.168.1.10, timeout is 2 seconds:
   !!!!!!!!!!
   Success rate is 100 percent (10/10), round-trip min/avg/max = 53/77/94 ms

   R1#
```

Step 4: Send a ping from PC1 to R1.

From Windows go to **Start > Programs > Accessories > Command Prompt**. In the Command Prompt window that opens, ping R1 by issuing the following command:

```
   C:\> ping 192.168.1.1
```

The ping should respond with successful results.

Step 5: Send an extended ping from PC1 to R1.

To accomplish this, enter the following command at the Windows command prompt:

```
   C:\>ping 192.168.1.1 –n 10
```

There should be 10 successful responses from the command.

Task 11: Using `traceroute`.

The **traceroute** command is an excellent utility for troubleshooting the path that a packet takes through an internetwork of routers. It can help to isolate problem links and routers along the way. The **traceroute** command uses ICMP packets and the error message generated by routers when the packet exceeds its Time-To-Live (TTL). This operation can be performed at either the user or privileged EXEC modes. The Windows version of this command is **tracert**.

Step 1: Use the `traceroute` command at the R1 privileged EXEC prompt to discover the path that a packet will take from the R1 router to PC1.

```
   R1#traceroute 192.168.1.10
   Type escape sequence to abort.
   Tracing the route to 192.168.1.10

       1   192.168.1.10    103 msec  81 msec   70 msec
     R1#
```

Step 2: Use the `tracert` command at the Windows command prompt to discover the path that a packet will take from the R1 router to PC1.

```
C:\>tracert 192.168.1.1

Tracing route to 192.168.1.1 over a maximum of 30 hops:

  1    71 ms 70 ms 73 ms 192.168.1.1

Trace complete.

C:\>
```

Task 12: Create a start.txt File.

Router configurations can be captured to a text (.txt) file and saved for later use. The configuration can be copied back to the router so that the commands do not have to be entered one at a time.

Step 1: View the running configuration of the router using the `show running-config` command.

```
R1#show running-config
!
version 12.3
!
hostname R1
!
!
enable secret 5 $1$J.hq$Ds72Qz86tvpcuW2X3FqBS.
!
no ip domain-lookup
!
interface FastEthernet0/0
 description R1 LAN
 mac-address 0007.eca7.1511
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 mac-address 0001.42dd.a220
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface Serial0/0/0
 description Link to R2
 ip address 192.168.2.1 255.255.255.0
 clock rate 64000
!
interface Serial0/0/1
 no ip address
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
ip classless
!
!
!
!
line con 0
 password cisco
line vty 0 4
 password cisco
 login
!
```

```
    end

    R1#
```

Step 2: Copy the command output.

Select the command output. From the HyperTerminal Edit menu, choose the copy command.

Step 3: Paste output in Notepad.

Open Notepad. Notepad is typically found on the **Start** menu under **Programs > Accessories**. From the Notepad Edit menu, click **Paste**.

Step 4: Edit commands.

Some commands will have to be edited or added before the startup script can be applied to a router. Some of these changes are:

- Adding a **no shutdown** command to FastEthernet and serial interfaces that are being used.
- Replacing the encrypted text in the **enable secret** command with the appropriate password.
- Removing the **mac-address** command from the interfaces.
- Removing the **ip classless** command.
- Removing unused interfaces.

Edit the text in the Notepad file as shown below:

```
hostname R1
!
!
enable secret class
!
no ip domain-lookup
!
interface FastEthernet0/0
 description R1 LAN
  ip address 192.168.1.1 255.255.255.0
 no shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 description Link to R2
 ip address 192.168.2.1 255.255.255.0
 clock rate 64000
 no shutdown
!
!
!
!
line con 0
 password cisco
line vty 0 4
 password cisco
 login
```

```
!
end
```

Step 5: Save the open file in Notepad to start.txt.

Task 13: Load the start.txt File onto the R1 Router.

Step 1: Erase the current startup configuration of R1.

Confirm the objective when prompted, and answer **no** if asked to save changes. The result should look something like this:

```
R1#erase startup-config
Erasing the nvram filesystem will remove all files! Continue? [confirm]
[OK]
Erase of nvram: complete
Router#
```

Step 2: When the prompt returns, issue the `reload` command.

Confirm the objective when prompted. After the router finishes the boot process, choose not to use the AutoInstall facility, as shown:

```
Would you like to enter the initial configuration dialog? [yes/no]: no
Would you like to terminate autoinstall? [yes]:
Press Enter to accept default.
Press RETURN to get started!
```

Step 3: Enter global configuration mode.

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

Step 4: Copy the commands.

In the start.txt file that was created in Notepad, select all the lines, and then choose **Edit > Copy**.

Step 5: From the HyperTerminal Edit menu, choose Paste to Host.

Step 6: Verify the running configuration.

After all of the pasted commands have been applied, use the **show running-config** command to verify that the running configuration appears as expected.

Step 7: Save the running configuration,

Save the running configuration to NVRAM using the **copy running-config startup-config** command.

```
R1#copy running-config startup-config
Building configuration...
[OK]
R1#
```

Appendix 1: Installing and Configuring Tera Term for use on Windows XP

Tera Term is a free terminal emulation program for Windows. It can be used in the lab environment in place of Windows HyperTerminal. Tera Term can be obtained at the following URL:

http://hp.vector.co.jp/authors/VA002416/teraterm.html

Download the "ttermp23.zip", unzip it, and install Tera Term.

Step 1: Open the Tera Terminal program.

Step 2: Assign Serial port.

To use Terra Term to connect to the router console, open the **New connection** dialog box and select the **Serial** port.

Step 3: Set Serial port parameters.

Set appropriate parameters for Port in the Serial section of the **Tera Term:New Connection** dialog box. Normally, your connection is through COM1. If you are unsure what port to use, ask your instructor for assistance.
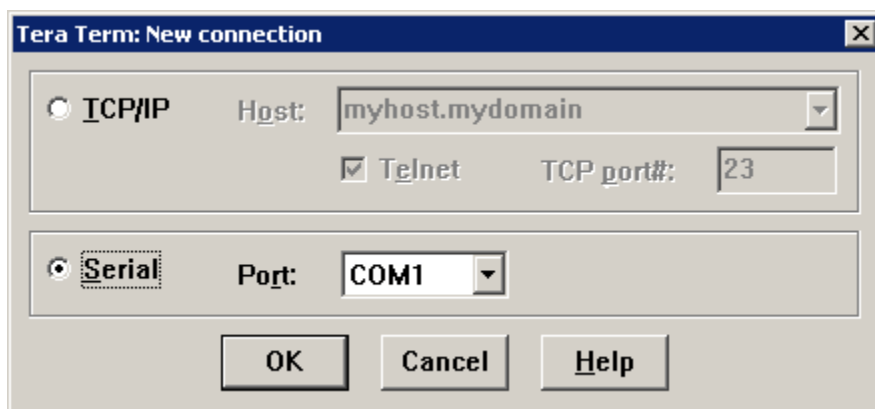
Step 4: Configure settings.

Terra Term has some settings that can be changed to make it more convenient to use. From the **Setup > Terminal** menu, check the **Term size = win size** checkbox. This setting allows command output to remain visible when the Terra Term window is resized.
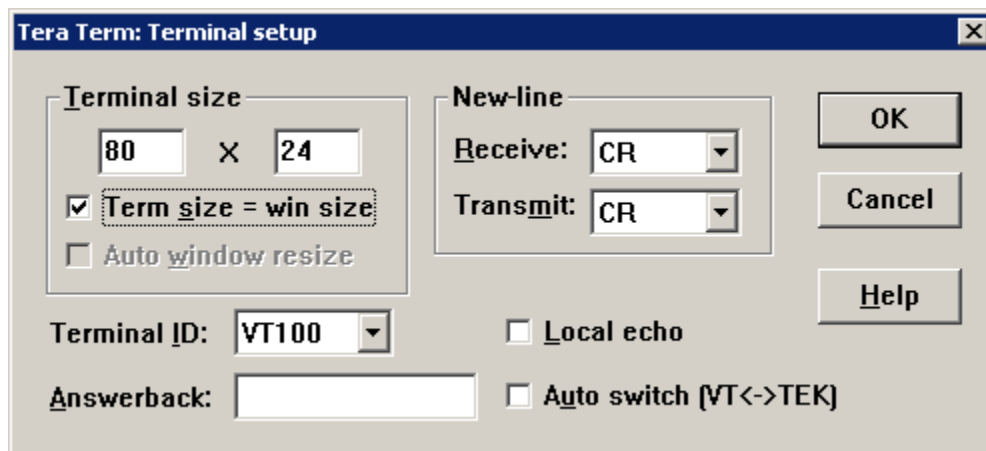
Step 5: Change scroll buffer number.

From the **Setup > Window** menu, change the scroll buffer number to a number higher than 100. This setting allows you to scroll up and view previous commands and outputs. If there are only 100 lines available in the buffer, only the last 100 lines of output are visible. In the example below, the scroll buffer has been changed to 1000 lines.
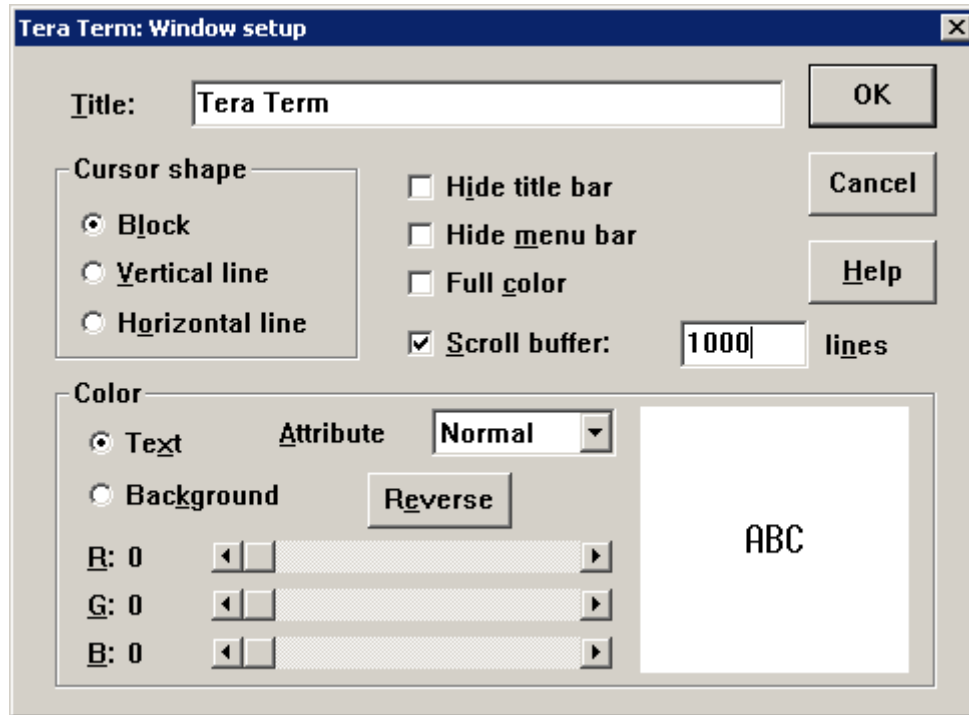
Appendix 2: Configuring Tera Term as the Default Telnet Client in Windows XP

Be default, Windows may be set to use HyperTerminal as the Telnet client. Windows may also be set to use the DOS version of Telnet. In the NetLab environment, you can change the Telnet client to **Local Telnet Client**, which means that NetLab will open the current Windows default Telnet client. This may be set to HyperTerminal or to the DOS-like version of Telnet embedded in the Windows operating system.

Complete the following steps to change your default Telnet client to Tera Term (or any other Telnet client):

Step 1: Go to Folder Options.

Double-click **My Computer**, and then choose **Tools > Folder Options**.

Step 2: Go to (NONE) URL:Telnet Protocol.

Click the **File Types** tab and scroll down in the list of **Registered file types:** until you find the **(NONE) URL:Telnet Protocol** entry. Select it and then click the **Advanced** button.
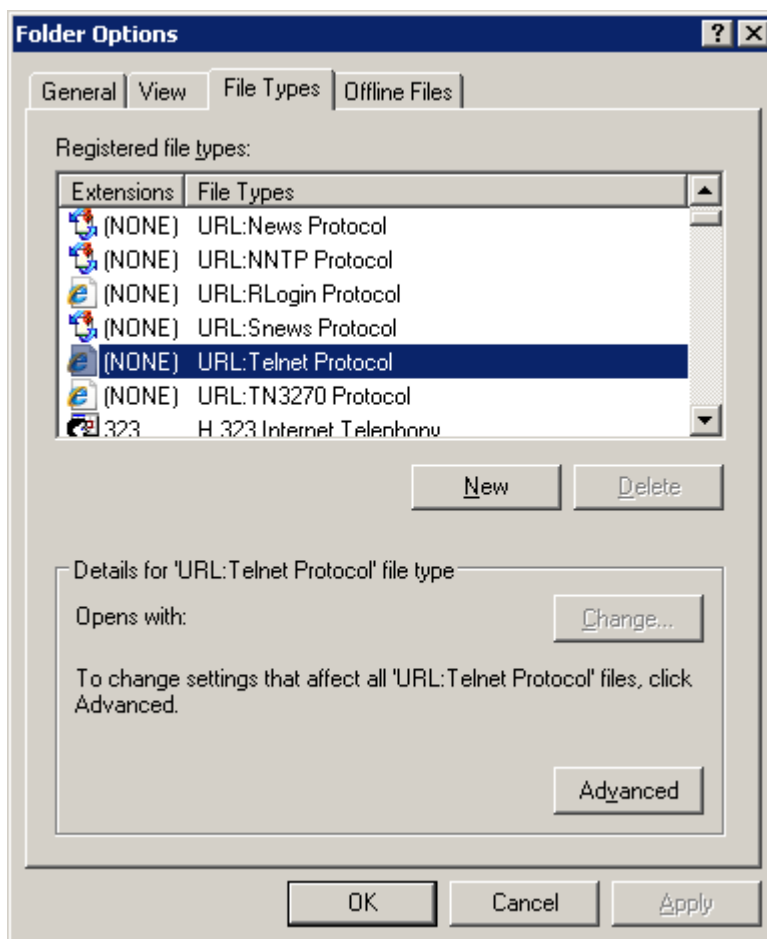
Step 3: Edit the open action.

In the **Edit File Type** dialog box, click **Edit** to edit the **open** action.
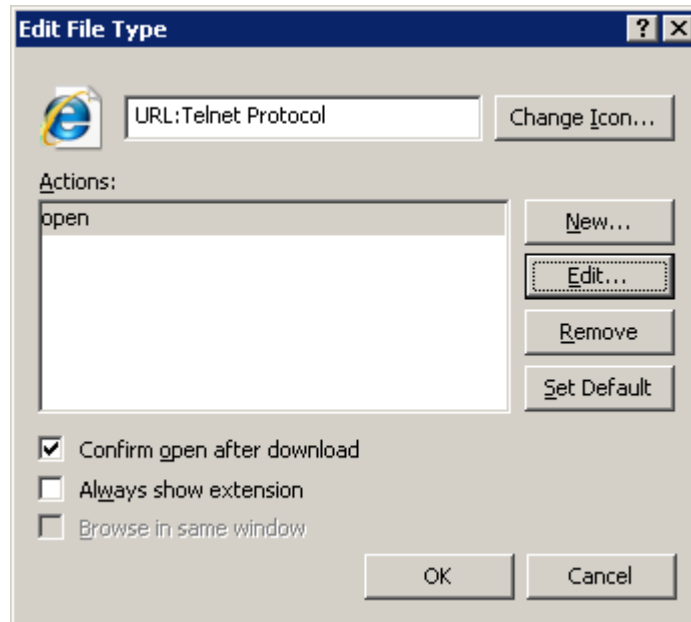
Step 4: Change the application.

In the **Editing action for type: URL: Telnet Protocol** dialog box, the **Application used to perform action** is currently set to HyperTerminal. Click **Browse** to change the application.
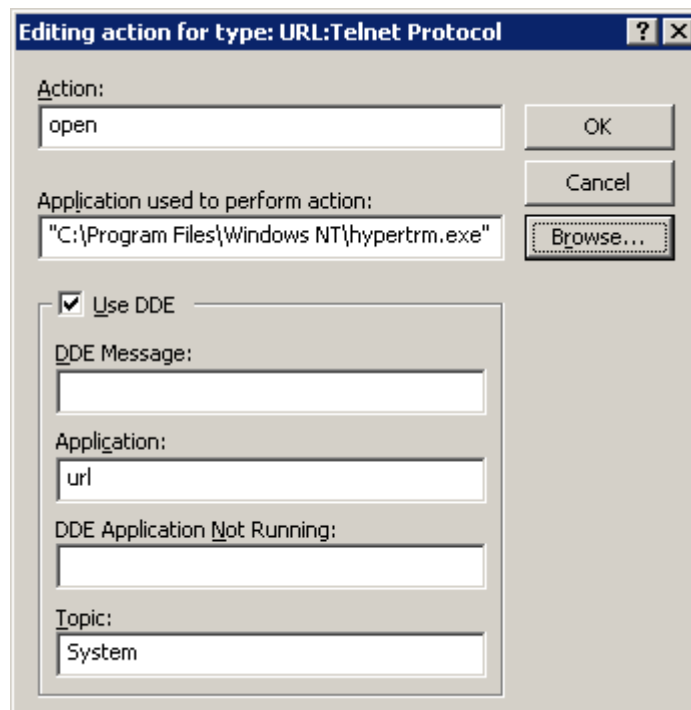
Step 5: Open ttermpro.exe.

Browse to the Tera Term installation folder. Click the ttermpro.exe file to specify this program for the **open** action, and then click **Open**.
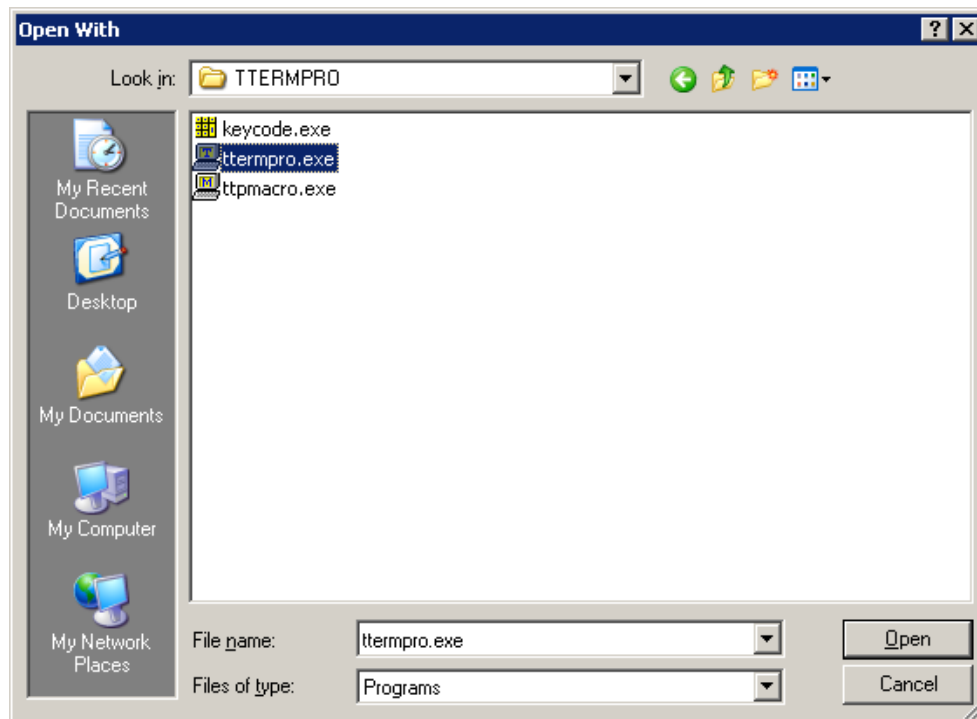
Step 6: Confirm ttermpro.exe and close.

Click **OK** twice and then **Close** to close the **Folder Options** dialog box. The Windows default Telnet client is now set to Tera Term.
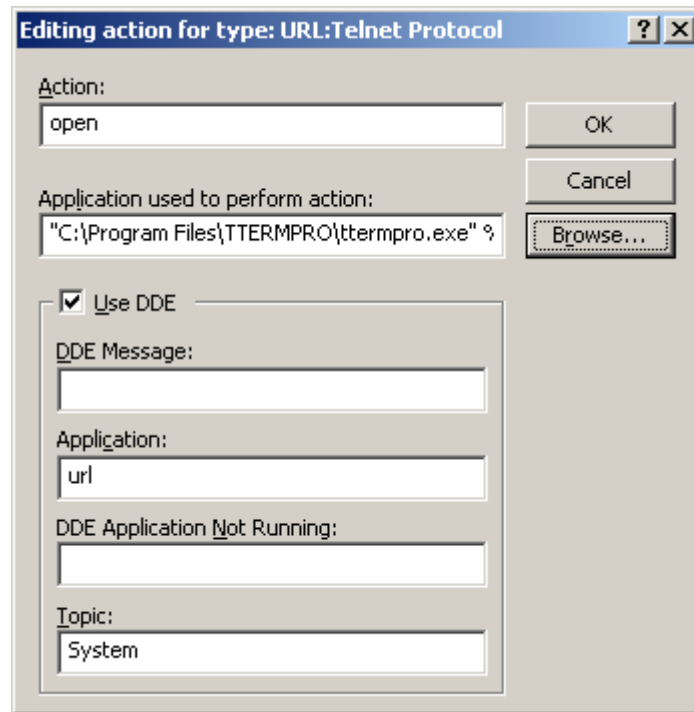
Appendix 3: Accessing and Configuring HyperTerminal

In most versions of Windows, HyperTerminal can be found by navigating to **Start > Programs > Accessories > Communications > HyperTerminal**.

Step 1: Create a new connection.

Open HyperTerminal to create a new connection to the router. Enter an appropriate description in the **Connection Description** dialog box and then click **OK**.
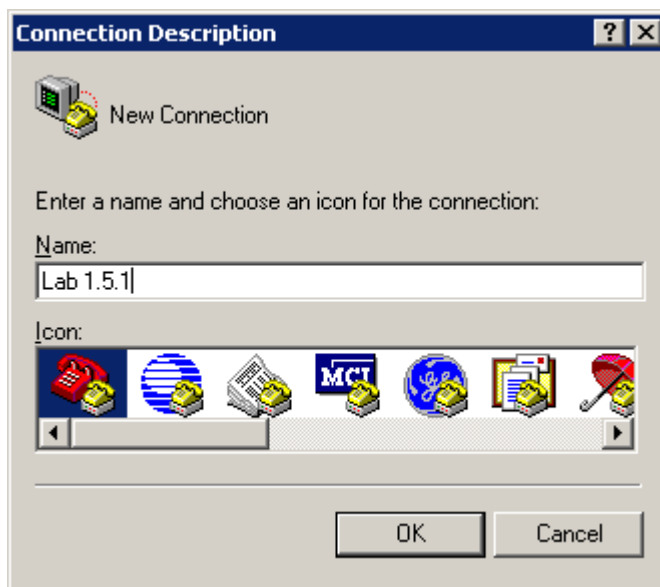
Step 2: Assign COM1 port.

On the **Connect To** dialog box, make sure the correct serial port is selected in the **Connect using** field. Some PCs have more than one COM port. Click **OK**.

Step 3: Set COM1 properties.

In the **COM1 Properties** dialog box under Port Setting, clicking **Restore Defaults** normally sets the correct properties. If not, set the properties to the values show in the following graphic, and then click OK.
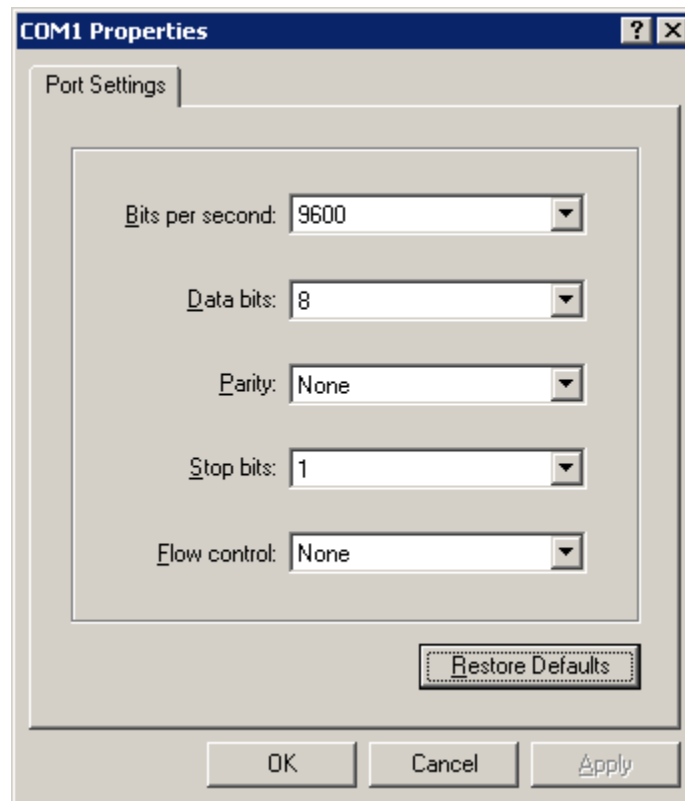
Step 4: Verify connection.

You should now have a console connection to the router. Press **Enter** to get a router prompt.

Lab 1.5.2: Basic Router Configuration

Topology Diagram
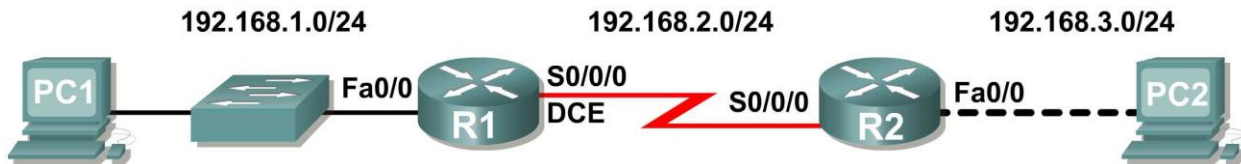
Addressing Table

Device	Interface	IP Address	Subnet Mask	Def. 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
PC1	N/A	192.168.1.10	255.255.255.0	192.168.1.1
PC2	N/A	192.168.3.10	255.255.255.0	192.168.3.1

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.
- Configure and activate Ethernet interfaces.
- Test and verify configurations.
- Reflect upon and 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 Topology Diagram to apply an addressing scheme to the network devices. When the network configuration is complete, examine the routing tables to verify that the network is operating properly. This lab is a shorter version of **Lab 1.5.1: Cabling a Network and Basic Router Configuration** and assumes you are proficient in basic cabling and configuration file management.

Task 1: Cable the Network.

Cable a network that is similar to the one in the Topology Diagram. The output used in this lab is from 1841 routers. You can use any current router in your lab as long as it has the required interfaces as shown in the topology. Be sure to use the appropriate type of Ethernet cable to connect from host to switch, switch to router, and host to router. Refer to **Lab 1.5.1: Cabling a Network and Basic Router Configuration** if you have any trouble connecting the devices. Be sure to connect the serial DCE cable to router R1 and the serial DTE cable to router R2.

Answer the following questions:

What type of cable is used to connect the Ethernet interface on a host PC to the Ethernet interface on a switch? _____

What type of cable is used to connect the Ethernet interface on a switch to the Ethernet interface on a router? _____

What type of cable is used to connect the Ethernet interface on a router to the Ethernet interface on a host PC? _____

Task 2: Erase and Reload the Routers.

Step 1: Establish a terminal session to router R1.

Refer to Lab 1.5.1, "Cabling a Network and Basic Router Configuration," for review of terminal emulation and connecting to a router.

Step 2: Enter privileged EXEC mode.

```
Router>enable
Router#
```

Step 3: Clear the configuration.

To clear the configuration, issue the **erase startup-config** command. Press **Enter** when prompted to **[confirm]** that you really do want to erase the configuration currently stored in NVRAM.

```
Router#erase startup-config
Erasing the nvram filesystem will remove all files! Continue? [confirm]
[OK]
Erase of nvram: complete
Router#
```

Step 4: Reload configuration.

When the prompt returns, issue the **reload** command. Answer **no** if asked to save changes.

What would happen if you answered **yes** to the question, "System configuration has been modified. Save?"

_____

_____

The result should look something like this:

```
Router#reload

System configuration has been modified. Save? [yes/no]: no
Proceed with reload? [confirm]
```

Press **Enter** when prompted to `[confirm]` that you really do want to reload the router. After the router finishes the boot process, choose not to use the AutoInstall facility, as shown:

```
Would you like to enter the initial configuration dialog? [yes/no]: no
Would you like to terminate autoinstall? [yes]: [Press Return]
Press Enter to accept default.
Press RETURN to get started!
```

Step 5: Repeat Steps 1 through 4 on router R2 to remove any startup configuration file that may be present.

Task 3: Perform Basic Configuration of Router R1.

Step 1: Establish a HyperTerminal session to router R1.

Step 2: Enter privileged EXEC mode.

```
Router>enable
Router#
```

Step 3: Enter global configuration mode.

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

Step 4: Configure the router name as R1.

Enter the command `hostname R1` at the prompt.

```
Router(config)#hostname R1
R1(config)#
```

Step 5: Disable DNS lookup.

Disable DNS lookup with the `no ip domain-lookup` command.

```
R1(config)#no ip domain-lookup
R1(config)#
```

Why would you want to disable DNS lookup in a lab environment?

_____

_____

What would happen if you disabled DNS lookup in a production environment?

_____

_____

Step 6: Configure the EXEC mode password.

Configure the EXEC mode password using the **enable secret** *password* command. Use **class** for the *password*.

```
R1(config)#enable secret class
R1(config)#
```

Why is it not necessary to use the **enable password** *password* command?

_____

_____

Step 7: Configure a message-of-the-day banner.

Configure a message-of-the-day banner using the **banner motd** command.

```
R1(config)#banner motd &
Enter TEXT message.  End with the character '&'.
*******************************
   !!!AUTHORIZED ACCESS ONLY!!!
*******************************
&
R1(config)#
```

When does this banner display?

_____

Why should every router have a message-of-the-day banner?

_____

Step 8: Configure the console password on the router.

Use **cisco** as the password. When you are finished, exit from line configuration mode.

```
R1(config)#line console 0
R1(config-line)#password cisco
R1(config-line)#login
R1(config-line)#exit
R1(config)#
```

Step 9: Configure the password for the virtual terminal lines.

Use **cisco** as the password. When you are finished, exit from line configuration mode.

```
R1(config)#line vty 0 4
R1(config-line)#password cisco
R1(config-line)#login
R1(config-line)#exit
R1(config)#
```

Step 10: Configure the FastEthernet0/0 interface.

Configure the FastEthernet0/0 interface with the IP address 192.168.1.1/24.

```
R1(config)#interface fastethernet 0/0
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#no shutdown
```

```
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed
state to up
R1(config-if)#
```

Step 11: Configure the Serial0/0/0 interface.

Configure the Serial0/0/0 interface with the IP address 192.168.2.1/24. Set the clock rate to 64000.

Note: The purpose of the **clock rate** command is explained in Chapter 2: Static Routes.

```
R1(config-if)#interface serial 0/0/0
R1(config-if)#ip address 192.168.2.1 255.255.255.0
R1(config-if)#clock rate 64000
R1(config-if)#no shutdown
R1(config-if)#
```

Note: The interface will not be activated until the serial interface on R2 is configured and activated

Step 12: Return to privileged EXEC mode.

Use the **end** command to return to privileged EXEC mode.

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

Step 13: Save the R1 configuration.

Save the R1 configuration using the **copy running-config startup-config** command.

```
R1#copy running-config startup-config
Building configuration...
[OK]
R1#
```

What is a shorter version of this command? _____

Task 4: Perform Basic Configuration of Router R2.

Step 1: For R2, repeat Steps 1 through 9 from Task 3.

Step 2: Configure the Serial 0/0/0 interface.

Configure the Serial 0/0/0 interface with the IP address 192.168.2.2/24.

```
R2(config)#interface serial 0/0/0
R2(config-if)#ip address 192.168.2.2 255.255.255.0
R2(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state
to up
R2(config-if)#
```

Step 3: Configure the FastEthernet0/0 interface.

Configure the FastEthernet0/0 interface with the IP address 192.168.3.1/24.

```
R2(config-if)#interface fastethernet 0/0
R2(config-if)#ip address 192.168.3.1 255.255.255.0
R2(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed
state to up
R2(config-if)#
```

Step 4: Return to privileged EXEC mode.

Use the **end** command to return to privileged EXEC mode.

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

Step 5: Save the R2 configuration.

Save the R2 configuration using the **copy running-config startup-config** command.

```
R2#copy running-config startup-config
Building configuration...
[OK]
R2#
```

Task 5: Configure IP Addressing on the Host PCs.

Step 1: Configure the host PC1.

Configure the host PC1 that is attached to R1 with an IP address of 192.168.1.10/24 and a default gateway of 192.168.1.1.

Step 2: Configure the host PC2.

Configure the host PC2 that is attached to R2 with an IP address of 192.168.3.10/24 and a default gateway of 192.168.3.1.

Task 6: Verify and Test the Configurations.

Step 1: Verify that routing tables have the following routes using the `show ip route` command.

The `show ip route` command and output will be thoroughly explored in upcoming chapters. For now, you are interested in seeing that both R1 and R2 have two routes. Both routes are designated with a C. These are the directly connected networks that were activated when you configured the interfaces on each router. If you do not see two routes for each router as shown in the following output, proceed to Step 2.

```
R1#show ip route
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

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

------------------------

R2#show ip route
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

C    192.168.2.0/24 is directly connected, Serial0/0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
```

Step 2: Verify interface configurations.

Another common problem is router interfaces that are not configured correctly or not activated. Use the `show ip interface brief` command to quickly verify the configuration of each router's interfaces. Your output should look similar to the following:

```
R1#show ip interface brief
Interface          IP-Address      OK? Method Status                Protocol
FastEthernet0/0    192.168.1.1     YES manual up                    up
FastEthernet0/1    unassigned      YES unset  administratively down down
Serial0/0/0        192.168.2.1     YES manual up                    up
Serial0/0/1        unassigned      YES unset  administratively down down
Vlan1              unassigned      YES manual administratively down down

------------------------
```

```
R2#show ip interface brief
Interface           IP-Address      OK? Method Status                 Protocol
FastEthernet0/0     192.168.3.1     YES manual up                     up
FastEthernet0/1     unassigned      YES unset  administratively down  down
Serial0/0/0         192.168.2.2     YES manual up                     up
Serial0/0/1         unassigned      YES unset  down                   down
Vlan1               unassigned      YES manual administratively down  down
```

If both interfaces are **up** and **up**, then both routes will be in the routing table. Verify this again by using the **show ip route** command.

Step 3: Test connectivity.

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

From the host attached to R1, is it possible to ping the default gateway? _____

From the host attached to R2, is it possible to ping the default gateway? _____

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

1. Check the PCs.

   Are they 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 the interfaces **up** and **up**? _____

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

Step 4: Test connectivity between router R1 and R2.

From the router R1, is it possible to ping R2 using the command **ping 192.168.2.2**? _____

From the router R2, is it possible to ping R1 using the command **ping 192.168.2.1**? _____

If the answer is **no** for the questions above, 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. 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**, then you should be able to successfully ping from R2 to R1 and from R2 to R3.

Task 7: Reflection

Step 1: Attempt to ping from the host connected to R1 to the host connected to R2.

This ping should be unsuccessful.

Step 2: Attempt to ping from the host connected to R1 to router R2.

This ping should be unsuccessful.

Step 3: Attempt to ping from the host connected to R2 to router R1.

This ping should be unsuccessful.

What is missing from the network that is preventing communication between these devices?

_____

_____

Task 8: 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**

If you need to review the procedures for capturing command output, refer to Lab 1.5.1, "Cabling a Network and Basic Router Configuration."

Task 9: 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 1.5.3: Challenge Router Configuration

Topology Diagram
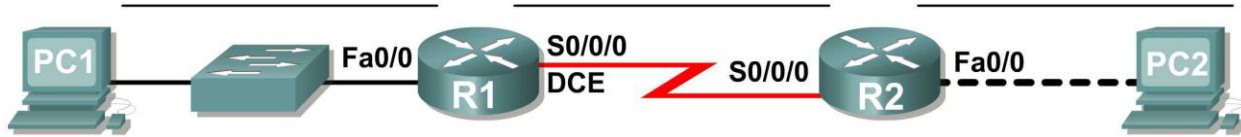
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0			N/A
	S0/0/0			N/A
R2	Fa0/0			N/A
	S0/0/0			N/A
PC1	NIC			
PC2	NIC			

Learning Objectives

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

- Subnet an address space given requirements.
- Assign appropriate addresses to interfaces and document.
- 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 Serial and Ethernet interfaces.
- Test and verify configurations.
- Reflect upon and document the network implementation.

Scenario

In this lab activity, you will design and apply an IP addressing scheme for the topology shown in the Topology Diagram. You will be given one class C address that you must subnet to provide a logical addressing scheme for the network. You must first cable the network as shown before the configuration can begin. Once the network is cabled, configure each device with the appropriate basic configuration commands. The routers will then be ready for interface address configuration according to your IP addressing scheme. When the configuration is complete, use the appropriate IOS commands to verify that the network is working properly.

Note: Use classful subnetting for this lab.

Task 1: Subnet the Address Space.

Step 1: Examine the network requirements.

You have been given the 192.168.1.0/24 address space to use in your network design. The network consists of the following segments:

- The network connected to router R1 will require enough IP addresses to support 20 hosts.
- The network connected to router R2 will require enough IP addresses to support 20 hosts.
- The link between router R1 and router R2 will require IP addresses at each end of the link.

(**Note:** Remember that the interfaces of network devices are also host IP addresses and are included in the above addressing scheme.)

Step 2: Consider the following questions when creating your network design.

How many subnets are needed for this network? _____

What is the subnet mask for this network in dotted decimal format? _____

What is the subnet mask for the network in slash format? _____

How many usable hosts are there per subnet? _____

Step 3: Assign subnetwork addresses to the Topology Diagram.

1. Assign the first subnet (lowest subnet) to the network attached to R1.

2. Assign the second subnet to the link between R1 and R2.

3. Assign the third subnet to the network attached to R2.

Task 2: Determine Interface Addresses.

Step 1: Assign appropriate addresses to the device interfaces.

1. Assign the first valid host address in first subnet to the LAN interface on R1.

2. Assign the last valid host address in first subnet to PC1.

3. Assign the first valid host address in second subnet to the WAN interface on R1.

4. Assign the last valid host address in second subnet to the WAN interface on R2.

5. Assign the first valid host address in third subnet to the LAN interface of R2.

6. Assign the last valid host address in third subnet to PC2.

Note: The fourth (highest) subnet is not required in this lab.

Step 2: Document the addresses to be used in the table provided under the Topology Diagram.

Task 3: 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 as shown in the topology.

Step 2: Clear any existing configurations on the routers.

Task 4: Perform Basic Router Configurations.

Perform basic configuration of the R1 and R2 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 5: Configure and Activate Serial and Ethernet Addresses.

Step 1: Configure the router interfaces.

Configure the interfaces on the R1 and R2 routers with the IP addresses from your network design. When you have finished, be sure to save the running configuration to the NVRAM of the router.

Step 2: Configure the PC interfaces.

Configure the Ethernet interfaces of PC1 and PC2 with the IP addresses and default gateways from your network design.

Task 6: Verify the Configurations.

Answer the following questions to verify that the network is operating as expected.

From the host attached to R1, is it possible to ping the default gateway? _____

From the host attached to R2, is it possible to ping the default gateway? _____

From the router R1, is it possible to ping the Serial 0/0/0 interface of R2? _____

From the router R2, is it possible to ping the Serial 0/0/0 interface of R1? _____

The answer to the above questions should be **yes**. If any of the above pings failed, check your physical connections and configurations. If necessary, refer to Lab 1.5.2, "Basic Router Configuration."

What is the status of the FastEthernet 0/0 interface of R1? _____

What is the status of the Serial 0/0/0 interface of R1? _____

What is the status of the FastEthernet 0/0 interface of R2? _____

What is the status of the Serial 0/0/0 interface of R2? _____

What routes are present in the routing table of R1?

_____

_____

What routes are present in the routing table of R2?

_____

_____

Task 7: Reflection

Are there any devices on the network that cannot ping each other?

_____

_____

What is missing from the network that is preventing communication between these devices?

_____

_____

Task 8: Document the Router Configurations.

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

- Running configuration
- Routing table
- Summary of status information for each interface

Lab 2.8.1: Basic Static Route Configuration

Topology Diagram
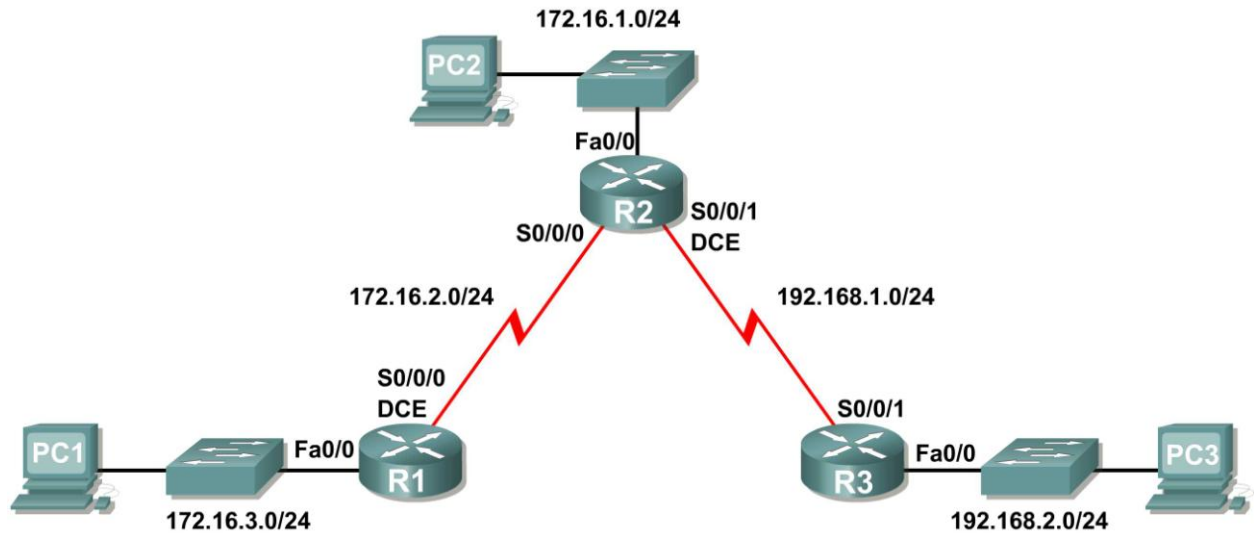
Addressing Table

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.

Lab 2.8.2: Challenge Static Route Configuration
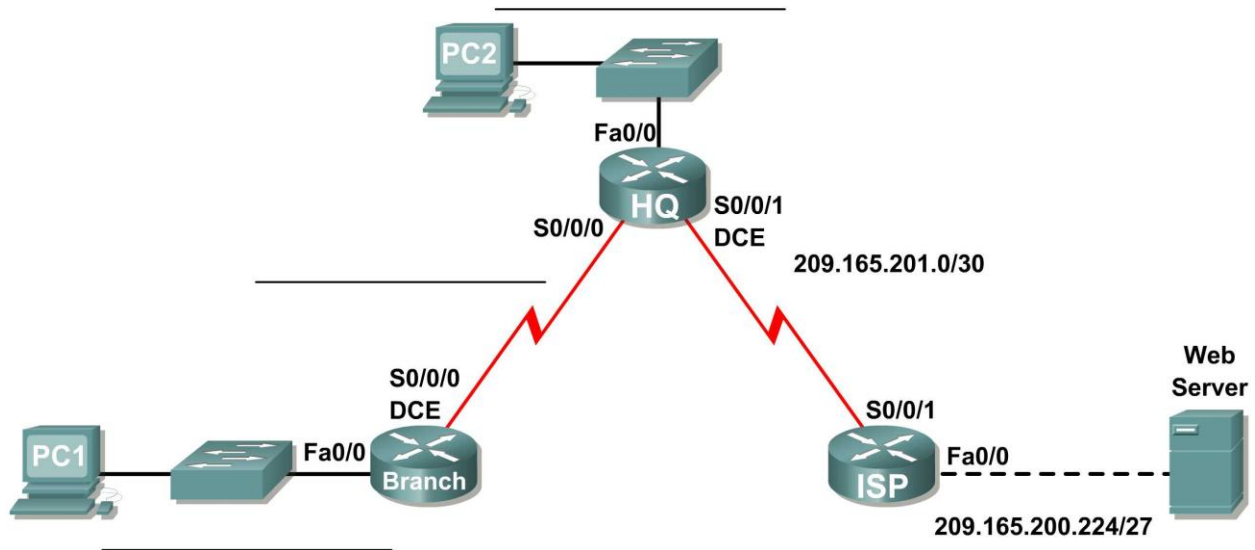
Topology Diagram

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
BRANCH	Fa0/0			N/A
	S0/0/0			N/A
HQ	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1	209.165.201.2	255.255.255.252	N/A
ISP	Fa0/0	209.165.200.225	255.255.255.224	N/A
	S/0/0/1	209.165.201.1	255.255.255.252	N/A
PC1	NIC			
PC2	NIC			
Web Server	NIC	209.165.200.253	255.255.255.224	209.165.200.225

Learning Objectives

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

- Subnet an address space given requirements.
- Assign appropriate addresses to interfaces and document.
- 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 Serial and Ethernet interfaces.
- Determine appropriate static, summary, and default routes.
- Test and verify configurations.
- Reflect upon and document the network implementation.

Scenario

In this lab activity, you will be given a network address that must be subnetted to complete the addressing of the network shown in the Topology Diagram. The addressing for the LAN connected to the ISP router and the link between the HQ and ISP routers has already been completed. Static routes will also need to be configured so that hosts on networks that are not directly connected will be able to communicate with each other.

Task 1: Subnet the Address Space.

Step 1: Examine the network requirements.

The addressing for the LAN connected to the ISP router and the link between the HQ and ISP routers has already been completed. You have been given the 192.168.2.0/24 address space to complete the network design. Subnet this network to provide enough IP addresses to support 60 hosts.

Step 2: Consider the following questions when creating your network design:

How many subnets need to be created from the 192.168.2.0/24 network? _____

What are the network addresses of the subnets?

     Subnet 0: _____

     Subnet 1: _____

     Subnet 2: _____

     Subnet 3: _____

What is the subnet mask for these networks in dotted decimal format? _____

What is the subnet mask for the network in slash format? _____

How many usable hosts are there per subnet? _____

Step 3: Assign subnetwork addresses to the Topology Diagram.

1. Assign subnet 1 to the LAN attached to HQ.
2. Assign subnet 2 to the WAN link between HQ and BRANCH.
3. Assign subnet 3 to the LAN attached to BRANCH.
4. Subnet 0 will be available for future expansion.

Task 2: Determine Interface Addresses.

Step 1: Assign appropriate addresses to the device interfaces.

1. Assign the first valid host address in subnet 1 to the LAN interface on HQ.
2. Assign the last valid host address in subnet 1 to PC2.
3. Assign the first valid host address in subnet 2 to the WAN interface on BRANCH.
4. Assign the second valid host address in subnet 2 to the WAN interface on HQ.

5.   Assign the first valid host address in subnet 3 to the LAN interface of BRANCH.

6.   Assign the last valid host address in subnet 3 to PC1.

Step 2: Document the addresses to be used in the table provided under the Topology Diagram.

Task 3: 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 as shown in the topology.

Step 2: Clear any existing configurations on the routers.

Task 4: Perform Basic Router Configurations.

Perform basic configuration of the BRANCH, HQ, and ISP 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.

7.   Synchronize unsolicited messages and debug output with solicited output and prompts for the console and virtual terminal lines.

8.   Configure an EXEC timeout of 15 minutes.

Task 5: Configure and Activate Serial and Ethernet Addresses.

Step 1: Configure the interfaces on the BRANCH, HQ, and ISP routers.

Configure the interfaces on the BRANCH, HQ, and ISP routers with the IP addresses from the table provided under the Topology Diagram. When you have finished, be sure to save the running configuration to the NVRAM of the router.

Step 2: Configure the Ethernet interfaces.

Configure the Ethernet interfaces on PC1, PC2, and the Web Server with the IP addresses from the table provided under the Topology Diagram.

Task 6: Verify Connectivity to Next-Hop Device.

You should *not* have connectivity between end devices yet. However, you can test connectivity between two routers and between and end device and its default gateway.

Step 1: Verify BRANCH and HQ connectivity.

Verify that BRANCH can ping across the WAN link to HQ and that HQ can ping across the WAN link that it shares with ISP.

Step 2: Verify PC1, PC2, and Web Server connectivity.

Verify that PC1, PC2, and the Web Server can ping their respective default gateways.

Task 7: Configure Static Routing on BRANCH.

Step 1: Consider the type of static routing that is needed on BRANCH.

What networks are present in the BRANCH routing table? List the networks with slash notation.

_____

_____

What networks are missing from the BRANCH routing table? List the networks with slash notation.

_____

_____

_____

Can one summary route that includes all of the missing networks be created? _____

How many WAN routes are available to traffic leaving the LAN connected to BRANCH? _____

Step 2 Configure BRANCH with a default static route pointing to HQ.

Because BRANCH is a stub router, we should configure BRANCH with a default static route pointing to HQ. Record the command to configure a default static route using the appropriate exit interface.

_____

Step 3 View the routing table of BRANCH to verify the new static route entry.

You should see a `Gateway of Last Resort` set on BRANCH.

Without testing it first, do you think that PC1 can now successfully ping PC2? _____

Why or why not?

_____
_____
_____

Task 8: Configure Static Routing on HQ.

Step 1: Consider the type of static routing that is needed on HQ.

What networks are present in the HQ routing table? List the networks with slash notation.

_____

_____

_____

What networks are missing from the HQ routing table? List the networks with slash notation.

_____

_____

Can one summary route that includes all of the missing networks be created? _____

HQ is in a unique position as the hub router in this hub-and-spoke topology. Traffic from the BRANCH LAN destined for the Internet must pass through HQ. HQ must be able to send any traffic for which it does not have a route to ISP. What kind of route would you need to configure on HQ to solve this problem?

_____

HQ is also the intermediary for any traffic from the Internet destined for the BRANCH LAN. Therefore, HQ must be able to route to that LAN. What kind of route would you need to configure on HQ to solve this problem?

_____

Step 2: Configure HQ with a static route.

Configure HQ with a static route to the BRANCH LAN using the Serial 0/0/0 interface of HQ as the exit interface. Record the command that you used.

_____

Step 3: Configure HQ with a default static route.

Configure the HQ router with a default static route pointing to ISP using the next-hop IP address. Record the command you used.

_____

Step 4: View the routing table of HQ to verify the new static route entries.

Without testing it first, do you think that PC1 can now successfully ping PC2? _____

Why or why not?

_____

_____

Without testing it first, do you think that PC1 or PC2 can now successfully ping the Web Server? _____

Why or why not?

_____

_____

_____

_____

Task 9: Configure Static Routing on ISP.

In a real-world implementation of this topology, you would not be configuring the ISP router. However, your service provider is an active partner in solving your connectivity needs. Service provider administrators are human, too, and make mistakes. Therefore, it is important that you understand the types of errors an ISP could make that would cause your networks to lose connectivity.

Step 1: Consider the type of static routing that is needed on ISP.

What networks are present in the ISP routing table? List the networks with slash notation.

_____

_____

What networks are missing from the ISP routing table? List the networks with slash notation.

_____

_____

_____

Can one summary route that includes all of the missing networks be created? _____

Step 2: Configure ISP with a summary static route.

Using the next-hop IP address, configure ISP with a summary static route that includes all of the subnets that are missing from the routing table. Record the command that you used.

_____

Note: The summary route will also include the subnet zero route that is reserved for future expansion.

Step 3: View the routing table of ISP to verify the new static route entry.

Task 10: Verify the Configurations.

Answer the following questions to verify that the network is operating as expected:

From PC2, is it possible to ping PC1? _____

From PC2, is it possible to ping the Web Server? _____

From PC1, is it possible to ping the Web Server? _____

The answer to these questions should be **yes**. If any of the above pings failed, check your physical connections and configurations. For a review of basic troubleshooting techniques, see Lab 1.5.1, "Cabling a Network and Basic Router Configuration."

What routes are present in the routing table of BRANCH?

_____

_____

_____

What routes are present in the routing table of HQ?

_____

_____

_____

_____

_____

What routes are present in the routing table of ISP?

_____

_____

_____

Task 11: Reflection

If a default static route was not configured on BRANCH, how many individual static routes would be needed for hosts on the BRANCH LAN to communicate with all of the networks in the Topology Diagram? _____

If a summary static route was not configured on ISP, how many individual static routes would be needed for hosts on the ISP LAN to communicate with all of the networks in the Topology Diagram? _____

Task 12: Document the Router Configurations

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

- Running configuration
- Routing table
- Interface summarization

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.

Lab 2.8.3: Troubleshooting Static Routes

Topology Diagram
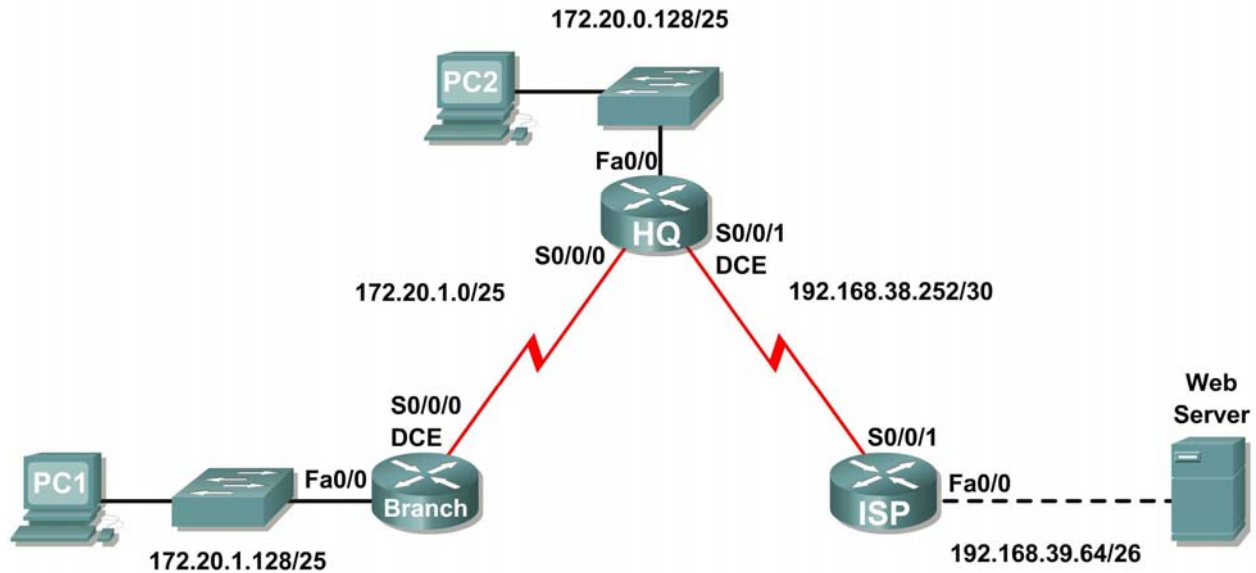
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
BRANCH	Fa0/0	172.20.1.129	255.255.255.128	N/A
	S0/0/0	172.20.1.1	255.255.255.128	N/A
HQ	Fa0/0	172.20.0.129	255.255.255.128	N/A
	S0/0/0	172.20.1.2	255.255.255.128	N/A
	S0/0/1	192.168.38.254	255.255.255.252	N/A
ISP	FA0/0	192.168.39.65	255.255.255.192	N/A
	S0/0/1	192.168.38.253	255.255.255.252	N/A
PC1	NIC	172.20.1.135	255.255.255.128	172.20.1.129
PC2	NIC	172.20.0.135	255.255.255.128	172.20.0.129
Web Server	NIC	192.168.39.70	255.255.255.192	192.168.39.65

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.
- Load the routers with supplied scripts.
- Discover points where the network is not converged.

- Gather information about errors in the network.
- Propose solutions to network errors.
- Implement solutions to network errors.
- Document the corrected network.

Scenario

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

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 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 the BRANCH router:

```
hostname BRANCH
!
!
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 172.20.1.129 255.255.255.128
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 172.20.1.1 255.255.255.128
 clock rate 64000
 no shutdown
!
ip route 0.0.0.0 0.0.0.0 172.20.0.129
!
line con 0
line vty 0 4
password cisco
 login
!
end
```

Step 2: Load the following script onto the HQ router:

```
hostname HQ
```

```
 !
 no ip domain-lookup
 !
 interface FastEthernet0/0
  ip address 172.20.0.129 255.255.255.128
  duplex auto
  speed auto
  no shutdown
 !
 interface Serial0/0/0
  ip address 172.20.1.2 255.255.255.128
  no shutdown
 !
 interface Serial0/0/1
  ip address 192.168.38.254 255.255.255.252
  clock rate 64000
  no shutdown
 !
 ip route 192.168.39.64 255.255.255.192 192.168.38.253
 !
 line con 0
 line vty 0 4
 password cisco
  login
 !
 end
```

Step 3: Load the following script onto the ISP router:

```
 hostname ISP
 !
 no ip domain-lookup
 !
 interface FastEthernet0/0
  ip address 192.168.39.65 255.255.255.192
 !
 interface Serial0/0/1
  ip address 192.168.38.253 255.255.255.252
  no shutdown
 !
 ip route 172.20.0.0 255.255.255.0 192.168.38.254
 !
 line con 0
 line vty 0 4
 password cisco
  login
 !
 end
```

Task 3: Troubleshoot the BRANCH Router.

Step 1: Begin troubleshooting at the host connected to the BRANCH router.

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

From the host PC1, is it possible to ping the Web Server on the ISP LAN? _____

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

Step 2: Examine the BRANCH router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

_____

If there are any problems with the status of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the static routing configuration on the BRANCH router.

Begin by viewing the routing table.

What routes are shown in the routing table?

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

If there are any problems with the routing table, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 6: If you have recorded any commands above, apply them to the router configuration now.

Step 7: View routing information.

If any changes were made to the configuration in the previous step, view routing table again.

Does the information in the routing table indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the routing table again.

Step 8: Attempt to ping between the hosts again.

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

From the host PC1, is it possible to ping the web server on the ISP LAN? _____

From the host PC1, is it possible to ping the Serial 0/0/0 interface of HQ? _____

Task 4: Troubleshoot the HQ Router.

Step 1: Begin troubleshooting at the host connected to the HQ router.

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

From the host PC2, is it possible to ping the Web Server on the ISP LAN? _____

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

Step 2: Examine the HQ router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

_____

If there are any problems with the status of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the static routing configuration on the HQ router.

Begin by viewing the routing table.

What routes are shown in the routing table?

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

If there are any problems with the routing table, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 6: If you have recorded any commands above, apply them to the router configuration now.

Step 7: View routing information.

If any changes were made to the configuration in the previous step, view the routing table again.

Does the information in the routing table indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the routing table again.

Step 8: Attempt to ping between the hosts again.

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

From the host PC2, is it possible to ping the Serial 0/0/1 interface of the ISP router? _____

From the host PC1, is it possible to ping the Web Server on the ISP LAN? _____

Task 5: Troubleshoot the ISP Router.

Step 1: Begin troubleshooting at the host connected to the ISP router.

From the Web Server on the ISP LAN, is it possible to ping PC1? _____

From the Web Server on the ISP LAN, is it possible to ping PC2? _____

From the Web Server on the ISP LAN, is it possible to ping the default gateway? _____

Step 2: Examine the ISP router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

_____

If there are any problems with the status of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the static routing configuration on the ISP router.

Begin by viewing the routing table.

What routes are shown in the routing table?

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

If there are any problems with the routing table, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 6: If you have recorded any commands above, apply them to the router configuration now.

Step 7: View routing information.

If any changes were made to the configuration in the previous step, view the routing table again.

Does the information in the routing table indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the routing table again.

Step 8: Attempt to ping between the hosts again.

From the Web Server on the ISP LAN, is it possible to ping PC1? _____

From the Web Server on the ISP LAN, is it possible to ping PC2? _____

From the Web Server on the ISP LAN, is it possible to the WAN interface of the BRANCH router? _____

Task 6: Reflection

There were a number of configuration errors in the scripts that were provided for this lab. Use the space below to write a brief description of the errors that you found.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Task 7: 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**

If you need to review the procedures for capturing command output, see Lab 1.5.1, "Cabling a Network and Basic Router Configuration."

Lab 3.5.2: Subnetting Scenario 1

Topology Diagram
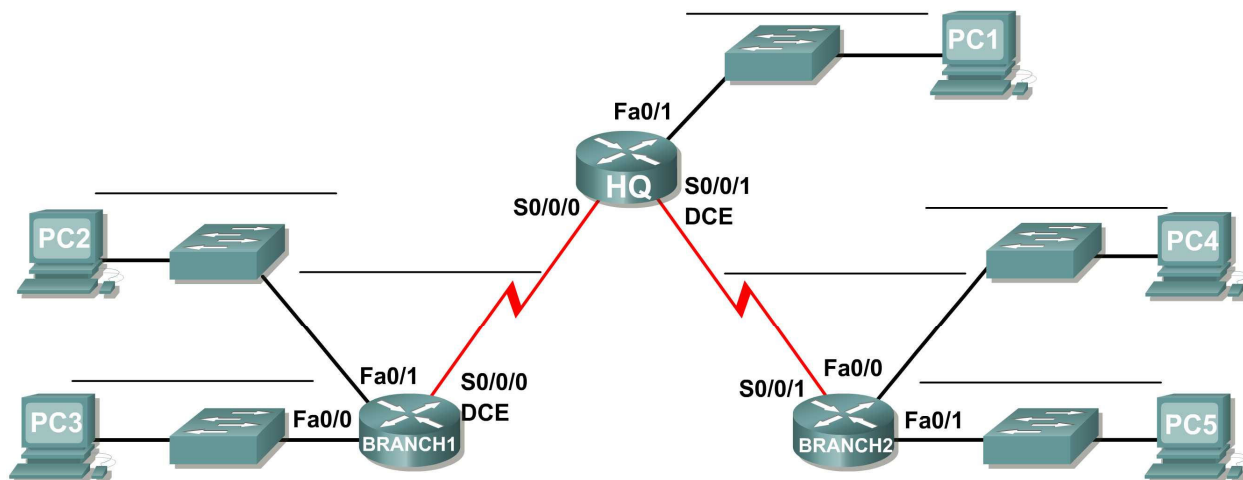
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/1			N/A
	S0/0/0			N/A
	S0/0/1			N/A
BRANCH1	Fa0/0			N/A
	Fa0/1			N/A
	S0/0/0			N/A
BRANCH2	Fa0/0			N/A
	Fa0/1			N/A
	S0/0/1			N/A
PC1	NIC			
PC2	NIC			
PC3	NIC			
PC4	NIC			
PC5	NIC			

Learning Objectives

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

- Determine the number of subnets needed.
- Determine the number of hosts needed.
- Design an appropriate addressing scheme.
- Assign addresses and subnet mask pairs to device interfaces and hosts.
- Examine the use of the available network address space.
- Determine how static routing could be applied to the network.

Scenario

In this lab, you have been given the network address 192.168.9.0/24 to subnet and provide the IP addressing for the network shown in the Topology Diagram. The network has the following addressing requirements:

- The BRANCH1 LAN 1 will require 10 host IP addresses.
- The BRANCH1 LAN 2 will require 10 host IP addresses.
- The BRANCH2 LAN 1 will require 10 host IP addresses.
- The BRANCH2 LAN 2 will require 10 host IP addresses.
- The HQ LAN will require 20 host IP addresses.
- The link from HQ to BRANCH1 will require an IP address for each end of the link.
- The link from HQ to BRANCH2 will require an IP address for each end of the link.

(**Note:** Remember that the interfaces of network devices are also host IP addresses and are included in the above addressing requirements.)

Task 1: Examine the Network Requirements.

Examine the network requirements and answer the questions below. Keep in mind that IP addresses will be needed for each of the LAN interfaces.

How many subnets are needed? _____

What is the maximum number of IP addresses that are needed for a single subnet? _____

How many IP addresses are needed for each of the branch LANs? _____

What is the total number of IP addresses that are needed? _____

Task 2: Design an IP Addressing Scheme.

Step 1: Subnet the 192.168.9.0 network into the appropriate number of subnets.

What will the subnet mask be for the subnetworks? _____

How many usable host IP addresses are there per subnet? _____

Fill in the following chart with the subnet information.

Subnet Number	Subnet Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
0				
1				
2				

Subnet Number	Subnet Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
3				
4				
5				
6				
7				

Step 2: Assign the subnets to the network shown in the Topology Diagram.

When assigning the subnets, keep in mind that routing will need to occur to allow information to be sent throughout the network. The subnets will be assigned to the networks to allow for route summarization on each of the routers.

1. Assign first subnet (lowest subnet) to the LAN connected to the Fa0/1 interface of BRANCH2. What is the subnet address? _____

2. Assign second subnet to LAN connected to the Fa0/0 interface of BRANCH2. What is the subnet address? _____

3. Assign third subnet to LAN connected to the Fa0/0 interface of BRANCH1. What is the subnet address? _____

4. Assign fourth subnet to LAN connected to the Fa0/1 interface of BRANCH1. What is the subnet address? _____

5. Assign fifth subnet to the WAN link from HQ to BRANCH1. What is the subnet address? _____

6. Assign sixth subnet to the WAN link from HQ to BRANCH2. _____

7. Assign seventh subnet to LAN connected to the Fa0/1 interface of HQ. What is the subnet address? _____

Note: The highest subnet will not be required in this topology.

Task 3: Assign IP Addresses to the Network Devices

Assign the appropriate addresses to the device interfaces. Document the addresses to be used in the Addressing Table provided under the Topology Diagram.

Step 1: Assign addresses to the HQ router.

1. Assign the first valid host address in the HQ LAN subnet to the LAN interface.

2. Assign the first valid host address in link from HQ to BRANCH1 subnet to the S0/0/0 interface.

3. Assign the first valid host address in link from HQ to BRANCH2 subnet to the S0/0/1 interface.

Step 2: Assign addresses to the BRANCH1 router.

1. Assign the first valid host address in the BRANCH1 LAN 1 subnet to the Fa0/0 LAN interface.

2. Assign the first valid host address in the BRANCH1 LAN 2 subnet to the Fa0/1 LAN interface.

3. Assign the last valid host address in link from HQ to BRANCH1 subnet to the WAN interface.

Step 3: Assign addresses to the BRANCH2 router.

1. Assign the first valid host address in the BRANCH2 LAN 1 subnet to the Fa0/0 LAN interface.

2. Assign the first valid host address in the BRANCH2 LAN 2 subnet to the Fa0/1 LAN interface.

3.   Assign the last valid host address in link from HQ to BRANCH2 subnet to the WAN interface.

Step 4: Assign addresses to the host PCs.

1.   Assign the last valid host address in the HQ LAN subnet to PC1.

2.   Assign the last valid host address in the BRANCH1 LAN 1 subnet to PC3.

3.   Assign the last valid host address in the BRANCH1 LAN 2 subnet to PC2.

4.   Assign the last valid host address in the BRANCH2 LAN 1 subnet to PC4.

5.   Assign the last valid host address in the BRANCH2 LAN 2 subnet to PC5.

Task 4: Test the Network Design.

Apply your addressing scheme. Check to see that all devices on directly connected networks can ping each other.

Task 5: Reflection

How many IP address in the 192.168.9.0 network are unused or unusable in this design? _____

What would the command be to add a default static route on the WAN interface of the BRANCH1 router?

_____

Can both of the BRANCH1 LANs be summarized into one route on the HQ router? _____

What would be the command used to add this summary route to the routing table?

_____

Can both of the BRANCH2 LANs be summarized into one route on the HQ router? _____

What would be the command used to add this summary route to the routing table?

_____

Can the HQ LAN and both of the BRANCH1 LANs be summarized into one route on the BRANCH2 router? This summarized route should also include the link between the HQ and BRANCH1 routers.
_____

What would be the command used to add this summary route to the routing table?

_____

Lab 3.5.3: Subnetting Scenario 2

Topology Diagram
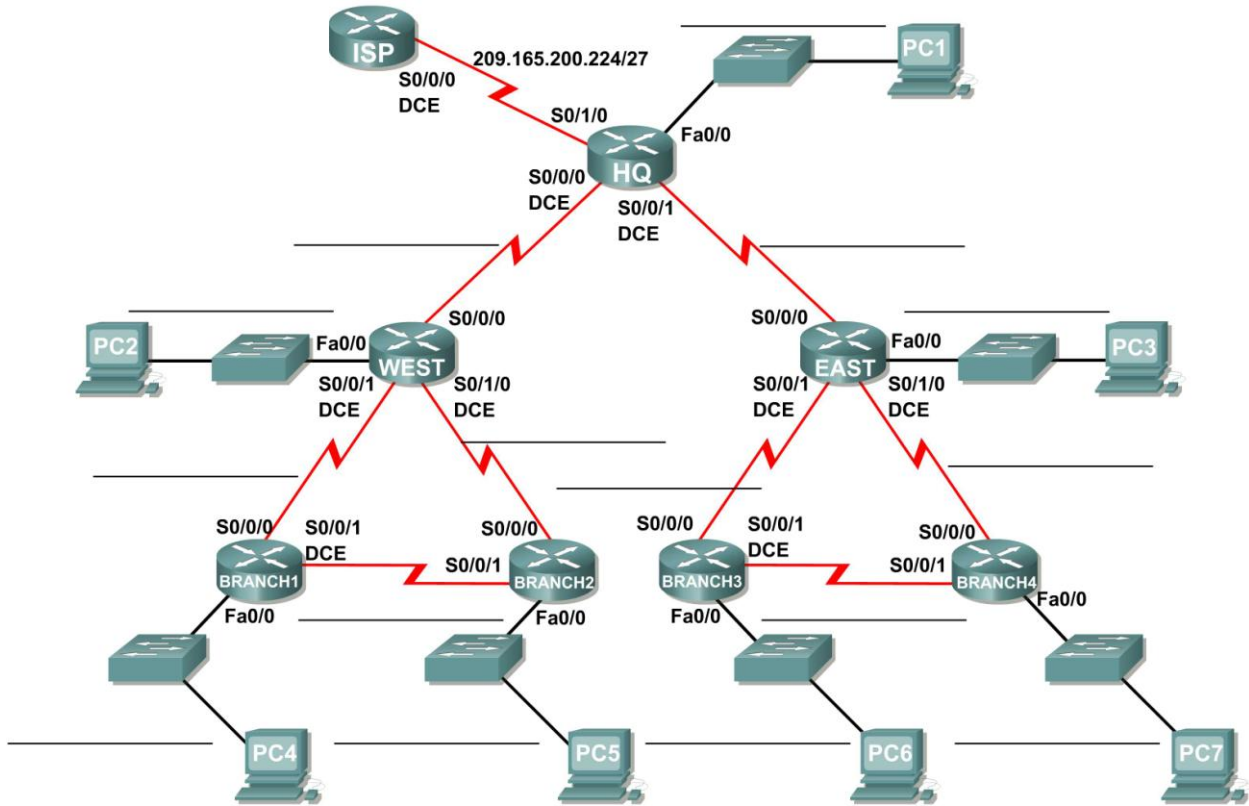
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
ISP	**S0/0/0**	209.165.200.227	255.255.255.224	N/A
HQ	**Fa0/0**			N/A
	S0/0/0			N/A
	S0/0/1			N/A
	S0/1/0	209.165.200.226	255.255.255.224	N/A
West	**Fa0/0**			N/A
	S0/0/0			N/A
	S0/0/1			N/A
	S0/1/0			N/A
East	**Fa0/0**			N/A
	S0/0/0			N/A
	S0/0/1			N/A
	S0/1/0			N/A
Branch 1	**Fa0/0**			N/A
	S0/0/0			N/A
	S0/0/1			N/A
Branch 2	**Fa0/0**			N/A
	S0/0/0			N/A
	S0/0/1			N/A
Branch 3	**Fa0/0**			N/A
	S0/0/0			N/A
	S0/0/1			N/A
Branch 4	**Fa0/0**			N/A
	S0/0/0			N/A
	S0/0/1			N/A
PC1	**NIC**			
PC2	**NIC**			
PC3	**NIC**			
PC4	**NIC**			
PC5	**NIC**			
PC6	**NIC**			
PC7	**NIC**			

Learning Objectives

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

- Determine the number of subnets needed.
- Determine the number of hosts needed.
- Design an appropriate addressing scheme.
- Assign addresses and subnet mask pairs to device interfaces and hosts.
- Examine the use of the available network address space.
- Determine how static routing could be applied to the network.

Scenario

In this lab, you have been given the network address 172.16.0.0/16 to subnet and provide the IP addressing for the network shown in the Topology Diagram. The network has the following addressing requirements:

- The Branch 1 LAN will require 100 host IP addresses.
- The Branch 2 LAN will require 100 host IP addresses.
- The Branch 3 LAN will require 100 host IP addresses.
- The Branch 4 LAN will require 100 host IP addresses.
- The West LAN will require 400 hosts.
- The East LAN will require 400 hosts.
- The HQ LAN will require 500 host IP addresses.
- The links between each of the routers will require an IP address for each end of the link.

  (**Note:** Remember that the interfaces of network devices are also host IP addresses and are included in the above addressing requirements.)

The IP addresses for the link from the HQ router to the ISP have already been assigned. The Serial 0/1/0 address of the HQ router is 209.165.200.226/27. The IP address of the Serial 0/0/0 of the ISP router is 209.165.200.227/27.

Task 1: Examine the Network Requirements.

Examine the network requirements and answer the questions below. Keep in mind that IP addresses will be needed for each of the LAN interfaces.

How many subnets are needed? _____

What is the maximum number of IP addresses that are needed for a single subnet? _____

How many IP addresses are needed for each of the branch LANs? _____

How many IP addresses are needed for all of the connections between routers? _____

What is the total number of IP addresses that are needed? _____

Task 2: Design an IP Addressing Scheme.

Step 1: Subnet the 172.16.0.0 network based on the maximum number of hosts required by the largest subnet.

What will the subnet mask be for the subnetworks? _____

How many usable host IP addresses are there per subnet? _____

Fill in the following chart with the subnet information.

Subnet Number	Subnet IP	First Usable Host IP	Last Usable Host IP	Broadcast Address
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Step 2: Assign the subnets to the network shown in the Topology Diagram.

When assigning the subnets, keep in mind that routing will need to occur to allow information to be sent throughout the network. The subnets will be assigned to the networks to allow for route summarization on each of the routers.

Note: The lowest subnet (subnet 0) will not be assigned in this lab. You should start assigning with the second lowest subnet (subnet 1).

1. Assign subnet 1 to the Branch 1 LAN subnet: _____

2. Assign subnet 2 to the Branch 2 LAN subnet: _____

3. Assign subnet 3 to the link between the Branch 1 and Branch 2 routers: _____

4. Assign subnet 4 to the link between the Branch 1 and West routers: _____

5. Assign subnet 5 to the link between the Branch 2 and West routers: _____

6. Assign subnet 6 to the West LAN subnet: _____

7. Assign subnet 7 to the link between the West and HQ routers: _____

8. Assign subnet 8 to the HQ LAN subnet: _____

9. Assign subnet 9 to the link between the HQ and East routers: _____

10. Assign subnet 10 to the East LAN subnet: _____

11. Assign subnet 11 to the link between the Branch 3 and East routers: _____

12. Assign subnet 12 to the link between the Branch 4 and East routers: _____

13. Assign subnet 13 to the link between the Branch 3 and Branch 4 routers: _____

14. Assign subnet 14 to the Branch 3 subnet: _____

15. Assign subnet 15 to the Branch 4 subnet: _____

Task 3: Assign IP Addresses to the Network Devices.

Assign the appropriate addresses to the device interfaces. Document the addresses to be used in the Addressing Table provided under the Topology Diagram.

Step 1: Assign addresses to the HQ router.

1. Assign the first valid host address in the HQ LAN subnet to the LAN interface.
2. Assign the first valid host address in the link from HQ to West subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from HQ to East subnet to the S0/0/1 interface.

Step 2: Assign addresses to the West router.

1. Assign the first valid host address in the West LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from HQ to West subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from West to Branch 1 subnet to the S0/0/1 interface.
4. Assign the first valid host address in the link from West to Branch 2 subnet to the S0/1/0 interface.

Step 3 Assign addresses to the East router.

1. Assign the first valid host address in the East LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from HQ to East subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from East to Branch 3 subnet to the S0/0/1 interface.
4. Assign the first valid host address in the link from East to Branch 4 subnet to the S0/1/0 interface.

Step 4 Assign addresses to the Branch 1 router.

1. Assign the first valid host address in the Branch 1 LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from West to Branch 1 subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from Branch 1 to Branch 2 subnet to the S0/0/1 interface.

Step 5 Assign addresses to the Branch 2 router.

1. Assign the first valid host address in the Branch 2 LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from West to Branch 2 subnet to the S0/0/0 interface.
3. Assign the last valid host address in the link from Branch 1 to Branch 2 subnet to the S0/0/1 interface.

Step 6 Assign addresses to the Branch 3 router.

1. Assign the first valid host address in the Branch 3 LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from East to Branch 3 subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from Branch 3 to Branch 4 subnet to the S0/0/1 interface.

Step 7 Assign addresses to the Branch 4 router.

1. Assign the first valid host address in the Branch 4 LAN subnet to the LAN interface.

2. Assign the last valid host address in the link from East to Branch 4 subnet to the S0/0/0 interface.

3. Assign the last valid host address in the link from Branch 3 to Branch 4 subnet to the S0/0/1 interface.

Step 8 Assign addresses to the host PCs

1. Assign the last valid host address in the HQ LAN subnet to PC1.

2. Assign the last valid host address in the West LAN subnet to PC2.

3. Assign the last valid host address in the East 1 LAN subnet to PC3.

4. Assign the last valid host address in the Branch 1 LAN subnet to PC4.

5. Assign the last valid host address in the Branch 2 LAN subnet to PC5.

6. Assign the last valid host address in the Branch 3 LAN subnet to PC6.

7. Assign the last valid host address in the Branch 4 LAN subnet to PC7.

Task 4: Test the Network Design.

Apply your addressing scheme. Check to see that all devices on directly connected networks can ping each other.

Task 5: Reflection

How many IP address in the 172.16.0.0 network are wasted in this design? _____

What would the command be to add a default static route for your entire network design from the HQ router to the ISP router?

_____

Can the West, Branch 1, and Branch 2 networks be summarized into one route on the HQ router? This summarized route should also include the serial links that connect the West, Branch 1, and Branch 2 routers. _____

What would be the command used to add this summary route to the routing table?

_____

Can the East, Branch 3, and Branch 4 networks be summarized into one route on the HQ router? This summarized route should also include the serial links that connect the East, Branch 3, and Branch 4 routers. _____

What would be the command used to add this summary route to the routing table?

_____

What would the command be to add a default static route on the West router to send traffic for all unknown destinations to the HQ router?

_____

What would the command be to add a default static route on the East router to send traffic for all unknown destinations to the HQ router?

_____

Can the Branch 1 and Branch 2 networks be summarized into one route on the West router? This summarized route should also include the serial link that connects the Branch 1 and Branch 2 routers. _____

What would be the command used to add this summary route to the routing table? Use the S0/0/1 interface of the West router as the exit interface.

_____

Can the Branch 3 and Branch 4 networks be summarized into one route on the East router? This summarized route should also include the serial link that connects the Branch 3 and Branch 4 routers. _____

What would be the command used to add this summary route to the routing table? Use the S0/0/1 interface of the East router as the exit interface.

_____

The Branch 1 router requires a static route for traffic destined for Branch 2. All other traffic should be sent to the West router using a default static route. What commands would be used to accomplish this?

_____

_____

The Branch 2 router requires a static route for traffic destined for Branch 1. All other traffic should be sent to the West router using a default static route. What commands would be used to accomplish this?

_____

_____

The Branch 3 router requires a static route for traffic destined for Branch 4. All other traffic should be sent to the East router using a default static route. What commands would be used to accomplish this?

_____

_____

The Branch 4 router requires a static route for traffic destined for Branch 3. All other traffic should be sent to the East router using a default static route. What commands would be used to accomplish this?

_____

_____

Lab 3.5.4: Subnetting Scenario 3

Topology Diagram

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
BRANCH1	Fa0/0			N/A
	Fa0/1			N/A
	S0/0/0			N/A
	S0/0/1			N/A
BRANCH2	Fa0/0			N/A
	Fa0/1			N/A
	S0/0/0			N/A
	S0/0/1			N/A
PC1	NIC			
PC2	NIC			
PC3	NIC			
PC4	NIC			
PC5	NIC			

Learning Objectives

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

- Determine the number of subnets needed.
- Determine the number of hosts needed.
- Design an appropriate addressing scheme.
- Conduct research to find a possible solution.

Scenario

In this lab, you have been given the network address 192.168.1.0/24 to subnet and provide the IP addressing for the network shown in the Topology Diagram. The network has the following addressing requirements:

- The BRANCH1 LAN 1 will require 15 host IP addresses.
- The BRANCH1 LAN 2 will require 15 host IP addresses.
- The BRANCH2 LAN 1 will require 15 host IP addresses.
- The BRANCH2 LAN 2 will require 15 host IP addresses.
- The HQ LAN will require 70 host IP addresses.
- The link from HQ to BRANCH1 will require an IP address for each end of the link.
- The link from HQ to BRANCH2 will require an IP address for each end of the link.
- The link from HQ to BRANCH1 to BRANCH2 will require an IP address for each end of the link.

(**Note:** Remember that the interfaces of network devices are also host IP addresses and are included in the above addressing requirements.)

Task 1: Examine the Network Requirements.

Examine the network requirements and answer the questions below. Keep in mind that IP addresses will be needed for each of the LAN interfaces.

How many subnets are needed? _____

What is the maximum number of IP addresses that are needed for a single subnet? _____

How many IP addresses are needed for each of the branch LANs? _____

What is the total number of IP addresses that are needed? _____

Task 2: Design an IP Addressing Scheme

Subnet the 192.168.1.0/24 network into the appropriate number of subnets.

Can the 192.168.1.0/24 network be subnetted to fit the network requirements? _____

If the "number of subnets" requirement is met, what is the maximum number of hosts per subnet? _____

If the "maximum number of hosts" requirement is met, what is the number of subnets that will be available to use? _____

Task 3: Reflection

You do not have enough address space to implement an addressing scheme. Research this problem and propose a possible solution. Increasing the size of your original address space is not an acceptable solution. (**Hint:** We will discuss solutions to this problem in Chapter 6.)

_____

_____

_____

Attempt to implement your solution. Successful implementation of a solution requires that:

- Only the 192.168.1.0/24 address space is used.
- PCs and routers can ping all IP addresses.

Lab 4.6.1: Routing Table Interpretation Lab

Addressing Table

Device	Interface	IP Address	Subnet Mask
HQ			
BRANCH1			
BRANCH2			

Learning Objectives

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

- Interpret router outputs.
- Identify the IP addresses for each router.
- Draw a diagram of the network topology.
- Cable and configure a network based on the topology diagram.
- Test and verify full connectivity.
- Reflect upon and document the network implementation.

Scenario

In this lab activity, you must recreate a network based only on the outputs from the **show ip route** command. Match the addresses to the corresponding interfaces and enter the information in the above address table. Configure the routers and verify connectivity. When complete, the outputs from the **show ip route** must be exactly the same as the supplied outputs. The **show ip route** command displays the current state of the routing table.

Task 1: Examine the router outputs.

Step 1: Examine the output from the HQ router.

```
HQ#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

     10.0.0.0/30 is subnetted, 1 subnets
C       10.10.10.252 is directly connected, Serial0/0/0
     172.16.0.0/30 is subnetted, 1 subnets
C       172.16.100.0 is directly connected, Serial0/0/1
R    192.168.1.0/24 [120/1] via 10.10.10.254, 00:00:03, Serial0/0/0
R    192.168.2.0/24 [120/1] via 10.10.10.254, 00:00:03, Serial0/0/0
R    192.168.3.0/24 [120/1] via 10.10.10.254, 00:00:03, Serial0/0/0
C    192.168.4.0/24 is directly connected, Loopback0
C    192.168.5.0/24 is directly connected, Loopback1
C    192.168.6.0/24 is directly connected, Loopback2
R    192.168.7.0/24 [120/1] via 172.16.100.2, 00:00:04, Serial0/0/1
R    192.168.8.0/24 [120/1] via 172.16.100.2, 00:00:04, Serial0/0/1
R    192.168.9.0/24 [120/1] via 172.16.100.2, 00:00:04, Serial0/0/1
```

Step 2: Examine the output from the BRANCH1 router.

```
BRANCH1#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

     10.0.0.0/30 is subnetted, 1 subnets
C       10.10.10.252 is directly connected, Serial0/0/0
R    172.16.0.0/16 [120/1] via 10.10.10.253, 00:00:04, Serial0/0/0
C    192.168.1.0/24 is directly connected, Loopback0
C    192.168.2.0/24 is directly connected, Loopback1
C    192.168.3.0/24 is directly connected, Loopback2
R    192.168.4.0/24 [120/1] via 10.10.10.253, 00:00:04, Serial0/0/0
R    192.168.5.0/24 [120/1] via 10.10.10.253, 00:00:04, Serial0/0/0
R    192.168.6.0/24 [120/1] via 10.10.10.253, 00:00:04, Serial0/0/0
R    192.168.7.0/24 [120/2] via 10.10.10.253, 00:00:04, Serial0/0/0
R    192.168.8.0/24 [120/2] via 10.10.10.253, 00:00:04, Serial0/0/0
R    192.168.9.0/24 [120/2] via 10.10.10.253, 00:00:04, Serial0/0/0
```

Step 3: Examine the output from the BRANCH2 router.

```
BRANCH2#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

R    10.0.0.0/8 [120/1] via 172.16.100.1, 00:00:19, Serial0/0/1
     172.16.0.0/30 is subnetted, 1 subnets
C       172.16.100.0 is directly connected, Serial0/0/1
R    192.168.1.0/24 [120/2] via 172.16.100.1, 00:00:19, Serial0/0/1
R    192.168.2.0/24 [120/2] via 172.16.100.1, 00:00:19, Serial0/0/1
R    192.168.3.0/24 [120/2] via 172.16.100.1, 00:00:19, Serial0/0/1
R    192.168.4.0/24 [120/1] via 172.16.100.1, 00:00:19, Serial0/0/1
R    192.168.5.0/24 [120/1] via 172.16.100.1, 00:00:19, Serial0/0/1
R    192.168.6.0/24 [120/1] via 172.16.100.1, 00:00:19, Serial0/0/1
C    192.168.7.0/24 is directly connected, Loopback0
C    192.168.8.0/24 is directly connected, Loopback1
C    192.168.9.0/24 is directly connected, Loopback2
```

Task 2: Create a diagram of the network based on the router outputs.

Step 1: Draw a diagram of the network based on your interpretation of the router outputs in the space provided below.

Topology Diagram
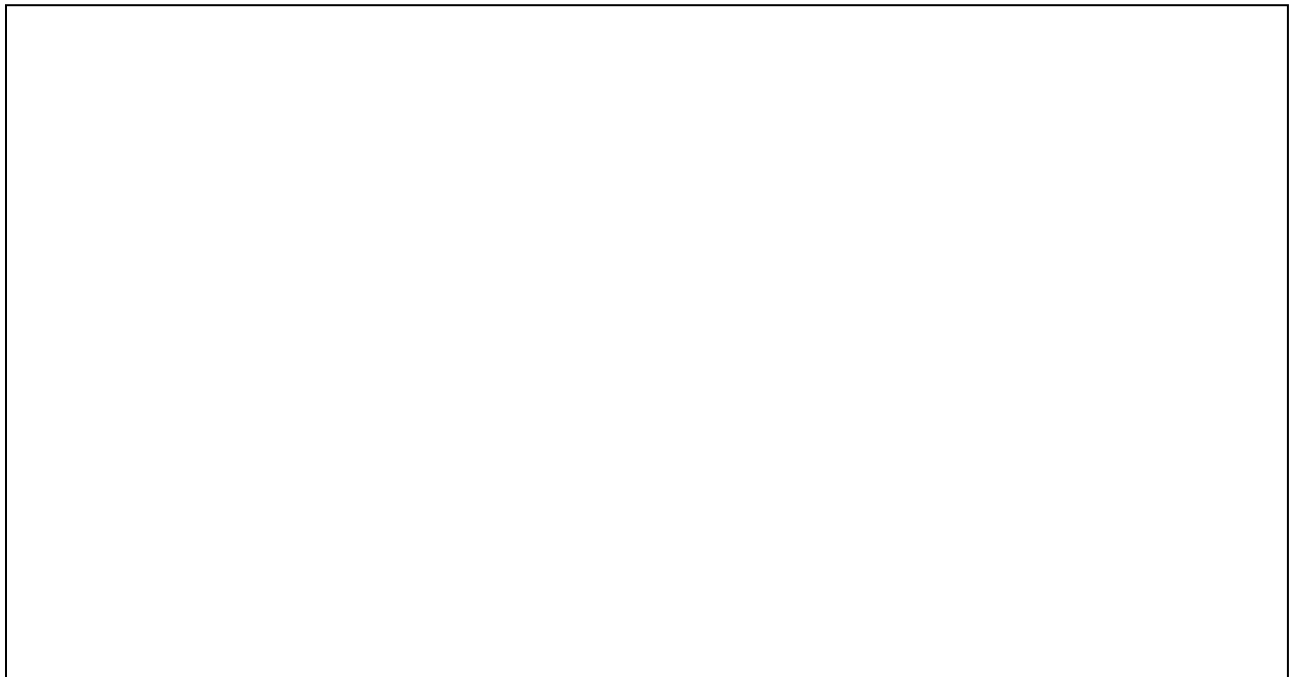
Step 2: Document the interface addresses in the Addressing Table.

Task 3: Create 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.

Step 3: Configure the HQ, BRANCH1, and BRANCH2 routers.

Configure the interfaces on the HQ, BRANCH1, and BRANCH2 routers with the IP addresses from the Addressing Table. The clock rate, DTE assignment, and DCE assignment of the Serial interfaces are at your discretion.

Task 4: Configure the routing protocol for each router.

Step 1: Enable the RIP routing protocol on the BRANCH1 router.

The RIP routing protocol will be used to advertise directly connected networks to the other routers in the topology. RIP configuration will be covered in greater detail in a later lab activity. The basic configuration steps necessary for this lab activity are provided below.

To enable RIP, enter global configuration mode and use the **router rip** command.

```
BRANCH1(config)#router rip
BRANCH1(config-router)#
```

Step 2: Enter the classful network addresses for each directly connected network.

Once you are in routing configuration mode, enter the classful network address for each directly connected network, using the **network** command. An example of the use of the **network** command is provided below.

```
BRANCH1(config-router)#network 192.168.1.0
BRANCH1(config-router)#
```

Be sure to configure a **network** statement for each network that is attached to a Serial or Loopback interface of the router.

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

```
BRANCH1(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
BRANCH1#copy run start
```

Step 3: Configure RIP on the HQ and BRANCH2 routers.

Use the **router rip** and **network** commands to configure the HQ and BRANCH2 routers to advertise directly connected networks to the other routers in the topology.

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

Step 4: Test and verify connectivity.

Use the `ping` command to verify that the router interfaces can communicate with each other. If you discover that two interfaces cannot ping each other, troubleshoot your IP addressing and router configuration.

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 – The output of the `show ip route` command for each of the routers should be exactly the same as the provided outputs
- Interface summarization

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 5.6.1: Basic RIP Configuration
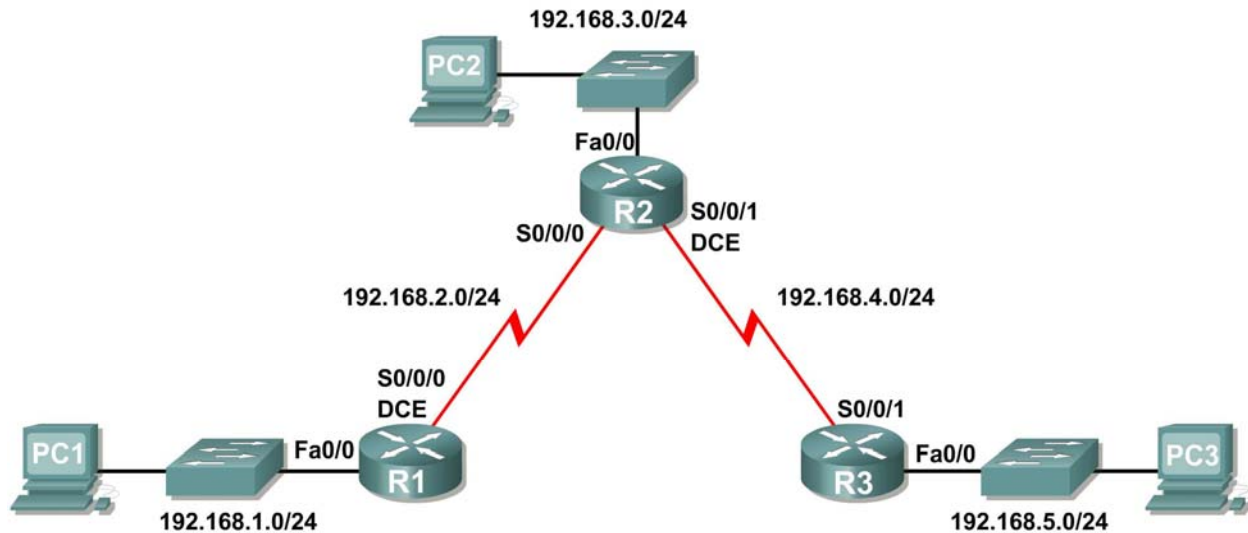
Topology Diagram

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
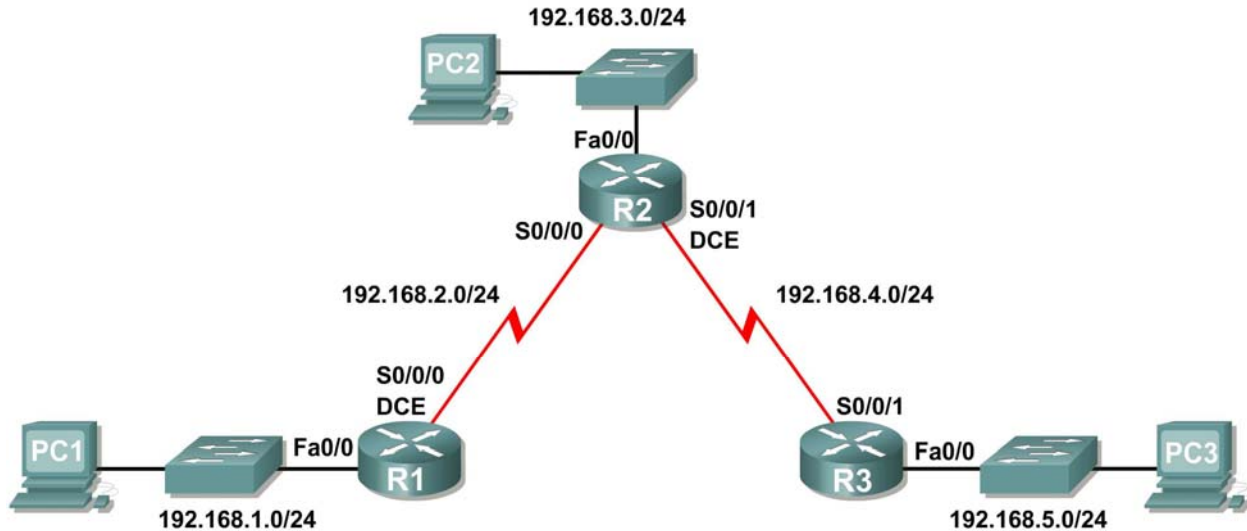
Topology Diagram

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
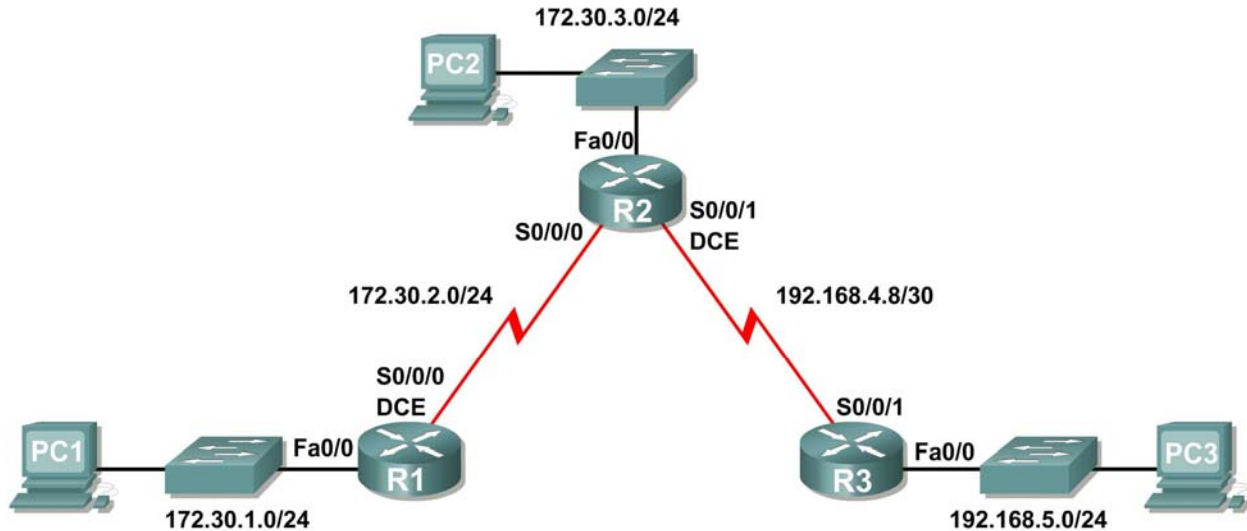
Topology Diagram

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
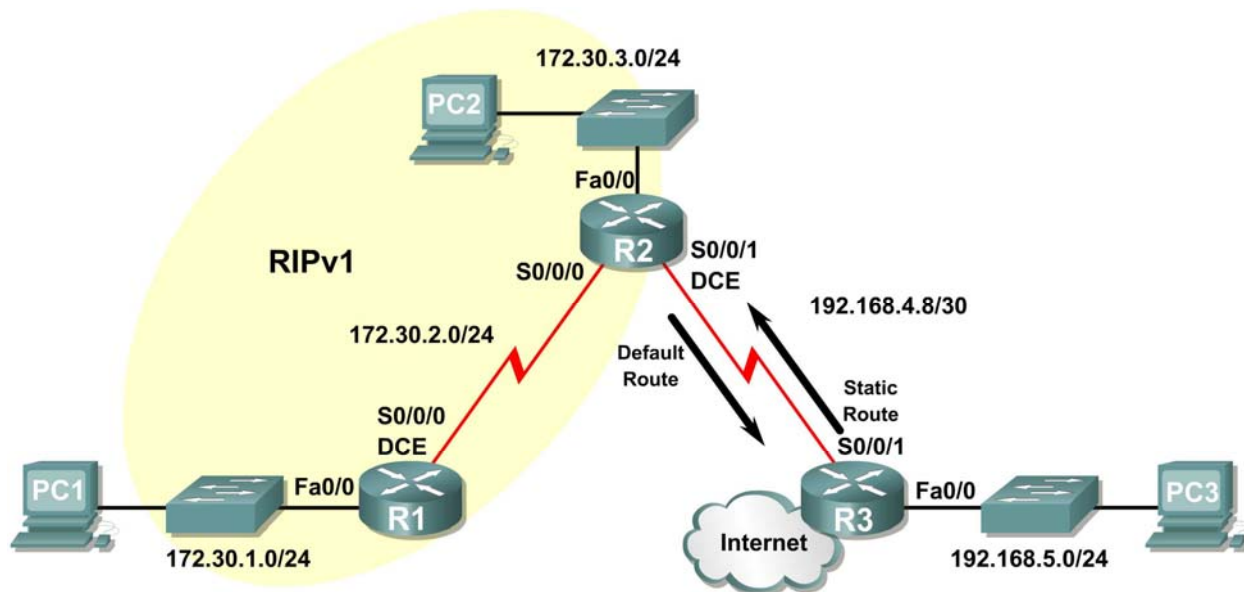
Background

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.

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Lab 5.6.2: Challenge RIP Configuration

Topology Diagram

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
BRANCH	Fa0/0			N/A
	S0/0/0			N/A
HQ	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
ISP	Fa0/0			N/A
	S0/0/1			N/A
PC1	NIC			
PC2	NIC			
PC3	NIC			

Learning Objectives

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

- Subnet an address space given requirements.
- Assign appropriate addresses to interfaces and document them in the Addressing Table.
- Cable a network according to the Topology Diagram.

- Erase the startup configuration and reload a router to the default state.
- Configure RIPv1 routing on all routers.
- Configure and propagate a static default route.
- Verify RIPv1 operation.
- Test and verify full connectivity.
- Reflect upon and document the network implementation.

Scenario

In this lab activity, you will be given a network address that must be subnetted to complete the addressing of the network shown in the Topology Diagram. A combination of RIPv1 and static routing will be required so that hosts on networks that are not directly connected will be able to communicate with each other.

Task 1: Subnet the Address Space.

Step 1: Examine the network requirements.

The addressing for the network has the following requirements:

- The ISP LAN will use the 209.165.202.128/27 network.
- The link between the ISP router and the HQ router will use the 209.165.200.224/30 network.
- The 192.168.1.0/24 network must be subnetted for use in the HQ LAN and the link between the HQ and BRANCH routers. The HQ LAN will require 50 host IP addresses.
- The BRANCH LAN will use the 10.10.2.0/23 network.

(**Note:** Remember that the interfaces of network devices are also host IP addresses and are included in the above addressing requirements.)

Step 2: Consider the following questions when creating your network design:

How many subnets need to be created from the 192.168.1.0/24 network? _____

What is the subnet mask for this network in dotted decimal format? _____

What is the subnet mask for the network in slash format? _____

What are the network addresses of the subnets?

Subnet 0: _____

Subnet 1: _____

Subnet 2: _____

Subnet 3: _____

How many usable host IP addresses are there per subnet? _____

How many usable hosts IP addresses are available in the BRANCH LAN? _____

Step 3: Assign subnetwork addresses to the Topology Diagram.

1. Assign subnet 1 in the 192.168.1.0 network to the WAN link between the HQ and BRANCH routers.

2. Assign subnet 2 in the 192.168.1.0 network to the LAN attached to the HQ router.

Task 2: Determine Interface Addresses.

Step 1: Assign appropriate addresses to the device interfaces.

1. Assign the first valid host address in the 209.165.202.128/27 network to the LAN interface on the ISP router.

2. Assign the last valid host address in the 209.165.202.128/27 network to PC3.

3. Assign the first valid host address in the 209.165.200.224/30 network to the WAN interface of the ISP router.

4. Assign the last valid host address in the 209.165.200.224/30 network to the Serial 0/0/1 interface of the HQ router.

5. Assign the first valid host address in the HQ LAN network to the LAN interface of the HQ router.

6. Assign the last valid host address in the HQ LAN network to PC 2.

7. Assign the first valid host address in the HQ/BRANCH WAN link to the Serial 0/0/0 interface of the HQ router.

8. Assign the last valid host address in the HQ/BRANCH WAN link to the Serial 0/0/0 interface of the BRANCH router.

9. Assign the first valid host address in the 10.10.2.0/23 network to the LAN interface on the BRANCH router.

10. Assign the last valid host address in the 10.10.2.0/23 network to PC1.

Step 2: Document the addresses to be used in the table provided under the Topology Diagram.

Task 3: 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 4: Perform Basic Router Configurations.

Perform basic configuration in the BRANCH, HQ, and ISP 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.

7. Synchronize unsolicited messages and debug output with solicited output and prompts for the console and virtual terminal lines.

8. Configure an EXEC timeout of 15 minutes.

Task 5: Configure and Activate Serial and Ethernet Addresses.

Step 1: Configure the BRANCH, HQ, and ISP routers.

Configure the interfaces on the BRANCH, HQ, and ISP routers with the IP addresses from the Addressing Table provided under the Topology Diagram.

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

Step 2: Configure the Ethernet interfaces of PC1, PC2, and PC3.

Configure the Ethernet interfaces of PC1, PC2, and PC3 with the IP addresses from the Addressing Table provided under the Topology Diagram.

Task 6: Verify Connectivity to Next-Hop Device.

You should *not* have connectivity between end devices yet. However, you can test connectivity between two routers and between an end device and its default gateway.

Step 1: Verify BRANCH connectivity.

Verify that BRANCH can ping across the WAN link to HQ and that HQ can ping across the WAN link it shares with ISP.

Step 2: Verify Ethernet interface connectivity.

Verify that PC1, PC2, and PC3 can ping their respective default gateways.

Task 7: Configure RIP Routing on the BRANCH Router.

Consider the networks that need to be included in the RIP updates that are sent out by the BRANCH router.

What networks are currently present in the BRANCH routing table before RIP is configured? List the networks with slash notation.

_____

_____

_____

What commands are required to enable RIP version 1 and include these networks in the routing updates?

_____

_____

_____

Are there any router interfaces that do not need to have RIP updates sent out? _____

What command is used to disable RIP updates on this interface?

_____

Task 8: Configure RIP and Static Routing on the HQ Router

Consider the type of static routing that is needed on HQ.

What networks are present in the HQ routing table? List the networks with slash notation.

_____

_____

_____

A static default route will need to be configured to send all packets with destination addresses that are not in the routing table to the ISP router. What command is needed to accomplish this? Use the appropriate exit interface on the HQ router in the command.

_____

What commands are required to enable RIPv1 and include the LAN network in the routing updates?

_____

_____

Are there any router interfaces that do not need to have RIP updates sent out? _____

What command is used to disable RIP updates on this interface?

_____

The HQ router needs to send the default route information to the BRANCH router in the RIP updates. What command is used to configure this?

_____

Task 9: Configure Static Routing on the ISP Router

Static routes will need to be configured on the ISP router for all traffic that is destined for the RFC 1918 addresses that are used on the BRANCH LAN, HQ LAN, and the link between the BRANCH and HQ routers.

What are the commands that will need to be configured on the ISP router to accomplish this?

ISP(config)# _____

ISP(config)#_____

Task 10: Verify the Configurations

Answer the following questions to verify that the network is operating as expected.

From PC2, is it possible to ping PC1? _____

From PC2, is it possible to ping PC3? _____

From PC1, is it possible to ping PC3? _____

The answer to the above questions should be **yes**. If any of the above pings failed, check your physical connections and configurations. Refer to the basic troubleshooting techniques used in the Chapter 1 labs.

What routes are present in the routing table of the BRANCH router?

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the BRANCH router?

_____

What routes are present in the routing table of the HQ router?

_____

_____

_____

_____

_____

What networks are present in the routing table of the ISP router?

_____

_____

_____

_____

What networks, including the metric, are present in the RIP updates sent from the HQ router?

_____

_____

What networks, including the metric, are present in the RIP updates sent from the BRANCH router?

_____

_____

Task 11: Reflection

If static routing were used instead of RIP on the BRANCH router, how many individual static routes would be needed for hosts on the BRANCH LAN to communicate with all of the networks in the Topology Diagram? _____

Task 12: 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

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.

Lab 5.6.3: RIP Troubleshooting

Topology Diagram
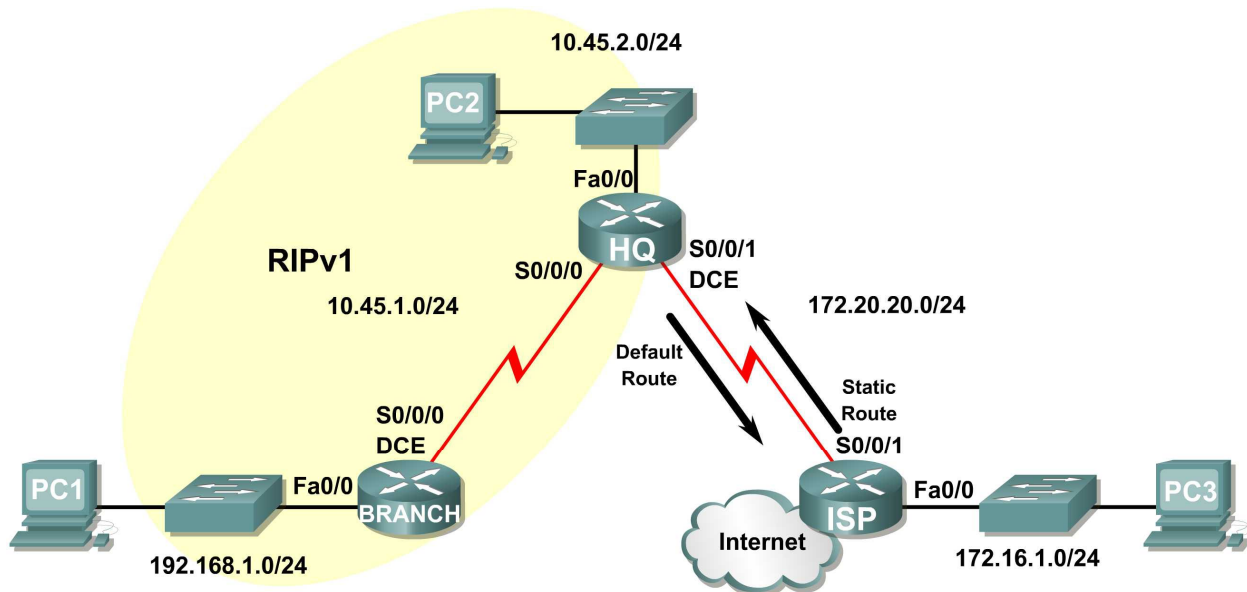
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
BRANCH	Fa0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0	10.45.1.254	255.255.255.0	N/A
HQ	Fa0/0	10.45.2.1	255.255.255.0	N/A
	S0/0/0	10.45.1.1	255.255.255.0	N/A
	S0/0/1	172.20.20.254	255.255.255.0	N/A
ISP	FA0/0	172.16.1.1	255.255.255.0	N/A
	S0/0/1	172.20.20.1	255.255.255.0	N/A
PC1	NIC	192.168.1.254	255.255.255.0	192.168.1.1
PC2	NIC	10.45.2.254	255.255.255.0	10.45.2.1
PC3	NIC	172.16.1.254	255.255.255.0	172.16.1.1

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.
- Load the routers with supplied scripts.

- Discover where convergence is not complete.
- Gather information about the non-converged portion of the network along with any other errors.
- Analyze information to determine why convergence is not complete.
- Propose solutions to network errors.
- Implement solutions to network errors.
- Document the corrected network.

Scenario

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

The network should also have the following requirements met:

- RIPv1 routing is configured on the BRANCH router.
- RIPv1 routing is configured on the HQ router.
- RIP updates must be disabled on the BRANCH and HQ LAN interfaces.
- Static default route is configured on the HQ router and shared with the BRANCH router via RIP updates.
- Static routes for all HQ and BRANCH networks are to be configured on the ISP router. The routes must be summarized wherever possible.

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 the BRANCH router.

```
hostname BRANCH
!
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
!
interface Serial0/0/0
 ip address 10.45.1.254 255.255.255.0
 clock rate 64000
 no shutdown
!
router rip
```

```
 passive-interface FastEthernet0/0
 network 10.0.0.0
!
line con 0
line vty 0 4
 password cisco
 login
!
end
```

Step 2: Load the following script onto the HQ router.

```
hostname HQ
!
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 10.45.2.1 255.255.255.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 10.45.1.1 255.255.255.0
 no shutdown
!
interface Serial0/0/1
 ip address 172.20.20.254 255.255.255.0
 clock rate 64000
 no shutdown
!
router rip
 passive-interface FastEthernet0/0
network 10.0.0.0
!
ip route 0.0.0.0 0.0.0.0 Serial0/0/1
!
line con 0
line vty 0 4
 password cisco
 login
!
end
```

Step 3: Load the following script onto the ISP router.

```
hostname ISP
!
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 172.16.1.1 255.255.255.0
 duplex auto
 speed auto
```

```
 no shutdown
!
interface Serial0/0/1
 ip address 172.20.20.1 255.255.255.0
 no shutdown
!
ip route 10.45.0.0 255.255.254.0 Serial0/0/1
ip route 192.168.1.0 255.255.255.0 Serial0/0/1
!
line con 0
line vty 0 4
 password cisco
 login
!
end
```

Task 3: Troubleshoot the BRANCH Router

Step 1: Begin troubleshooting at the Host connected to the BRANCH router.

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

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

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

Step 2: Examine the BRANCH router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

_____

If there are any problems with the status of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the BRANCH router.

What networks are shown in the routing table?

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

If there are any problems with the routing table, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

What networks are included in the RIP updates?

_____

_____

_____

Are there any problems with the RIP updates that are being sent out from the router?

_____

_____

_____

If there are any problems with the RIP configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 6: If you have recorded any commands above, apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors? _____

Does the information included in the RIP updates that are sent out indicate any configuration errors? _____

If the answer to either of these questions is **yes**, troubleshoot the routing configuration again.

What networks are included in the RIP updates?

_____

_____

_____

Step 8: Attempt to ping between the hosts again.

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

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

From the host PC1, is it possible to ping the Serial 0/0 interface of the HQ router? _____

Task 4: Troubleshoot the HQ Router

Step 1: Begin troubleshooting at the Host connected to the R2 router.

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

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

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

Step 2: Examine the HQ router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

_____

If there are any problems with the status of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View the summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the BRANCH router.

What networks are shown in the routing table?

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

If there are any problems with the routing table, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

What networks are included in the RIP updates?

_____

_____

_____

Are there any problems with the RIP updates that are being sent out from the router?

_____

_____

_____

If there are any problems with the RIP configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

_____

Step 6: If you have recorded any commands above, apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors? _____

Does the information included in the RIP updates that are sent out indicate any configuration errors? _____

If the answer to either of these questions is **yes**, troubleshoot the routing configuration again.

What networks are included in the RIP updates?

_____

_____

_____

Step 8: Verify that the HQ router is sending a default route to the BRANCH router.

Is there a default route in the BRANCH routing table? _____

If not, what commands are needed to configure this on the HQ router?

_____

_____

_____

Step 9: If you have recorded any commands above, apply them to the HQ router configuration now.

Step 10: View the BRANCH routing table.

If any changes were made to the configuration in the previous step, view the BRANCH routing table again.

Is there a default route in the BRANCH routing table? _____

If the answer is **no**, troubleshoot the RIP configuration again.

Step 11: Attempt to ping between the hosts again.

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

From the host PC2, is it possible to ping the Serial 0/1 interface of the ISP router? _____

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

Task 5: Troubleshoot the ISP Router

Step 1: Begin troubleshooting at the Host connected to the ISP router.

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

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

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

Step 2: Examine the ISP router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

_____

If there are any problems with the status of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View the summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the static routing configuration on the ISP router.

Begin by viewing the routing table.

What networks are shown in the routing table?

_____

_____

_____

_____

Are there any problems with the routing configuration?

_____

_____

If there are any problems with the routing configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 6: If you have recorded any commands above, apply them to the router configuration now.

Step 7: View the routing table.

If any changes were made to the configuration in the previous step, view the routing table again.

Does the information in the routing table indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the routing configuration again.

Step 8: Attempt to ping between the hosts again.

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

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

From the host PC3, is it possible to ping the WAN interface of the BRANCH router? _____

Task 6: Reflection

There were a number of configuration errors in the scripts that were provided for this lab. Use the space below to write a brief description of the errors that you found.

_____

_____

_____

_____

_____

_____

_____

_____

Task 7: Documentation

On each router, capture output from the following commands 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 8: 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.

Activity 6.4.1: Basic VLSM Calculation and Addressing Design

Topology Diagram
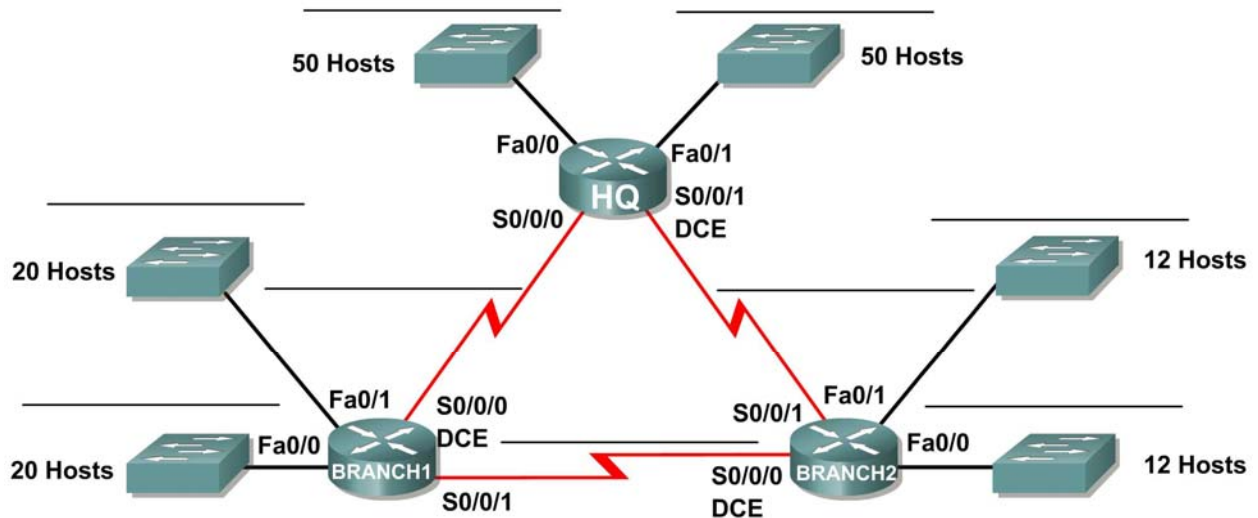
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0			N/A
	Fa0/1			N/A
	S0/0/0			N/A
	S0/0/1			N/A
Branch1	Fa0/0			N/A
	Fa0/1			N/A
	S0/0/0			N/A
	S0/0/1			N/A
Branch2	Fa0/0			N/A
	Fa0/1			N/A
	S0/0/0			N/A
	S0/0/1			N/A

Learning Objectives

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

- Determine the number of subnets needed.
- Determine the number of hosts needed for each subnet
- Design an appropriate addressing scheme using VLSM.
- Assign addresses and subnet mask pairs to device interfaces.
- Examine the use of the available network address space.

Scenario

In this activity, you have been given the network address 192.168.1.0/24 to subnet and provide the IP addressing for the network shown in the Topology Diagram. VLSM will be used so that the addressing requirements can be met using the 192.168.1.0/24 network. The network has the following addressing requirements:

- The HQ LAN1 will require 50 host IP addresses.
- The HQ LAN2 will require 50 host IP addresses.
- The Branch1 LAN1 will require 20 host IP addresses.
- The Branch1 LAN2 will require 20 host IP addresses
- The Branch2 LAN1 will require 12 host IP addresses.
- The Branch2 LAN2 will require 12 host IP addresses.
- The link from HQ to Branch1 will require an IP address for each end of the link.
- The link from HQ to Branch2 will require an IP address for each end of the link.
- The link Branch1 to Branch2 will require an IP address for each end of the link.

(**Note:** Remember that the interfaces of network devices are also host IP addresses and are included in the above addressing requirements.)

Task 1: Examine the Network Requirements.

Examine the network requirements and answer the questions below. Keep in mind that IP addresses will be needed for each of the LAN interfaces.

1. How many subnets are needed? _____
2. What is the maximum number of IP addresses that are needed for a single subnet? _____
3. How many IP addresses are needed for each of the BranchBranch1 LANs? _____
4. How many IP addresses are needed for each of the BranchBranch2 LANs? _____
5. How many IP addresses are needed for each of the WAN links between routers? _____
6. What is the total number of IP addresses that are needed? _____
7. What is the total number of IP addresses that are available in the 192.168.1.0/24 network? _____
8. Can the network addressing requirements be met using the 192.168.1.0/24 network? _____

Task 2: Design an IP Addressing Scheme

Step 1: Determine the subnet information for the largest network segment or segments.

In this case, the two HQ LANs are the largest subnets.

1. How many IP addresses are needed for each LAN? _____

2. What is the smallest size subnet that can be used to meet this requirement? _____

3. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 2: Assign subnets to HQ LANs.

Start at the beginning of the 192.168.1.0/24 network.

1. Assign the first available subnet to HQ LAN1.

2. Fill in the chart below with the appropriate information.

HQ LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

3. Assign the next available subnet to HQ LAN2.

4. Fill in the chart below with the appropriate information.

HQ LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 3: Determine the subnet information for the next largest network segment or segments.

In this case, the two Branch1 LANs are the next largest subnets.

1. How many IP addresses are needed for each LAN? _____

2. What is the smallest size subnet that can be used to meet this requirement? _____

3. What is the maximum number of IP addresses that can be assigned in this size subnet? _____ 30

Step 4: Assign subnet to BRANCH1 LANs.

Start with the IP address following the HQ LAN subnets.

1. Assign the next subnet to Branch1 LAN1.

2. Fill in the chart below with the appropriate information.

Branch1 LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

3. Assign the next available subnet to Branch1 LAN2.

4.   Fill in the chart below with the appropriate information.

Branch1 LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 5: Determine the subnet information for the next largest network segment or segments.

In this case, the two Branch2 LANs are the next largest subnets.

1.   How many IP addresses are needed for each LAN? _____

2.   What is the smallest size subnet that can be used to meet this requirement? _____

3.   What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 6: Assign subnets to BRANCH2 LANs.

Start with the IP address following the Branch1 LAN subnets.

1.   Assign the next subnet to the Branch2 LAN1. Fill in the chart below with the appropriate information.

Branch2 LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

2.   Assign the next available subnet to Branch2 LAN2.

3.   Fill in the chart below with the appropriate information.

Branch2 LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 7: Determine the subnet information for the links between the routers.

1.   How many IP addresses are needed for each link? _____

2.   What is the smallest size subnet that can be used to meet this requirement? _____

3.   What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 8: Assign subnets to links.

Start with the IP address following the Branch2 LAN subnets.

1.   Assign the next available subnet to the link between the HQ and Branch1 routers.

2.   Fill in the chart below with the appropriate information.

Link between HQ and Branch1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

3. Assign the next available subnet to the link between the HQ and Branch2 routers.

4. Fill in the chart below with the appropriate information.

Link between HQ and Branch2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

5. Assign the next available subnet to the link between the Branch1 and Branch2 routers.

6.   Fill in the chart below with the appropriate information.

Link between Branch1 and Branch2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Task 3: Assign IP Addresses to the Network Devices

Assign the appropriate addresses to the device interfaces. Document the addresses to be used in the Addressing Table provided under the Topology Diagram.

Step 1: Assign addresses to the HQ router.

1. Assign the first valid host address in the HQ LAN 1 subnet to the Fa0/0 LAN interface.

2. Assign the first valid host address in the HQ LAN 2 subnet to the Fao/1 LAN interface.

3. Assign the first valid host address in the link between HQ and Branch1 subnet to the S0/0/0 interface.

4. Assign the first valid host address in the link between HQ and Branch2 subnet to the S0/0/1 interface.

Step 2: Assign addresses to the Branch1 router.

1. Assign the first valid host address in the Branch1 LAN1 subnet to the Fa0/0 LAN interface.

2. Assign the first valid host address in the Branch1 LAN2 subnet to the Fa0/1 LAN interface.

3. Assign the last valid host address on the link between Branch1 and HQ subnet to the S0/0/0 interface

4. Assign the first valid host address on the link between Branch1 and Branch2 subnet to the S0/0/1 interface.

Step 3: Assign addresses to the Branch2 router.

1. Assign the first valid host address in the Branch2 LAN1 subnet to the Fa0/0 LAN interface.

2. Assign the first valid host address in the Branch 2 LAN 2 subnet to the Fa0/1 LAN interface.
3. Assign the last valid host address on the link between HQ and Branch2 subnet to the S0/0/1 interface

4. Assign the last valid host address on the link between Branch1 and Branch2 subnet to the S0/0/0 interface.

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Activity 6.4.2: Challenge VLSM Calculation and Addressing Design
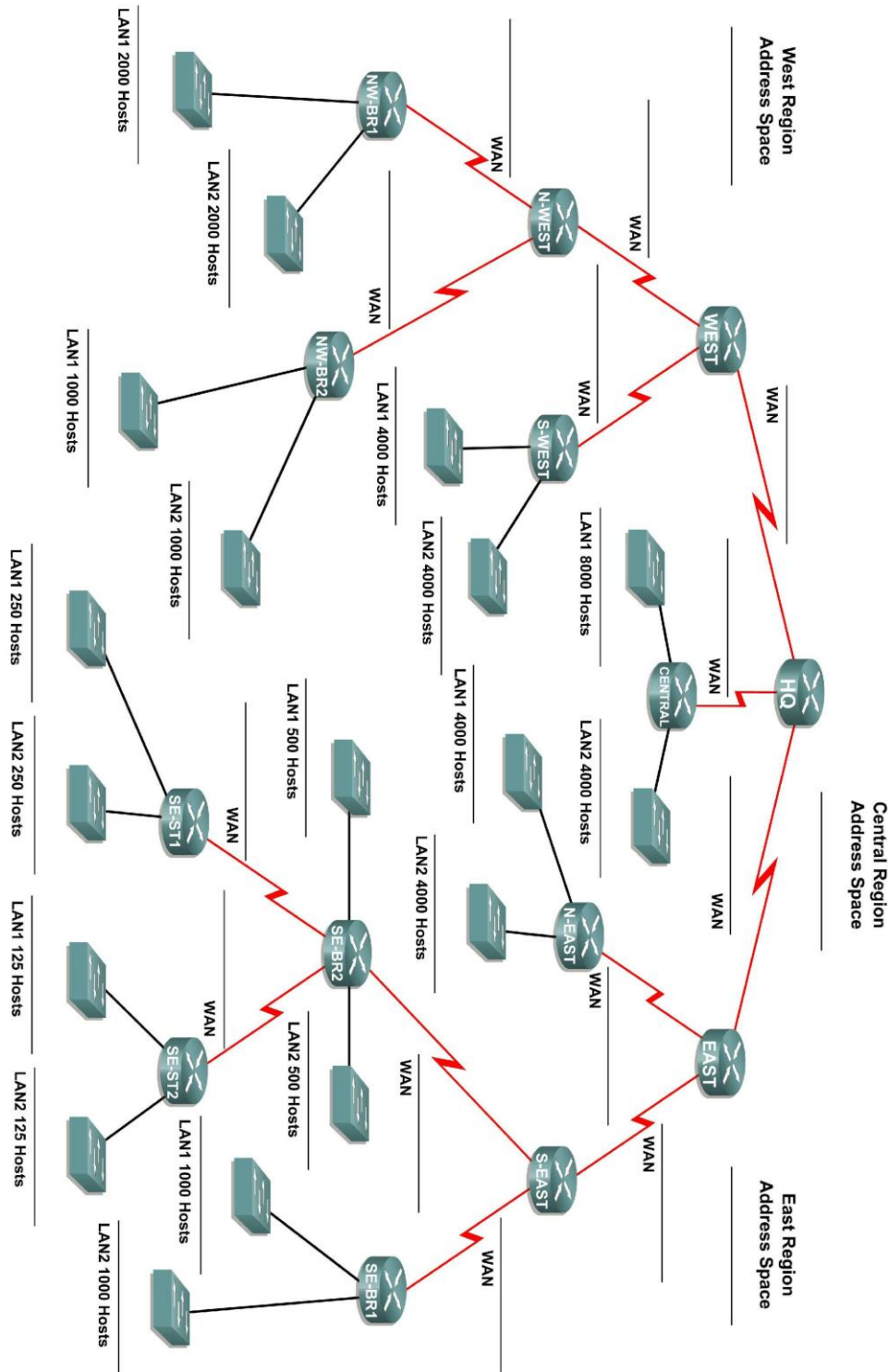
Topology Diagram

Learning Objectives

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

- Determine the number of subnets needed.
- Determine the number of hosts needed for each subnet
- Design an appropriate addressing scheme using VLSM.

Scenario

In this activity, you have been given the network address 172.16.0.0/16 to subnet and provide the IP addressing for the network shown in the Topology Diagram. VLSM will be used so that the addressing requirements can be met using the 172.16.0.0/16 network.

The network has the following addressing requirements:

- East Network Section
    - The N-EAST (Northeast) LAN1 will require 4000 host IP addresses.
    - The N-EAST (Northeast) LAN2 will require 4000 host IP addresses.
    - The SE-BR1 (Southeast Branch1) LAN1 will require 1000 host IP addresses.
    - The SE-BR1 (Southeast Branch1) LAN2 will require 1000 host IP addresses.
    - The SE-BR2 (Southeast Branch2) LAN1 will require 500 host IP addresses.
    - The SE-BR2 (Southeast Branch2) LAN2 will require 500 host IP addresses.
    - The SE-ST1 (Southeast Satellite1) LAN1 will require 250 host IP addresses.
    - The SE-ST1 (Southeast Satellite1) LAN2 will require 250 host IP addresses.
    - The SE-ST2 (Southeast Satellite2) LAN1 will require 125 host IP addresses.
    - The SE-ST2 (Southeast Satellite2) LAN2 will require 125 host IP addresses.
- West Network Section
    - The S-WEST (Southwest) LAN1 will require 4000 host IP addresses.
    - The S-WEST (Southwest) LAN2 will require 4000 host IP addresses.
    - The NW-BR1 (Northwest Branch1) LAN1 will require 2000 host IP addresses.
    - The NW-BR1 (Northwest Branch1) LAN2 will require 2000 host IP addresses.
    - The NW-BR2 (Northwest Branch2) LAN1 will require 1000 host IP addresses.
    - The NW-BR2 (Northwest Branch2) LAN2 will require 1000 host IP addresses.
- Central Network Section
    - The Central LAN1 will require 8000 host IP addresses.
    - The Central LAN2 will require 4000 host IP addresses.
- The WAN links between each of the routers will require an IP address for each end of the link.

(**Note:** Remember that the interfaces of network devices are also host IP addresses and are included in the above addressing requirements.)

Task 1: Examine the Network Requirements.

Examine the network requirements and answer the questions below. Keep in mind that IP addresses will be needed for each of the LAN interfaces.

1. How many LAN subnets are needed? _____

2. How many subnets are needed for the WAN links between routers? _____

3. How many total subnets are needed? _____

4. What is the maximum number of host IP addresses that are needed for a single subnet? _____

5. What is the least number of host IP addresses that are needed for a single subnet? _____

6. How many IP addresses are needed for the East portion of the network? Be sure to include the WAN links between the routers. _____

7. How many IP addresses are needed for the West portion of the network? Be sure to include the WAN links between the routers. _____

8. How many IP addresses are needed for the Central portion of the network? Be sure to include the WAN links between the routers. _____

9. What is the total number of IP addresses that are needed? _____

10. What is the total number of IP addresses that are available in the 172.16.0.0/16 network? _____

11. Can the network addressing requirements be met using the 172.16.0.0/16 network? _____

Task 2: Divide the Network into Three Subnetworks.

Step 1: Determine the subnet information for each network section.

To keep the subnets of each of the major network sections contiguous, begin by creating a main subnet for each of the East, West, and Central network sections.

1. What is the smallest size subnet that can be used to meet the addressing requirement for the East network? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

3. What is the smallest size subnet that can be used to meet the addressing requirement for the West network? _____

4. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

5. What is the smallest size subnet that can be used to meet the addressing requirement for the Central network? _____

6. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 2: Assign subnets.

1. Start at the beginning of the 172.16.0.0/16 network. Assign the first available subnet to the East section of the network.

2. Fill in the chart below with the appropriate information.

East Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

3. Assign the next available subnet to the West section of the network.

4. Fill in the chart below with the appropriate information.

West Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

5. Assign the next available subnet to the Central section of the network.

6. Fill in the chart below with the appropriate information.

Central Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Task 3: Design an IP Addressing Scheme for the Central Network.

Step 1: Determine the subnet information for the Central LAN1.

Use the address space that was designated for the Central network in Task 1.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 2: Assign subnet to Central LAN1.

Start at the beginning of the address space designated for the Central network.

1. Assign the first subnet to the Central LAN1.

2. Fill in the chart below with the appropriate information.

Central LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 3: Determine the subnet information for the Central LAN2.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 4: Assign subnet to Central LAN2.

1. Assign the next available subnet to the Central LAN2.

2. Fill in the chart below with the appropriate information.

Central LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 5: Determine the subnet information for the WAN link between the Central router and the HQ router.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 6: Assign subnet to WAN link.

1. Assign the next available subnet to the WAN link between the Central router and the HQ router.

2. Fill in the chart below with the appropriate information.

WAN link between Central and HQ Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Task 4: Design an IP Addressing Scheme for the West Network.

Step 1: Determine the subnet information for the S-WEST LAN1.

Use the address space that was designated for the West network in Task 1.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 2: Assign subnet to S-WEST LAN1.

Start at the beginning of the address space designated for the West network.

1. Assign the first subnet to the S-WEST LAN1.

2. Fill in the chart below with the appropriate information.

S-WEST LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 3: Determine the subnet information for the S-WEST LAN2.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 4: Assign subnet to S-WEST LAN2.

1. Assign the next available subnet to the S-WEST LAN2.

2. Fill in the chart below with the appropriate information.

S-WEST LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 5: Determine the subnet information for the NW-BR1 LAN1.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 6: Assign subnet to NW-BR1 LAN1.

1. Assign the next available subnet to the NW-BR1 LAN1.

2. Fill in the chart below with the appropriate information.

NW-BR1 LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 7: Determine the subnet information for the NW-BR1 LAN2.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 8: Assign subnet to NW-BR1 LAN2.

1. Assign the next available subnet to the NW-BR1 LAN2.

2. Fill in the chart below with the appropriate information.

NW-BR1 LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 9: Determine the subnet information for the NW-BR2 LAN1.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 10: Assign subnet to NW-BR2 LAN1.

1. Assign the next available subnet to the NW-BR2 LAN1.

2. Fill in the chart below with the appropriate information.

NW-BR2 LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 11: Determine the subnet information for the NW-BR2 LAN2.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 12: Assign subnet to NW-BR2 LAN2.

1. Assign the next available subnet to the NW-BR2 LAN2.

2. Fill in the chart below with the appropriate information.

NW-BR2 LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 13: Determine the subnet information for the WAN links between the routers in the West network.

1. How many router to router WAN links are present in the West network? _____

2. How many IP addresses are needed for each of these WAN links? _____

3. What is the smallest size subnet that can be used to meet this requirement? _____

4. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 14: Assign subnets to WAN links.

1. Assign the next available subnets to the WAN links between the routers.

2. Fill in the chart below with the appropriate information.

WAN links between the Routers in the West Network

WAN Link	Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address
HQ to WEST						
WEST to S-WEST						
WEST to N-WEST						
N-WEST to NW-BR1						
N-WEST to NW-BR2						

Task 5: Design an IP Addressing Scheme for the East Network.

Step 1: Determine the subnet information for the N-EAST LAN1.

Use the address space that was designated for the East network in Task 1.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 2: Assign subnet to N-EAST LAN1.

Start at the beginning of the address space designated for the East network.

1. Assign the first subnet to the N-EAST LAN1.

2. Fill in the chart below with the appropriate information.

N-EAST LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 3: Determine the subnet information for the N-EAST LAN2.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 4: Assign subnet to N-EAST LAN2.

1. Assign the next available subnet to the N-EAST LAN2.

2. Fill in the chart below with the appropriate information.

N-EAST LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 5: Determine the subnet information for the SE-BR1 LAN1.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 6: Assign subnet to SE-BR1 LAN1.

1. Assign the next available subnet to the SE-BR1 LAN1.

2. Fill in the chart below with the appropriate information.

SE-BR1 LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 7: Determine the subnet information for the SE-BR1 LAN2.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 8: Assign subnet to SE-BR1 LAN2.

1. Assign the next available subnet to the SE-BR1 LAN2.

2. Fill in the chart below with the appropriate information.

SE-BR1 LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 9: Determine the subnet information for the SE-BR2 LAN1.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 10: Assign subnet to SE-BR2 LAN1.

1. Assign the next available subnet to the SE-BR2 LAN1.

2. Fill in the chart below with the appropriate information.

SE-BR2 LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 11: Determine the subnet information for the SE-BR2 LAN2.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 12: Assign subnet to SE-BR2 LAN2.

1. Assign the next available subnet to the SE-BR2 LAN2.

2. Fill in the chart below with the appropriate information.

SE-BR2 LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 13: Determine the subnet information for the SE-ST1 LAN1.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 14: Assign subnet to SE-ST1 LAN1.

1. Assign the next available subnet to the SE-ST1 LAN1.

2. Fill in the chart below with the appropriate information.

SE-ST1 LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 15: Determine the subnet information for the SE-ST1 LAN2.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 16: Assign subnet to SE-ST1 LAN2.

1. Assign the next available subnet to the SE-ST1 LAN2.

2. Fill in the chart below with the appropriate information.

SE-ST1 LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 17: Determine the subnet information for the SE-ST2 LAN1.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 18: Assign subnet to SE-ST2 LAN1.

1. Assign the next available subnet to the SE-ST2 LAN1.

2. Fill in the chart below with the appropriate information.

SE-ST2 LAN1 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 19: Determine the subnet information for the SE-ST2 LAN2.

1. What is the smallest size subnet that can be used to meet this requirement? _____

2. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 20: Assign subnet to SE-ST2 LAN2.

1. Assign the next available subnet to the SE-ST2 LAN2.

2. Fill in the chart below with the appropriate information.

SE-ST2 LAN2 Subnet

Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address

Step 21: Determine the subnet information for the WAN links between the routers in the East network.

1. How many router to router WAN links are present in the East network? _____

2. How many IP addresses are needed for each of these WAN links? _____

3. What is the smallest size subnet that can be used to meet this requirement? _____

4. What is the maximum number of IP addresses that can be assigned in this size subnet? _____

Step 22: Assign subnets to WAN links.

1. Assign the next available subnets to the WAN links between the routers.

2. Fill in the chart below with the appropriate information.

WAN links between the Routers in the East Network

WAN link	Network Address	Decimal Subnet Mask	CIDR Subnet Mask	First Usable IP Address	Last Usable IP Address	Broadcast Address
HQ to EAST						
EAST to S-EAST						
EAST to N-EAST						
S-EAST to SE-BR1						
S-EAST to SE-BR2						
SE-BR2 to SE-ST1						
SE-BR2 to SE-ST2						

Activity 6.4.3: Troubleshooting a VLSM Addressing Design

Topology Diagram
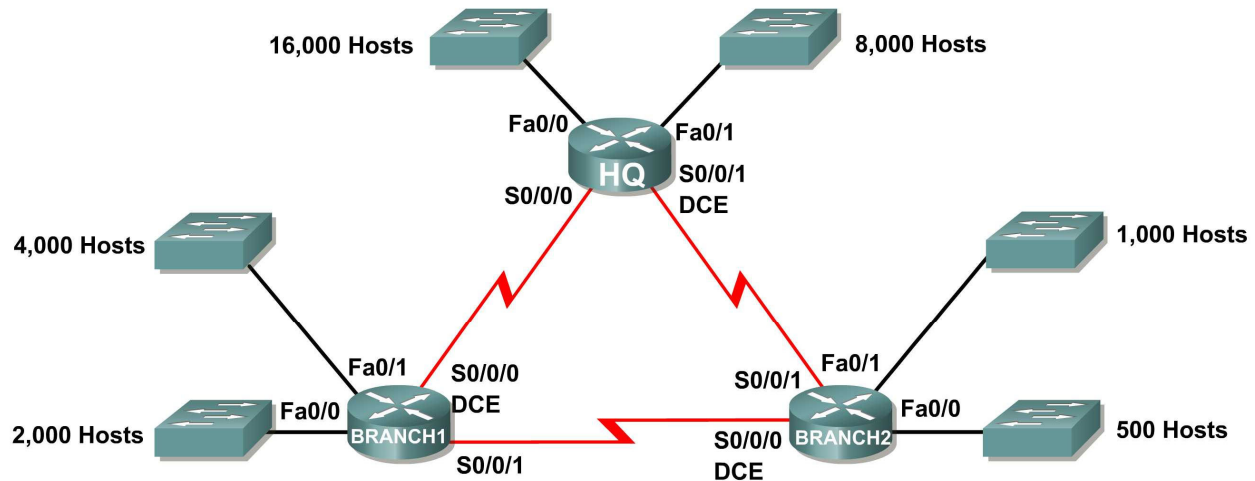
Addressing Table

Subnet	Number of IP Addresses Needed	Network Address
HQ LAN1	16,000	172.16.128.0/19
HQ LAN2	8,000	172.16.192.0/18
Branch1 LAN1	4,000	172.16.224.0/20
Branch1 LAN2	2,000	172.16.240.0/21
Branch2 LAN1	1,000	172.16.244.0/24
Branch2 LAN2	500	172.16.252.0/23
Link from HQ to Branch1	2	172.16.254.0/28
Link from HQ to Branch2	2	172.16.254.6/30
Link from Branch1 to Branch2	2	172.16.254.8/30

Learning Objectives

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

- Discover errors in a VLSM design.
- Propose solutions for VLSM design errors.
- Document the corrected VLSM assignments.

Scenario

In this activity, the network address 172.16.128.0/17 has been used to provide the IP addressing for the network shown in the Topology Diagram. VLSM has been used to subnet the address space incorrectly. You will need to troubleshoot the addressing that has been assigned for each subnet to determine where errors are present and then determine the correct addressing assignments, where needed.

Task 1: Examine the Addressing for the HQ LANs.

Step 1: Examine the addressing assignment for the HQ LAN1 subnet and answer the questions below:

1. How many IP addresses are needed for the HQ LAN1 subnet? _____

2. How many IP addresses are available in the currently assigned subnet? _____

3. Will the currently assigned subnet fulfill the size requirement for the HQ LAN1 subnet? _____

4. If the answer to the previous question is **no**, propose a new subnet mask that will allow for the correct number of IP addresses. _____

5. Does the subnet overlap with any of the other currently assigned networks? _____

6. If the answer to the previous question is **yes**, propose a new subnet mask that will allow for the correct number of IP addresses without overlapping into any other subnets. _____

Step 2: Examine the addressing assignment for the HQ LAN2 subnet and answer the questions below.

1. How many IP addresses are needed for the HQ LAN2 subnet? _____

2. How many IP addresses are available in the currently assigned subnet? _____

3. Will the currently assigned subnet fulfill the size requirement for the HQ LAN2 subnet? _____

4. If the answer to the previous question is **no**, propose a new subnet mask that will allow for the correct number of IP addresses. _____

5. Does the subnet overlap with any of the other currently assigned networks? _____

6. If the answer to the previous question is **yes**, propose a new subnet mask that will allow for the correct number of IP addresses without overlapping into any other subnets. _____

Task 2: Examine the Addressing for the Branch1 LANs.

Step 1: Examine the addressing assignment for the Branch1 LAN1 subnet and answer the questions below.

1. How many IP addresses are needed for the Branch1 LAN1 subnet? _____

2. How many IP addresses are available in the currently assigned subnet? _____

3. Will the currently assigned subnet fulfill the size requirement for the Branch1 LAN1 subnet? _____

4. If the answer to the previous question is **no**, propose a new subnet mask that will allow for the correct number of IP addresses. _____

5. Does the subnet overlap with any of the other currently assigned networks?_____

6. If the answer to the previous question is **yes**, propose a new subnet mask that will allow for the correct number of IP addresses without overlapping into any other subnets. _____

Step 2: Examine the addressing assignment for the Branch1 LAN2 and answer the questions below.

1. How many IP addresses are needed for the Branch1 LAN2 subnet? _____

2. How many IP addresses are available in the currently assigned subnet? _____

3. Will the currently assigned subnet fulfill the size requirement for the Branch1 LAN2 subnet? _____

4. If the answer to the previous question is **no**, propose a new subnet mask that will allow for the correct number of IP addresses. _____

5. Does the subnet overlap with any of the other currently assigned networks?_____

6. If the answer to the previous question is **yes**, propose a new network address that will allow for the correct number of IP addresses without overlapping into any other subnets. _____

Task 3: Examine the Addressing for the Branch2 LANs.

Step 1: Examine the addressing assignment for the Branch2 LAN1 subnet and answer the questions below.

1. How many IP addresses are needed for the Branch2 LAN1 subnet? _____

2. How many IP addresses are available in the currently assigned subnet? _____

3. Will the currently assigned subnet fulfill the size requirement for the Branch2 LAN1 subnet? _____

4. If the answer to the previous question is **no**, propose a new subnet mask that will allow for the correct number of IP addresses. _____

5. Does the subnet overlap with any of the other currently assigned networks?_____

6. If the answer to the previous question is **yes**, propose a new subnet mask that will allow for the correct number of IP addresses without overlapping into any other subnets. _____

Step 2: Examine the addressing assignment for the Branch2 LAN2 and answer the questions below.

1. How many IP addresses are needed for the Branch2 LAN2 subnet? _____

2. How many IP addresses are available in the currently assigned subnet? _____

3. Will the currently assigned subnet fulfill the size requirement for the Branch2 LAN2 subnet? _____

4. If the answer to the previous question is **no**, propose a new subnet mask that will allow for the correct number of IP addresses. _____

5. Does the subnet overlap with any of the other currently assigned networks?_____

6. If the answer to the previous question is **yes**, propose a new network address that will allow for the correct number of IP addresses without overlapping into any other subnets.
    _____

Task 4: Examine the Addressing for the Links between Routers.

Step 1: Examine the addressing assignment for the link between the HQ and Branch1 routers and answer the questions below.

1. How many IP addresses are needed for the link between the HQ and Branch1 routers? _____

2. How many IP addresses are available in the currently assigned subnet? _____

3. Will the currently assigned subnet fulfill the size requirement for the link between the HQ and Branch1 routers? _____

4. If the answer to the previous question is **no**, propose a new subnet mask that will allow for the correct number of IP addresses. _____

5. Does the subnet overlap with any of the other currently assigned networks?_____

6. If the answer to the previous question is **yes**, propose a new subnet mask that will allow for the correct number of IP addresses without overlapping into any other subnets.
    _____

Step 2: Examine the addressing assignment for the link between the HQ and Branch2 routers and answer the questions below.

1. How many IP addresses are needed for the link between the HQ and Branch2 routers? _____

2. How many IP addresses are available in the currently assigned subnet? _____

3. Will the currently assigned subnet fulfill the size requirement for the link between the HQ and Branch2 routers? _____

4. If the answer to the previous question is **no**, propose a new subnet mask that will allow for the correct number of IP addresses. _____

5. Does the subnet overlap with any of the other currently assigned networks?_____

6. If the answer to the previous question is **yes**, propose a new network address that will allow for the correct number of IP addresses without overlapping into any other subnets.
    _____

Step 3: Examine the addressing assignment for the link between the Branch1 and Branch2 routers and answer the questions below.

1. How many IP addresses are needed for the link between the Branch1 and Branch2 routers? _____

2. How many IP addresses are available in the currently assigned subnet? _____

3. Will the currently assigned subnet fulfill the size requirement for the link between the Branch1 and Branch2 routers? _____

4. If the answer to the previous question is **no**, propose a new subnet mask that will allow for the correct number of IP addresses. _____

5. Does the subnet overlap with any of the other currently assigned networks?_____

6. If the answer to the previous question is **yes**, propose a new subnet mask that will allow for the correct number of IP addresses without overlapping into any other subnets.

    _____

Task 5: Document the Corrected Addressing Information.

Record the corrected addressing information in the Addressing Table below.

Subnet	Number of IP Addresses Needed	Network Address
HQ LAN1	16,000	
HQ LAN2	8,000	
Branch1 LAN1	4,000	
Branch1 LAN2	2,000	
Branch2 LAN1	1,000	
Branch2 LAN2	500	
Link from HQ to Branch1	2	
Link from HQ to Branch2	2	
Link from Branch1 to Branch2	2	

Activity 6.4.4: Basic Route Summarization

Topology Diagram
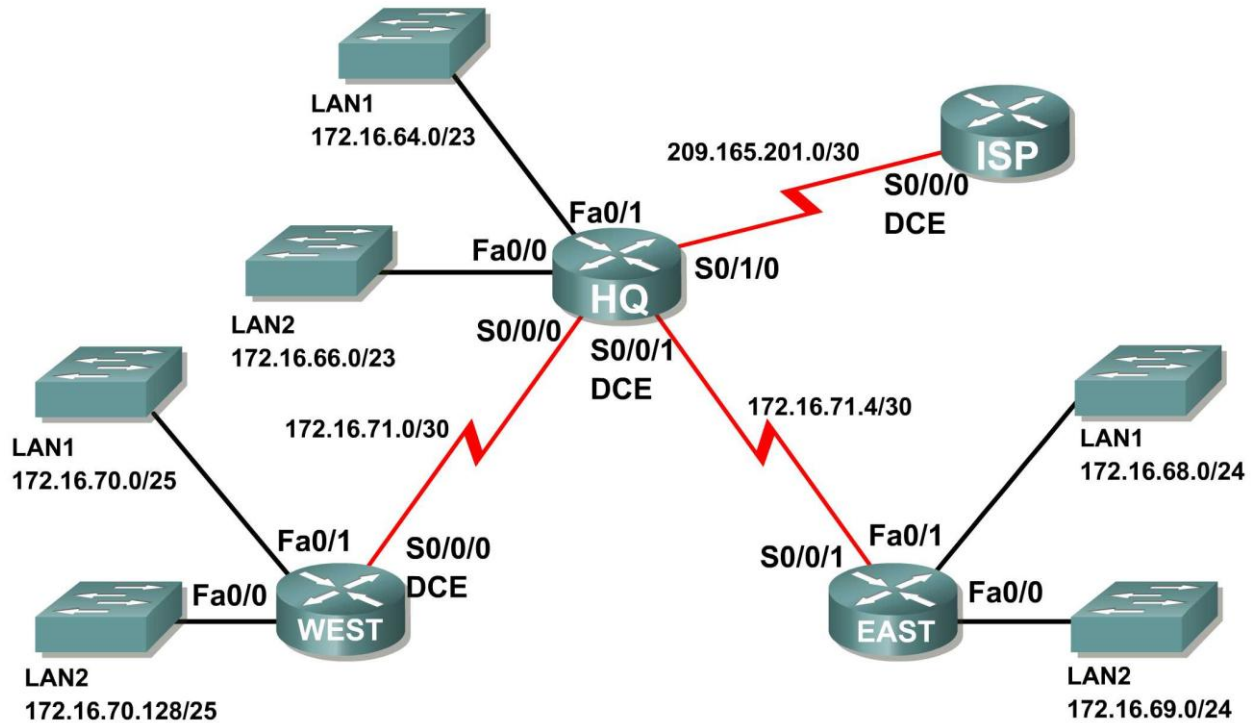
Addressing Table

Subnet	Network Address
HQ LAN1	172.16.64.0/23
HQ LAN2	172.16.66.0/23
EAST LAN1	172.16.68.0/24
EAST LAN2	172.16.69.0/24
WEST LAN1	172.16.70.0/25
WEST LAN2	172.16.70.128/25
Link from HQ to EAST	172.16.71.4/30
Link from HQ to WEST	172.16.71.0/30
Link from HQ to ISP	209.165.201.0/30

Learning Objectives

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

- Determine summarized routes that can be used to reduce the size of routing tables.

Scenario

In this activity, you have been given the network shown in the Topology Diagram. The subnetting and address assignments have already been completed for the network segments. Determine summarized routes that can be used to reduce the number of entries in routing tables.

Task 1: Determine the Summary Route for the HQ LANs.

Step 1: List the HQ LAN1 and LAN2 in binary format.

LAN1_____

LAN2_____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the two networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What are the matching bits for the two networks?
   _____

2. Add zeroes to make up the remainder of the network address in binary form.
   _____

3. What is the network address for the summary route in decimal
   format?_____

Task 2: Determine the Summary Route for the EAST LANs.

Step 1: List the EAST LAN1 and LAN2 in binary format.

LAN1_____
LAN2_____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the two networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What are the matching bits for the two networks?
   _____

2. Add zeroes to make up the remainder of the network address in binary form.
   _____

3. What is the network address for the summary route in decimal
   format?_____

Task 3: Determine the Summary Route for the WEST LANs.

Step 1: List the WEST LAN1 and LAN2 in binary format.

LAN1_____

LAN2_____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the two networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What are the matching bits for the two networks?
   _____

2. Add zeroes to make up the remainder of the network address in binary form.
   _____

3. What is the network address for the summary route in decimal
   format?_____

Task 4: Determine the Summary Route for the HQ, EAST, and WEST LANs.

Step 1: List summary networks for the HQ, EAST, and WEST LANs in binary format.

HQ Summary Route_____

EAST Summary Route_____

WEST Summary Route_____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the three networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What are the matching bits for the three networks?
   _____

2. Add zeroes to make up the remainder of the network address in binary form.
   _____

3. What is the network address for the summary route in decimal
   format?_____

Activity 6.4.5: Challenge Route Summarization

Topology Diagram
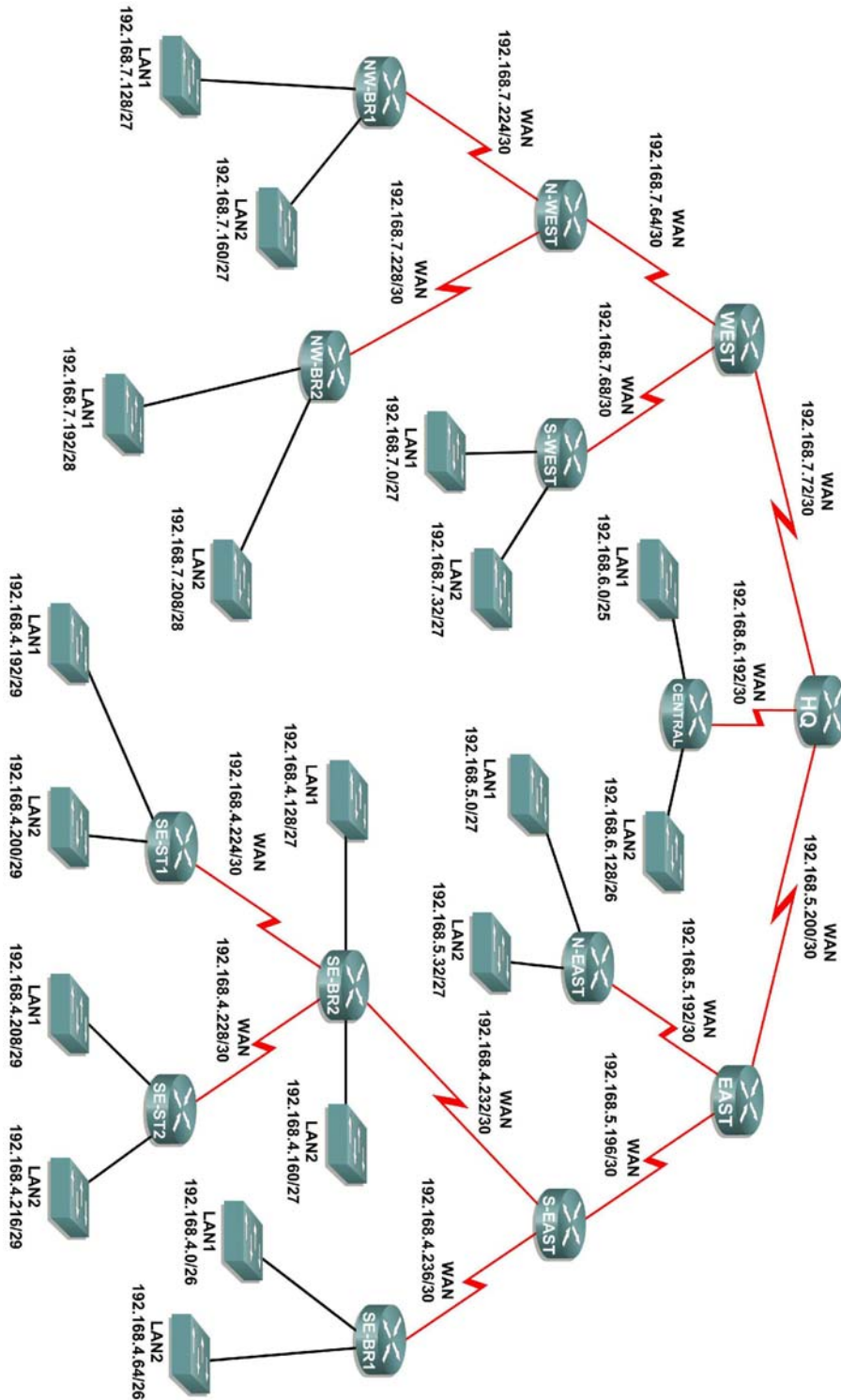
Addressing Table

Subnet	Network Address
S-WEST LAN1	192.168.7.0/27
S-WEST LAN2	192.168.7.32/27
Link from WEST to N-WEST	192.168.7.64/30
Link from WEST to S-WEST	192.168.7.68/30
Link from HQ to WEST	192.168.7.72/30
NW-BR1 LAN1	192.168.7.128/27
NW-BR1 LAN2	192.168.7.160/27
NW-BR2 LAN1	192.168.7.192/28
NW-BR2 LAN2	192.168.7.208/28
Link from N-WEST to NW-BR1	192.168.7.224/30
Link from N-WEST to NW-BR2	192.168.7.228/30
CENTRAL LAN1	192.168.6.0/25
CENTRAL LAN2	192.168.6.128/26
Link from HQ to CENTRAL	192.168.6.192/30
N-EAST LAN1	192.168.5.0/27
N-EAST LAN2	192.168.5.32/27
Link from EAST to N-EAST	192.168.5.192/30
Link from EAST to S-EAST	192.168.5.196/30
Link from HQ to EAST	192.168.5.200/30
SE-BR1 LAN1	192.168.4.0/26
SE-BR1 LAN2	192.168.4.64/26
SE-BR2 LAN1	192.168.4.128/27
SE-BR2 LAN2	192.168.4.160/27
SE-ST1 LAN1	192.168.4.192/29
SE-ST1 LAN2	192.168.4.200/29
SE-ST2 LAN1	192.168.4.208/29
SE-ST2 LAN2	192.168.4.216/29
Link from SE-BR2 to SE-ST1	192.168.4.224/30
Link from SE-BR2 to SE-ST2	192.168.4.228/30
Link from S-EAST to SE-BR2	192.168.4.232/30
Link from S-EAST to SE-BR1	192.168.4.236/30

Learning Objectives

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

- Determine summarized routes that can be used to reduce the size of routing tables.

Scenario

In this activity, you have been given the network shown in the Topology Diagram. The subnetting and address assignments have already been completed for the network segments. Determine summarized routes that can be used to reduce the number of entries in routing tables.

Task 1: Determine the Summary Route for the S-WEST LANs.

Step 1: List the S-WEST LAN1 and LAN2 in binary format.

LAN1 _____

LAN2 _____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the two networks?_____

2. What is the subnet mask for the summary route in decimal format?_____

**Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.**

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal format?_____

Task 2: Determine the Summary Route for the NW-BR1 LANs.

Step 1: List the NW-BR1 LAN1 and LAN2 in binary format.

LAN1 _____

LAN2 _____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal format?_____

Task 3: Determine the Summary Route for the NW-BR2 LANs.

Step 1: List the NW-BR2 LAN1 and LAN2 in binary format.

LAN1 _____

LAN2 _____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?

   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 4: Determine the Summary Route for the Northwest Portion of the Network.

Use the networks listed below to determine a summary route for the Northwest portion of the network.

Step 1: List the Northwest network segments in binary format.

NW-BR1 Summary   _____

NW-BR2 Summary   _____

Link from N-WEST to NW-BR1   _____

Link from N-WEST to NW-BR2   _____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?

   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 5: Determine the Summary Route for the West Portion of the Network.

Use the networks listed below to determine a summary route for the West portion of the network.

Step 1: List the West network segments in binary format.

S-WEST Summary	_____
N-WEST Summary	_____
Link from WEST to N-WEST	_____
Link from WEST to S-WEST	_____
Link from HQ to WEST	_____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 6: Determine the Summary Route for the Central Portion of the Network.

Use the networks listed below to determine a summary route for the Central portion of the network.

Step 1: List the Central network segments in binary format.

CENTRAL LAN1	_____
CENTRAL LAN2	_____
Link from HQ to CENTRAL	_____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 7: Determine the Summary Route for the N-EAST LANs.

Step 1: List the N-EAST LAN1 and LAN2 in binary format.

LAN1 _____

LAN2 _____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 8: Determine the Summary Route for the SE-BR1 LANs.

Step 1: List the SE-BR1 LAN1 and LAN2 in binary format.

LAN1 _____

LAN2 _____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 9: Determine the Summary Route for the SE-BR2 LANs.

Step 1: List the SE-BR2 LAN1 and LAN2 in binary format.

LAN1 _____

LAN2 _____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 10: Determine the Summary Route for the SE-ST1 LANs.

Step 1: List the SE-ST1 LAN1 and LAN2 in binary format.

LAN1 _____

LAN2 _____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 11: Determine the Summary Route for the SE-ST2 LANs.

Step 1: List the SE-ST2 LAN1 and LAN2 in binary format.

LAN1 _____

LAN2 _____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 12: Determine the Summary Route for the Southeast Portion of the Network.

Use the networks listed below to determine a summary route for the Southeast portion of the network.

Step 1: List the Southeast network segments in binary format.

SE-BR1 Summary	_____
SE-BR2 Summary	_____
SE-ST1 Summary	_____
SE-ST2 Summary	_____
Link from SE-BR2 to SE-ST1	_____
Link from SE-BR2 to SE-ST2	_____
Link from S-EAST to SE-BR1	_____
Link from S-EAST to SE-BR2	_____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
   _____

2. What is the network address for the summary route in decimal
   format?_____

Task 13: Determine the Summary Route for the East Portion of the Network.

Use the networks listed below to determine a summary route for the East portion of the network.

Step 1: List the East network segments in binary format.

S-EAST Summary	_____
N-EAST Summary	_____
Link from EAST to N-EAST	_____
Link from EAST to S-EAST	_____
Link from HQ to EAST	_____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
   format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
    _____

2. What is the network address for the summary route in decimal
    format?_____

Task 14: Determine the Summary Route for the Entire Network.

Use the networks listed below to determine a summary route for the entire network.

Step 1: List the East, West, and Central summary routes in binary format.

EAST Summary	_____
WEST Summary	_____
CENTRAL Summary	_____

Step 2: Count the number of left-most matching bits to determine the mask for the summary route.

1. How many left-most matching bits are present in the networks?_____

2. What is the subnet mask for the summary route in decimal
    format?_____

Step 3: Copy the matching bits and then add all zeros to determine the summarized network address.

1. What is the summary route in binary form?
    _____

2. What is the network address for the summary route in decimal
    format?_____

Activity 6.4.6: Troubleshooting Route Summarization

Topology Diagram
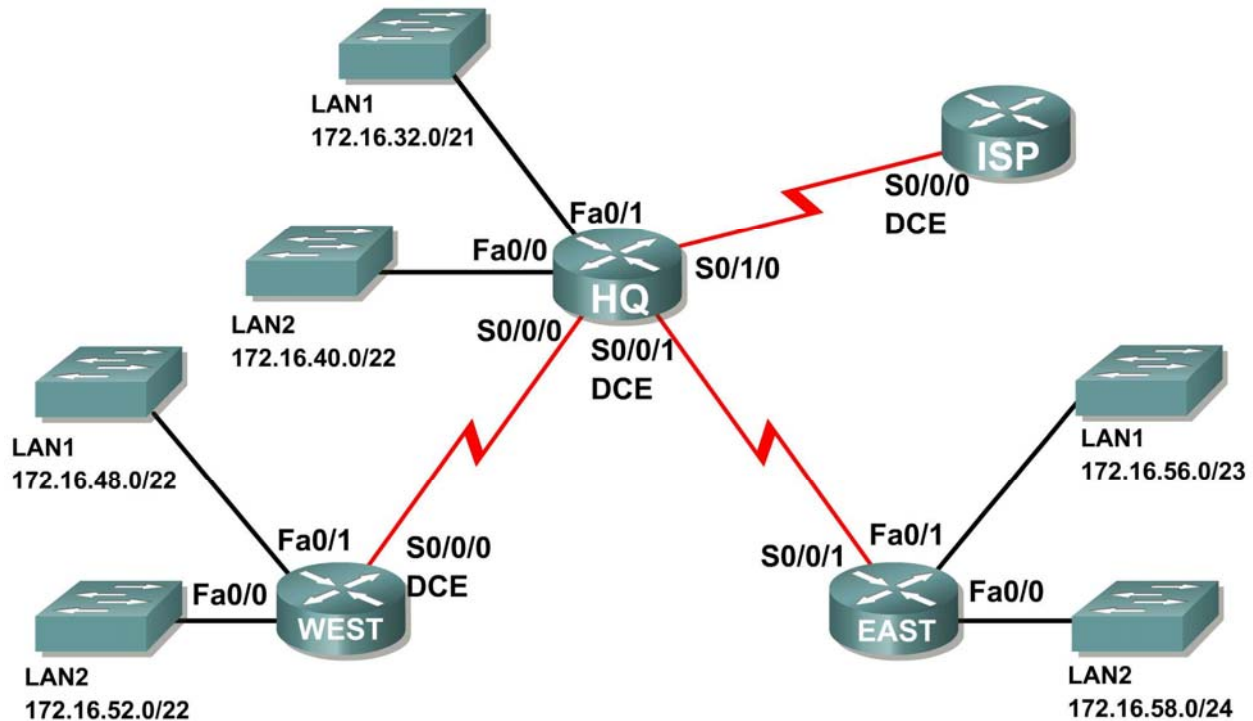
Addressing Table

Router	Summary Route	Network Address
HQ	WEST LANs	172.16.52.0/21
HQ	EAST LANs	172.16.56.0/23
WEST	HQ LANs	172.16.32.0/19
WEST	EAST LANs	172.16.58.0/23
EAST	HQ LANs	172.16.30.0/20
EAST	WEST LANs	172.16.48.0/21
ISP	HQ, WEST, and EAST LANs	172.16.32.0/18

Learning Objectives

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

- Discover errors in route summarization.
- Propose solutions for summarized routes.
- Document the corrected summarized routes.

Scenario

In this activity, the LAN IP addressing has already been completed for the network shown in the Topology Diagram. VLSM has been used to subnet the address space. The summary routes that are shown in the Addressing Table below the Topology Diagram are incorrect. You will need to troubleshoot the summary routes that have been assigned to determine where errors are present and determine the correct summary routes where needed.

Task 1: Examine the Summary Routes on the HQ Router.

Examine the summary routes on the HQ router and answer the questions below.

1. What is the summary route for the WEST LANs? _____

2. Is this summary route correct? _____

3. If the route is not correct, what is the correct summary route for the WEST LANs?
    _____

4. What is the summary route for the EAST LANs? _____

5. Is this summary route correct? _____

6. If the route is not correct, what is the correct summary route for the EAST LANs?
    _____

Task 2: Examine the Summary Routes on the WEST Router.

Examine the summary routes on the WEST router and answer the questions below.

1. What is the summary route for the HQ LANs? _____

2. Is this summary route correct? _____

3. If the route is not correct, what is the correct summary route for the HQ LANs?
    _____

4. What is the summary route for the EAST LANs? _____

5. Is this summary route correct? _____

6. If the route is not correct, what is the correct summary route for the EAST LANs?
    _____

Task 3: Examine the Summary Routes on the EAST Router.

Examine the summary routes on the EAST router and answer the questions below.

1.   What is the summary route for the WEST LANs? _____

2.   Is this summary route correct? _____

3.   If the route is not correct, what is the correct summary route for the WEST LANs?
     _____

4.   What is the summary route for the HQ LANs? _____

5.   Is this summary route correct? _____

6.   If the route is not correct, what is the correct summary route for the HQ LANs?
     _____

Task 4: Examine the Summary Route on the ISP Router.

Examine the summary route on the ISP router and answer the questions below.

1.   What is the summary route for the HQ, WEST, and EAST LANs?
     _____

2.   Is this summary route correct? _____

3.   If the route is not correct, what is the correct summary route for the HQ, WEST, and EAST LANs?
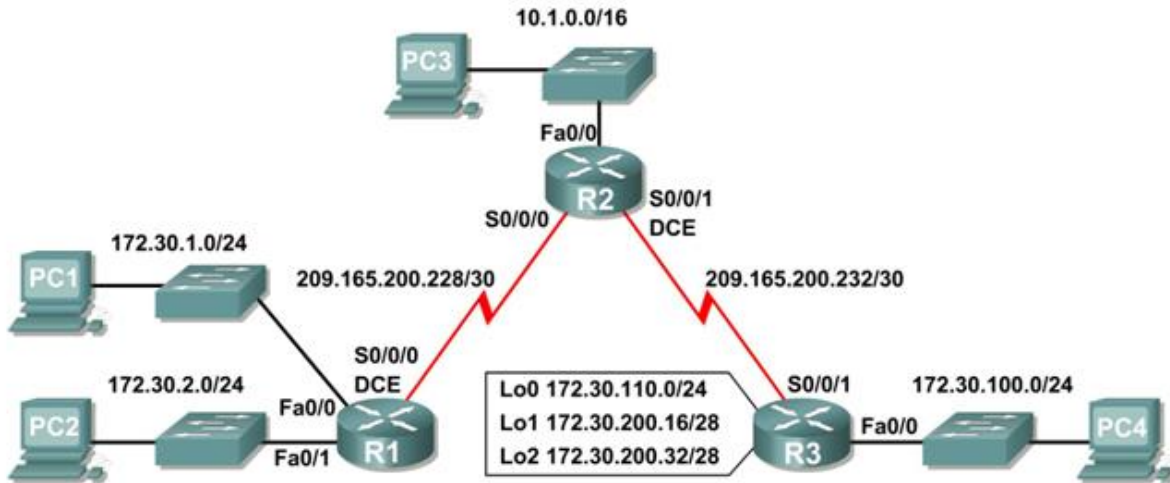   _____

Task 5: Document the Corrected Summary Routes.

Record the corrected summary routes in the Addressing Table below.

Router	Summary Route	Network Address
HQ	WEST LANs	
HQ	EAST LANs	
WEST	HQ LANs	
WEST	EAST LANs	
EAST	HQ LANs	
EAST	WEST LANs	
ISP	HQ, WEST, and EAST LANs	

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.

Lab 7.5.2: RIPv2 Challenge Configuration Lab

Topology Diagram
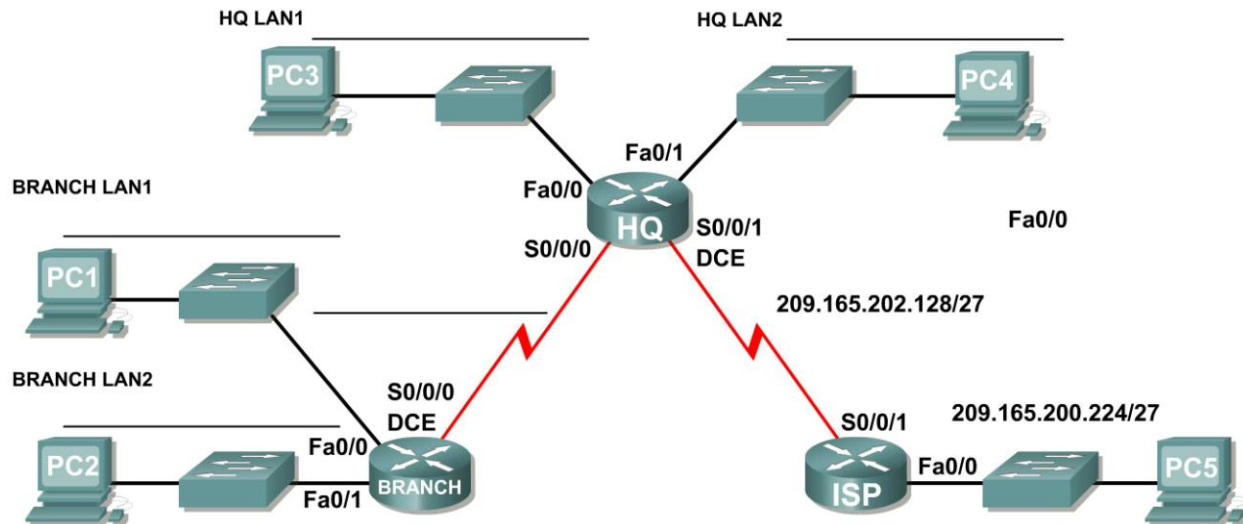
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
BRANCH	Fa0/0			N/A
	Fa0/1			N/A
	S0/0/0			N/A
HQ	Fa0/0			N/A
	Fa0/1			N/A
	S0/0/0			N/A
	S0/0/1			N/A
ISP	Fa0/0			N/A
	S0/0/1			N/A
PC1	NIC			
PC2	NIC			
PC3	NIC			
PC4	NIC			
PC5	NIC			

Learning Objectives

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

- Create an efficient VLSM design given the requirements.
- Assign appropriate addresses to interfaces and document the addresses.
- Cable a network according to the Topology Diagram.
- Erase the startup configuration and reload a router to the default state.
- Configure routers including RIP version 2.
- Configure and propagate a static default route.
- Verify RIP version 2 operation.
- Test and verify full connectivity.
- Reflect upon and document the network implementation.

Scenario

In this lab activity, you will be given a network address that must be subnetted using VLSM to complete the addressing of the network shown in the Topology Diagram. A combination of RIP version 2 and static routing will be required so that hosts on networks that are not directly connected will be able to communicate with each other.

Task 1: Subnet the Address Space.

Step 1: Examine the network requirements.

The addressing for the network has the following requirements:

- The ISP LAN will use the 209.165.200.224/27 network.
- The link between ISP and HQ will use the 209.165.202.128/27 network.
- The 192.168.40.0/24 network must be subnetted using VLSM for all other addresses in the network.
    - The HQ LAN1 will require 50 host IP addresses.
    - The HQ LAN2 will require 50 host IP addresses.
    - The BRANCH LAN1 will require 30 host IP addresses.
    - The BRANCH LAN2 will require 12 host IP addresses.
    - The link between HQ and BRANCH will require an IP address at each end.
    (**Note:** Remember that the interfaces of network devices are also host IP addresses and are included in the above addressing requirements.)

Step 2: Consider the following questions when creating your network design:

How many subnets need to be created from the 192.168.40.0/24 network? _____

How many total IP addresses are required from the 192.168.40.0/24 network? _____

What subnet mask will be used for the HQ LAN1 subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the HQ LAN2 subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the BRANCH LAN1 subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the BRANCH LAN2 subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the link between the HQ and BRANCH routers?
_____

What is the maximum number of host addresses that could be used on this subnet? _____

Step 3: Assign subnetwork addresses to the Topology Diagram.

1. Assign subnet 0 of the 192.168.40.0 network to the HQ LAN1 subnet.
   What is the network address of this subnet? _____

2. Assign subnet 1 of the 192.168.40.0 network to the HQ LAN2 subnet.
   What is the network address of this subnet? _____

3. Assign subnet 2 of the 192.168.40.0 network to the BRANCH LAN1 subnet.
   What is the network address of this subnet? _____

4. Assign subnet 3 of the 192.168.40.0 network to the BRANCH LAN2 subnet.
   What is the network address of this subnet? _____

5. Assign subnet 4 of the 192.168.40.0 network to the link between the HQ and BRANCH routers.
   What is the network address of this subnet? _____

Task 2: Determine Interface Addresses.

Step 1: Assign appropriate addresses to the device interfaces.

1. Assign the first valid host address in the 209.165.200.224/27 network to the LAN interface on the ISP router.

2. Assign the last valid host address in 209.165.200.224/27 network to PC5.

3. Assign the first valid host address in the 209.165.202.128/27 network to the WAN interface of ISP.

4. Assign the last valid host address in the 209.165.202.128/27 network to the Serial 0/0/1 interface of HQ.

5. Assign the first valid host address in the HQ LAN1 network to the LAN1 interface of HQ.

6. Assign the last valid host address in the HQ LAN1 network to PC 3.

7. Assign the first valid host address in the HQ LAN2 network to the LAN2 interface of HQ.

8. Assign the last valid host address in the HQ LAN2 network to PC 4.

9. Assign the first valid host address in the HQ/BRANCH WAN link to the Serial 0/0/0 interface of HQ.

10. Assign the last valid host address in the HQ/BRANCH WAN link to the Serial 0/0/0 interface of BRANCH.

11. Assign the first valid host address in the BRANCH LAN1 network to the LAN1 interface of BRANCH.

12. Assign the last valid host address in the BRANCH LAN1 network to PC 1.

13. Assign the first valid host address in the BRANCH LAN2 network to the LAN2 interface of BRANCH.

14. Assign the last valid host address in the BRANCH LAN2 network to PC 2.

Step 2: Document the addresses to be used in the table provided under the Topology Diagram.

Task 3: 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 as 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 4: Perform Basic Router Configurations.

Perform basic configuration of the BRANCH, HQ, and ISP 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.
7. Synchronize unsolicited messages and debug output with solicited output and prompts for the console and virtual terminal lines.
8. Configure an EXEC timeout of 15 minutes.

Task 5: Configure and Activate Serial and Ethernet Addresses

Step 1: Configure the BRANCH, HQ, and ISP routers.

Configure the interfaces on BRANCH, HQ, and ISP with the IP addresses from the Addressing Table provided under the Topology Diagram.

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

Step 2: Configure the Ethernet interfaces of PC1, PC2, PC3, PC4, and PC5.

Configure the Ethernet interfaces of PC1, PC2, PC3, PC4, and PC5 with the IP addresses from the Addressing Table provided under the Topology Diagram.

Task 6: Verify Connectivity to Next-Hop Device.

You should *not* have connectivity between end devices yet. However, you can test connectivity between two routers and between an end device and its default gateway.

Step 1: Verify BRANCH connectivity.

Verify that BRANCH can ping across the WAN link to HQ and that HQ can ping across the WAN link it shares with ISP.

Step 2: Verify that PC1, PC2, PC3, PC4, and PC5 can ping their respective default gateways.

Task 7: Configure RIPv2 Routing on the BRANCH Router.

Consider the networks that need to be included in the RIP updates that are sent out by BRANCH.

What networks are present in the BRANCH routing table? List the networks with slash notation.

_____

_____

_____

What commands are required to enable RIP version 2 and include the connected networks in the routing updates?

_____

_____

_____

_____

_____

Are there any router interfaces that do not need to have RIP updates sent out? _____

What command is used to disable RIP updates on these interfaces?

_____

_____

Task 8: Configure RIPv2 and Static Routing on HQ.

Consider the type of static routing that is needed on HQ.

What networks are present in the HQ routing table? List the networks with slash notation.

_____

_____

_____

A static default route will need to be configured to send all packets with destination addresses that are not in the routing table to ISP. What command is needed to accomplish this? Use the appropriate exit interface on HQ in the command.

_____

What commands are required to enable RIP version 2 and include the LAN1 and LAN2 networks as well as the link between HQ and BRANCH in the routing updates?

_____

_____

_____

_____

_____

Are there any router interfaces that do not need to have RIP updates sent out? _____

What command is used to disable RIP updates on these interfaces?

_____

_____

HQ needs to send the default route information to BRANCH in the RIP updates. What command is used to configure this?

_____

Task 9: Configure Static Routing on the ISP Router.

Note: In a real-world implementation of this topology, you would not be configuring the ISP router. However, your service provider is an active partner in solving your connectivity needs. Service provider administrators are human, too, and make mistakes. Therefore, it is important that you understand the types of errors an ISP could make that would cause your networks to lose connectivity.

Static routes will need to be configured on ISP for all traffic that is destined for the RFC 1918 addresses that are used on the BRANCH LANs, HQ LANs, and the link between the BRANCH and HQ routers.

What are the commands that will need to be configured on the ISP router to accomplish this?

_____

Task 10: Verify the Configurations.

Answer the following questions to verify that the network is operating as expected:

From PC1, is it possible to ping PC3? _____

From PC1, is it possible to ping the PC5? _____

From PC4, is it possible to ping the PC5? _____

The answer to the above questions should be **yes**. If any of the above pings failed, check your physical connections and configurations. Refer to your basic troubleshooting techniques used in the Chapter 1 labs.

What routes are present in the routing table of the BRANCH router?

_____

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of BRANCH?

_____

What routes are present in the routing table of the HQ router?

_____

_____

_____

_____

_____

_____

_____

What networks are present in the routing table of ISP?

_____

_____

_____

What networks are present in the RIP updates sent from HQ?

_____

_____

_____

What networks are present in the RIP updates sent from BRANCH?

_____

_____

Task 11: Reflection

Why is it necessary to use RIPv2 instead of RIPv1 with this network design?

_____

_____

_____

Task 12: Document the Router Configurations

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

- Running configuration
- Routing table
- Interface summarization

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.

Lab 7.5.3: RIPv2 Troubleshooting Lab

Topology Diagram
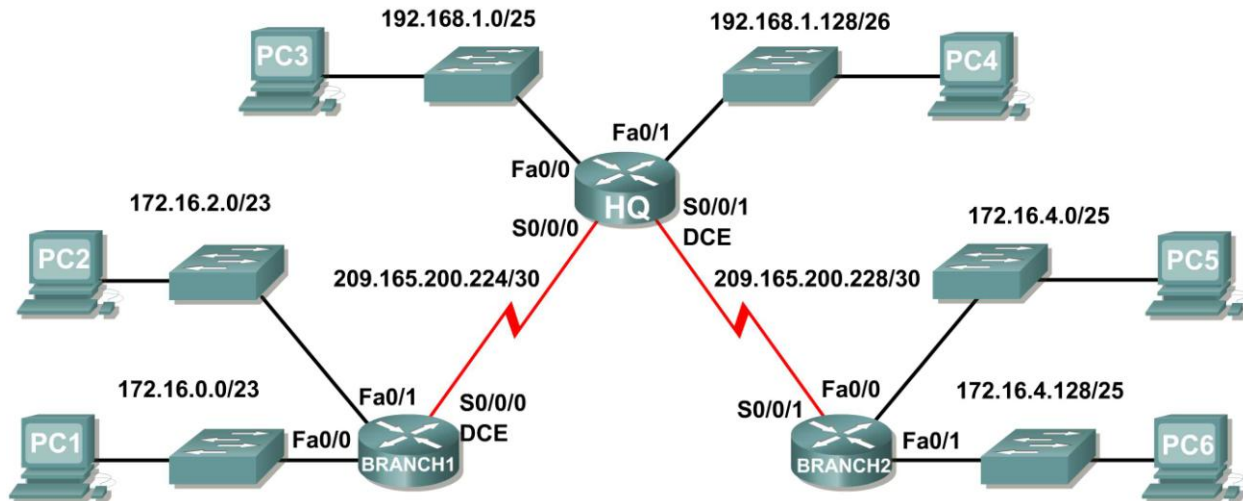
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0	192.168.1.1	255.255.255.128	N/A
	Fa0/1	192.168.1.129	255.255.255.192	N/A
	S0/0/0	209.165.200.225	255.255.255.252	N/A
	S0/0/1	209.165.200.229	255.255.255.252	N/A
BRANCH1	Fa0/0	172.16.0.1	255.255.254.0	N/A
	Fa0/1	172.16.2.1	255.255.254.0	N/A
	S0/0/0	209.165.200.226	255.255.255.252	N/A
BRANCH2	Fa0/0	172.16.4.1	255.255.255.128	N/A
	Fa0/1	172.16.4.129	255.255.255.128	N/A
	S0/0/1	209.165.200.230	255.255.255.252	N/A
PC1	NIC	172.16.0.10	255.255.254.0	172.16.0.1
PC2	NIC	172.16.2.10	255.255.254.0	172.16.2.1
PC3	NIC	192.168.1.10	255.255.255.128	192.168.1.1
PC4	NIC	192.168.1.138	255.255.255.192	192.168.1.129
PC5	NIC	172.16.4.10	255.255.255.128	172.16.4.1
PC6	NIC	172.16.4.138	255.255.255.128	172.16.4.129

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.
- Load the routers with supplied scripts.
- Gather information about the non-converged portion of the network along with any other errors.
- Analyze information to determine why convergence is not complete.
- Propose solutions to network errors.
- Implement solutions to network errors.
- Document the corrected network.

Scenario

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

The network should also have the following requirements met:.

- RIPv2 routing is configured on the BRANCH1 router.
- RIPv2 routing is configured on the BRANCH2 router.
- RIPv2 routing is configured on the HQ router.
- RIP updates must be disabled on the BRANCH1, BRANCH2, and HQ LAN interfaces.

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 the 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 the BRANCH1 router:

```
hostname BRANCH1
!
interface FastEthernet0/0
 ip address 172.16.0.1 255.255.254.0
 duplex auto
 speed auto
 no shutdown
!
interface FastEthernet0/1
 ip address 172.16.2.1 255.255.254.0
 duplex auto
```

```
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 209.165.200.226 255.255.255.252
 clock rate 64000
 no shutdown
!
router rip
passive-interface FastEthernet0/0
 passive-interface FastEthernet0/1
 network 172.16.0.0
 network 209.165.200.0
!
ip classless
!
line con 0
line vty 0 4
 login
!
end
```

Step 2: Load the following script onto the BRANCH2 router.

```
hostname BRANCH2
!
interface FastEthernet0/0
 ip address 172.16.4.129 255.255.255.128
 duplex auto
 speed auto
 no shutdown
!
interface FastEthernet0/1
 ip address 172.16.4.1 255.255.255.128
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/1
 ip address 209.165.200.230 255.255.255.252
 no shutdown
!
router rip
 version 2
 passive-interface FastEthernet0/0
 passive-interface FastEthernet0/1
 network 209.165.200.0
!
ip classless
!
line con 0
line vty 0 4
 login
!
end
```

Step 3: Load the following script onto the HQ router.

```
hostname HQ
!
interface FastEthernet0/0
 ip address 192.168.1.1 255.255.255.128
 duplex auto
 speed auto
 no shutdown
!
interface FastEthernet0/1
 ip address 192.168.1.129 255.255.255.192
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 209.165.200.225 255.255.255.252
 no shutdown
!
interface Serial0/0/1
 ip address 209.165.200.229 255.255.255.252
 no shutdown
!
router rip
 version 2
 passive-interface FastEthernet0/0
 passive-interface FastEthernet0/1
 network 192.168.1.0
 network 209.165.200.0
!
ip classless
!
line con 0
line vty 0 4
 login
!
end
```

Task 3: Troubleshoot the BRANCH1 Router

Step 1: Begin troubleshooting at the Host connected to BRANCH1.

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

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

From the host PC1, is it possible to ping PC5? _____

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

Step 2: Examine BRANCH1 to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the configuration of the interfaces?

_____

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on BRANCH1.

What networks and routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

If there are any problems with the routing configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Are there any problems with the routing table that could be due to errors on other parts of the network?

_____

_____

_____

What networks are included in the RIP updates being sent from BRANCH1?

_____

_____

_____

Are there any problems with the RIP updates that are being sent out from the router?

_____

_____

_____

If there are any additional problems with the RIP configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 6: If you have recorded any commands above; apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors? _____

Does the information included in the RIP updates that are sent out indicate any configuration errors? _____

If the answer to either of these questions is **yes**, troubleshoot the routing configuration again.

What networks and routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

Step 8: Attempt to ping between the hosts again.

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

From the host PC1, is it possible to ping PC4? _____

From the host PC1, is it possible to ping the Serial 0/0/1 interface of the HQ router? _____

Task 4: Troubleshoot HQ

Step 1: Begin troubleshooting at the host PC3.

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

From the host PC3, is it possible to ping PC5? _____

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

Step 2: Examine the HQ router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the configuration of the interfaces?

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: Troubleshoot the routing configuration on HQ.

What networks and routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

If there are any problems with the routing table, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

What networks are included in the RIP updates?

_____

_____

_____

Are there any problems with the RIP updates that are being sent out from HQ?

_____

_____

If there are any problems with the RIP configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 5: If you have recorded any commands above, apply them to the router configuration now.

Step 6: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors on HQ? _____

Does the information included in the RIP updates that are sent out indicate any configuration errors on HQ? _____

If the answer to either of these questions is **yes**, troubleshoot the routing configuration again.

Step 7: Attempt to ping between the hosts again.

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

From the host PC3, is it possible to ping PC5? _____

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

Task 5: Troubleshoot BRANCH2

Step 1: Begin troubleshooting at the Host PC5.

From the host PC5, is it possible to ping PC6? _____

From the host PC5, is it possible to ping PC1? _____

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

Step 2: Examine BRANCH2 to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the configuration of the interfaces?

_____

_____

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View the summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on BRANCH2.

Begin by viewing the routing table.

What networks and routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

Step 6: Examine the routes that are being sent out in the routing updates from BRANCH2.

Are there any problems with these routing updates?

_____

_____

If there are any problems with the routing configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 7: If you have recorded any commands above, apply them to the router configuration now.

Step 8: Attempt to ping the hosts again.

From the host PC5, is it possible to ping PC6? _____

From the host PC5, is it possible to ping PC1? _____

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

From the HQ router, is it possible to ping PC1? _____

From the HQ router, is it possible to ping PC5? _____

Step 9: Examine the routing updates that are being received on BRANCH2.

What networks are being received in the RIP updates?

_____

_____

_____

Are there any problems with these routing updates?

_____

_____

_____

If there are any problems with the routing configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Do these commands need to be applied only to BRANCH2, or do they also need to be applied to any other routers in the network?

_____

_____

_____

Step 10: If you have recorded any commands above, apply them to the router configuration now.

Step 11: View the routing information.

If any changes were made to the configuration in the previous step, view the routing table again.

Does the information in routing table or routing updates indicate any configuration errors? _____

If the answer is **yes**, troubleshoot the routing configuration again.

Step 12: Attempt to ping between the hosts again.

From the host PC5, is it possible to ping PC6? _____

From the host PC5, is it possible to ping PC1? _____

From the host PC5, is it possible to ping PC3? _____

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

From the HQ router, is it possible to ping PC1? _____

From the HQ router, is it possible to ping PC5? _____

Task 6: Reflection

There were a number of configuration errors in the scripts that were provided for this lab. Use the space below to write a brief description of the errors that you found.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Task 7: 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 8: 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 8.4.1: Investigating the Routing Table Lookup Process

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.
- Determine level 1 and level 2 routes.
- Modify the configuration to reflect static and default routing.
- Enable classful routing and investigate classful routing behavior.
- Enable classless routing and investigate classless routing behavior.

Scenarios

In this lab activity, there are two separate scenarios. In the first scenario, you will examine level 1 and level 2 routes in the routing table. In the second scenario, you will examine classful and classless routing behavior.

- Scenario A: Level 1 and Level 2 Routes
- Scenario B: Classful and Classless Routing Behavior

Scenario A: Level 1 and Level 2 Routes

Topology Diagram
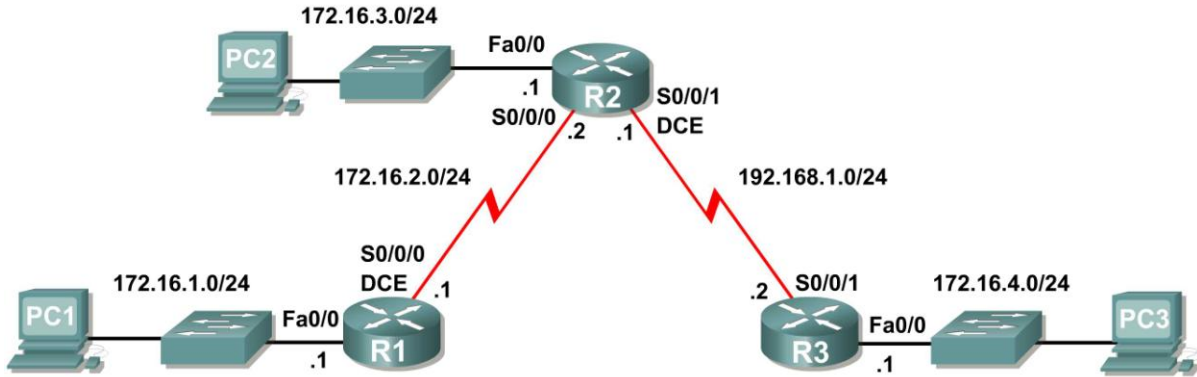
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	172.16.1.1	255.255.255.0	N/A
	S0/0/0	172.16.2.1	255.255.255.0	N/A
R2	Fa0/0	172.16.3.1	255.255.255.0	N/A
	S0/0/0	172.16.2.2	255.255.255.0	N/A
	S0/0/1	192.168.1.1	255.255.255.0	N/A
R3	Fa0/0	172.16.4.1	255.255.255.0	N/A
	S0/0/1	192.168.1.2	255.255.255.0	N/A
PC1	NIC	172.16.1.10	255.255.255.0	172.16.1.1
PC2	NIC	172.16.3.10	255.255.255.0	172.16.3.1
PC3	NIC	172.16.4.10	255.255.255.0	172.16.4.1

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.

Configure RIP version 1 routing on each of the routers. Include `network` statements for each of the directly connected networks.

Task 5: Observe Routes Being Deleted and Added to the Routing Table.

Step 1: View the routing table on the R1 router.

What networks are shown in the routing table?

_____

_____

_____

_____

_____

Step 2: Use the `debug ip routing` command to observe changes in the routing table as they occur on the R1 router.

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

Step 3: Shut down the Serial0/0/0 interface and observe the debug output.

```
R1(config-if)#shutdown

%LINK-5-CHANGED: Interface Serial0/0/0, changed state to administratively
down
RT: interface Serial0/0/0 removed from routing table
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state
to down
RT: del 172.16.2.0 via 0.0.0.0, connected metric [0/0]
RT: delete network route to 172.16.2.0
RT: NET-RED 172.16.2.0/24
RT: del 172.16.3.0 via 172.16.2.2, rip metric [120/1]
RT: delete network route to 172.16.3.0
RT: NET-RED 172.16.3.0/24
RT: del 192.168.1.0 via 172.16.2.2, rip metric [120/1]
RT: delete network route to 192.168.1.0
RT: NET-RED 192.168.1.0/24
```

Step 4: View the routing table on the R1 router and observe the changes that occurred when the Serial0/0/0 interface was disabled.

```
R1# show ip route

<Output omitted>

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
R1#
```

Step 5: Enable the Serial0/0/0 interface and observe the debug output.

```
R1(config-if)#no shutdown

RT: SET_LAST_RDB for 172.16.2.0/24
    NEW rdb: is directly connected

RT: add 172.16.2.0/24 via 0.0.0.0, connected metric [0/0]
RT: NET-RED 172.16.2.0/24RT: SET_LAST_RDB for 172.16.0.0/16
    NEW rdb: via 172.16.2.2

RT: add 172.16.3.0/24 via 172.16.2.2, rip metric [120/1]
RT: NET-RED 172.16.3.0/24RT: SET_LAST_RDB for 192.168.1.0/24
    NEW rdb: via 172.16.2.2

RT: add 192.168.1.0/24 via 172.16.2.2, rip metric [120/1]
RT: NET-RED 192.168.1.0/24
```

Why is the route to 172.16.2.0/24 added first?

_____

Why is there a delay before the other routes are added?

_____

Step 6: Disable the debug output with either the `no debug ip routing` or the `undebug all` command.

Task 6: Determine Level 1 and Level 2 Routes

Step 1: Examine the R1 routing table.

```
R1#show ip route

<Output ommited>

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 3 subnets
C       172.16.1.0/24 is directly connected, FastEthernet0/0
C       172.16.2.0/24 is directly connected, Serial0/0/0
R       172.16.3.0/24 [120/1] via 172.16.2.2, 00:00:14, Serial0/0/0
R    192.168.1.0/24 [120/1] via 172.16.2.2, 00:00:14, Serial0/0/0
R1#
```

Which of these routes are level 1 routes?

_____

_____

_____

_____

Why are these routes level 1 routes?

_____

_____

Are any of the level 1 routes ultimate routes?

_____

_____

_____

Why is this route an ultimate route?

_____

_____

Are any of the level 1 routes parent routes?

_____

_____

Why is this route a level 1 parent route?

_____

_____

Which of the routes are level 2 routes?

_____

_____

_____

_____

Why are these routes level 2 routes?

_____

_____

Scenario B: Classful and Classless Routing Behavior

Topology Diagram
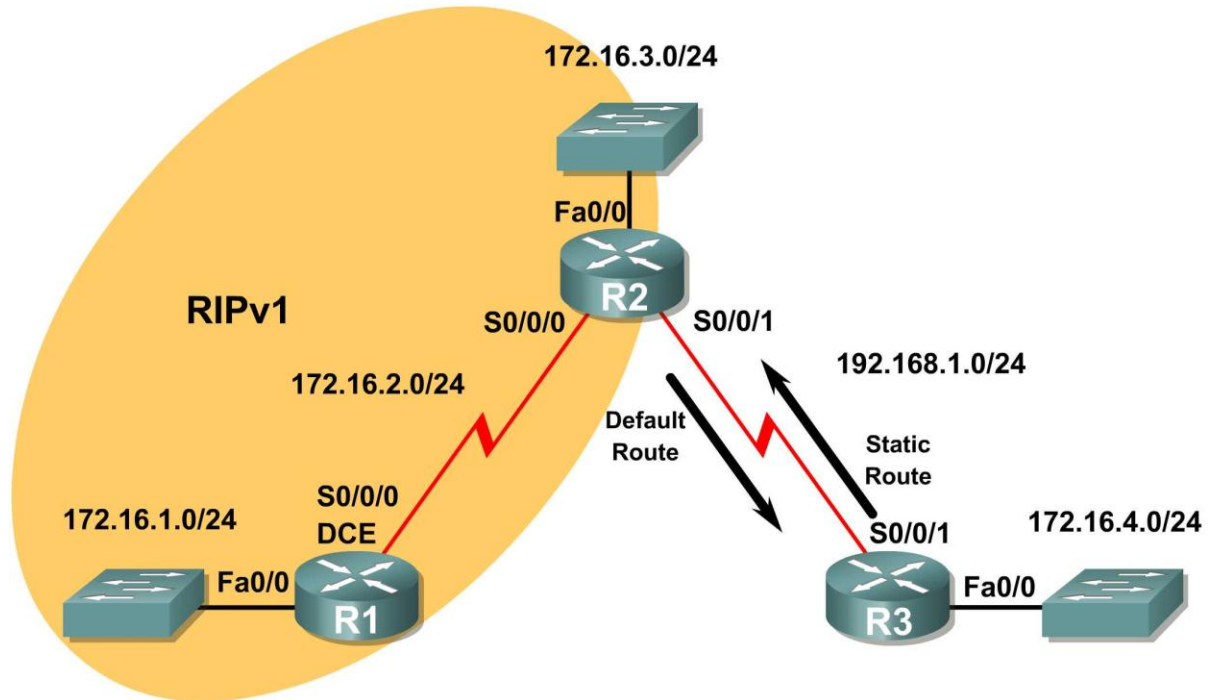
Task 1: Make Changes between Scenario A and Scenario B

Step 1: Remove the RIP configuration from R3 and configure a static route to 172.16.0.0/16.

```
R3(config)#no router rip
R3(config)#ip route 172.16.0.0 255.255.0.0 Serial0/0/1
```

Step 2: Remove the 192.168.1.0 network from the R2 RIP configuration.

```
R2(config)#router rip
R2(config-router)#no network 192.168.1.0
```

Step 3: Add a static default route to R3 on the R2 router.

Include the **default-information originate** command in the configuration so that the default static route is included in the RIP updates.

```
R2(config)#ip route 0.0.0.0 0.0.0.0 Serial0/0/1
R2(config)#router rip
R2(config-router)#default-information originate
```

Task 2: Enable Classful Routing Behavior on the Routers

Step 1: Use the `no ip classless` command to configure the route lookup process to use classful route lookups.

R1
```
R1(config)#no ip classless
```

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

R3
```
R3(config)#no ip classless
```

Step 2: Examine the routing table on the R2 router.

```
R2#show ip route

<output omitted>

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     172.16.0.0/24 is subnetted, 4 subnets
R       172.16.1.0 [120/1] via 172.16.2.1, 00:00:00, Serial0/0/0
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
C    192.168.1.0/24 is directly connected, Serial0/0/1
S*   0.0.0.0/0 is directly connected, Serial0/0/1

R2#
```

Step 3: Ping from R2 to PC3 and observe the results.

```
R2#ping 172.16.4.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.4.10, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

The ping is unsuccessful because the router is using classful routing behavior.

The route lookup process on the R2 router searches the routing table and finds that the first 16 bits of the destination address are a match with the parent route 172.16.0.0/16. Since the destination address matches the parent route, the child routes are checked.

What are the child routes of the 172.16.0.0/16 parent network?

_____

_____

_____

How many bits in the destination address must match in order for a packet to be forwarded using one of the child routes? _____

Does the destination address of the ping packets match any of the child routes of 172.16.0.0/16? _____

Since the **no ip classless** command has been used to configure the R2 router to use classful routing behavior, once a level 1 match is found the router will not search beyond the child routes for a lesser match. Even though there is a default static route configured, it will not be used, and the packet will be dropped.

Task 3: Enable Classless Routing Behavior on the Routers

Step 1: Use the ip classless command to reenable classless routing.

R1
```
R1(config)#ip classless
```

R2
```
R2(config)#ip classless
```

R3
```
R3(config)#ip classless
```

Step 2: Examine the routing table on R2.

Notice that the routing table is the still the same even though the router configuration has been changed to use classless routing behavior.

```
R2#show ip route

<output omitted>

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     172.16.0.0/24 is subnetted, 4 subnets
R       172.16.1.0 [120/1] via 172.16.2.1, 00:00:00, Serial0/0/0
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
C    192.168.1.0/24 is directly connected, Serial0/0/1
S*   0.0.0.0/0 is directly connected, Serial0/0/1
R2#
```

Step 3: Repeat the ping from R2 to PC3 and observe results.
```
R2#ping 172.16.4.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.4.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent, round-trip min/avg/max = 28/28/28 ms
```

The ping is successful this time because the router is using classless routing behavior.

The destination address of the packet is a match with the level 1 parent route 172.16.0.0/16 but there is not a match with any of the child routes of this parent route.

Since classless routing behavior is configured, the router will now continue to search the routing table for a route where there may be fewer bits that match, but the route is still a match. The mask of a default route is /0, which means that no bits need to match. In classless routing behavior, if no other route matches, the default route will always match.

```
S*    0.0.0.0/0 is directly connected, Serial0/0/1
```

Since there is a default route configured on the R2 router, this route is used to forward the packets to PC3.

Step 4: Examine the routing table on R3 to determine how the traffic generated by the ping command is returned to R2.

```
R3#show ip route

<output omitted>

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
S       172.16.0.0/16 is directly connected, Serial0/0/1
C       172.16.4.0/24 is directly connected, FastEthernet0/0
C    192.168.1.0/24 is directly connected, Serial0/0/1
R3#
```

Notice that in the routing table for R3, both the 172.16.4.0/24 subnet route and the 172.16.0.0/16 classful network route are level 2 child routes of the 172.16.0.0/16 parent route. In this case, R3 uses the 172.16.0.0/16 child route and forwards the return traffic out Serial 0/0/1 back to R2.

Lab 8.4.2: Show IP Route Challenge Lab

Addressing Table

Device	Interface	IP Address	Subnet Mask
R1			
R2			
R3			
R4			
R5			

Learning Objectives

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

- Determine network topology based on the outputs from the show ip route command.
- Cable a network according to the Topology Diagram.
- Determine router interface addressing based on outputs.
- Perform basic configuration tasks on a router.
- Determine level 1 and level 2 routes.

Scenario

In this lab activity, you will determine the topology of a network using the outputs from the **show ip route command.** You must draw a topology diagram and determine the interface addressing on each router. Then you must build and configure the network based on the outputs. The DTE and DCE assignment is at your discretion. When complete, the outputs from your network must match those given below.

Task 1: Examine the router outputs.

Step 1: Examine the output from the R1 router.

```
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

     10.0.0.0/30 is subnetted, 4 subnets
R       10.10.10.0 [120/1] via 10.10.10.6, 00:00:09, Serial0/0/0
C       10.10.10.4 is directly connected, Serial0/0/0
C       10.10.10.8 is directly connected, Serial0/0/1
R       10.10.10.12 [120/1] via 10.10.10.10, 00:00:09, Serial0/0/1
     172.16.0.0/16 is variably subnetted, 10 subnets, 5 masks
C       172.16.1.0/27 is directly connected, FastEthernet0/0
R       172.16.1.32/28 [120/2] via 10.10.10.10, 00:00:09, Serial0/0/1
R       172.16.1.192/26 [120/1] via 10.10.10.6, 00:00:09, Serial0/0/0
R       172.16.2.0/26 [120/2] via 10.10.10.6, 00:00:09, Serial0/0/0
R       172.16.2.64/27 [120/1] via 10.10.10.10, 00:00:09, Serial0/0/1
C       172.16.3.0/25 is directly connected, FastEthernet0/1
R       172.16.3.128/26 [120/1] via 10.10.10.6, 00:00:09, Serial0/0/0
R       172.16.3.192/29 [120/2] via 10.10.10.6, 00:00:09, Serial0/0/0
R       172.16.4.0/27 [120/1] via 10.10.10.10, 00:00:09, Serial0/0/1
R       172.16.4.128/25 [120/2] via 10.10.10.10, 00:00:09, Serial0/0/1
C    192.168.1.0/24 is directly connected, Loopback0
S*   0.0.0.0/0 is directly connected, Loopback0
```

Step 2: Examine the output from the R2 router.

```
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 10.10.10.2 to network 0.0.0.0

     10.0.0.0/30 is subnetted, 4 subnets
C       10.10.10.0 is directly connected, Serial0/0/0
R       10.10.10.4 [120/1] via 10.10.10.2, 00:00:04, Serial0/0/0
R       10.10.10.8 [120/2] via 10.10.10.2, 00:00:04, Serial0/0/0
R       10.10.10.12 [120/3] via 10.10.10.2, 00:00:04, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 10 subnets, 5 masks
R       172.16.1.0/27 [120/2] via 10.10.10.2, 00:00:04, Serial0/0/0
R       172.16.1.32/28 [120/4] via 10.10.10.2, 00:00:04, Serial0/0/0
R       172.16.1.192/26 [120/1] via 10.10.10.2, 00:00:04, Serial0/0/0
C       172.16.2.0/26 is directly connected, FastEthernet0/0
R       172.16.2.64/27 [120/3] via 10.10.10.2, 00:00:04, Serial0/0/0
R       172.16.3.0/25 [120/2] via 10.10.10.2, 00:00:04, Serial0/0/0
R       172.16.3.128/26 [120/1] via 10.10.10.2, 00:00:04, Serial0/0/0
C       172.16.3.192/29 is directly connected, FastEthernet0/1
R       172.16.4.0/27 [120/3] via 10.10.10.2, 00:00:04, Serial0/0/0
R       172.16.4.128/25 [120/4] via 10.10.10.2, 00:00:04, Serial0/0/0
R    192.168.1.0/24 [120/2] via 10.10.10.2, 00:00:04, Serial0/0/0
R*   0.0.0.0/0 [120/2] via 10.10.10.2, 00:00:04, Serial0/0/0
```

Step 3: Examine the output from the R3 router.

```
R3#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 10.10.10.5 to network 0.0.0.0
```

```
        10.0.0.0/30 is subnetted, 4 subnets
C       10.10.10.0 is directly connected, Serial0/0/1
C       10.10.10.4 is directly connected, Serial0/0/0
R       10.10.10.8 [120/1] via 10.10.10.5, 00:00:04, Serial0/0/0
R       10.10.10.12 [120/2] via 10.10.10.5, 00:00:04, Serial0/0/0
        172.16.0.0/16 is variably subnetted, 10 subnets, 5 masks
R       172.16.1.0/27 [120/1] via 10.10.10.5, 00:00:04, Serial0/0/0
R       172.16.1.32/28 [120/3] via 10.10.10.5, 00:00:04, Serial0/0/0
C       172.16.1.192/26 is directly connected, FastEthernet0/1
R       172.16.2.0/26 [120/1] via 10.10.10.1, 00:00:03, Serial0/0/1
R       172.16.2.64/27 [120/2] via 10.10.10.5, 00:00:04, Serial0/0/0
R       172.16.3.0/25 [120/1] via 10.10.10.5, 00:00:04, Serial0/0/0
C       172.16.3.128/26 is directly connected, FastEthernet0/0
R       172.16.3.192/29 [120/1] via 10.10.10.1, 00:00:03, Serial0/0/1
R       172.16.4.0/27 [120/2] via 10.10.10.5, 00:00:04, Serial0/0/0
R       172.16.4.128/25 [120/3] via 10.10.10.5, 00:00:04, Serial0/0/0
R    192.168.1.0/24 [120/1] via 10.10.10.5, 00:00:04, Serial0/0/0
R*   0.0.0.0/0 [120/1] via 10.10.10.5, 00:00:04, Serial0/0/0
```

Step 4: Examine the output from the R4 router.

```
R4#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 10.10.10.9 to network 0.0.0.0

        10.0.0.0/30 is subnetted, 4 subnets
R       10.10.10.0 [120/2] via 10.10.10.9, 00:00:14, Serial0/0/0
R       10.10.10.4 [120/1] via 10.10.10.9, 00:00:14, Serial0/0/0
C       10.10.10.8 is directly connected, Serial0/0/0
C       10.10.10.12 is directly connected, Serial0/0/1
        172.16.0.0/16 is variably subnetted, 10 subnets, 5 masks
R       172.16.1.0/27 [120/1] via 10.10.10.9, 00:00:14, Serial0/0/0
R       172.16.1.32/28 [120/1] via 10.10.10.14, 00:00:17, Serial0/0/1
R       172.16.1.192/26 [120/2] via 10.10.10.9, 00:00:14, Serial0/0/0
R       172.16.2.0/26 [120/3] via 10.10.10.9, 00:00:14, Serial0/0/0
C       172.16.2.64/27 is directly connected, FastEthernet0/1
R       172.16.3.0/25 [120/1] via 10.10.10.9, 00:00:14, Serial0/0/0
R       172.16.3.128/26 [120/2] via 10.10.10.9, 00:00:14, Serial0/0/0
R       172.16.3.192/29 [120/3] via 10.10.10.9, 00:00:14, Serial0/0/0
C       172.16.4.0/27 is directly connected, FastEthernet0/0
R       172.16.4.128/25 [120/1] via 10.10.10.14, 00:00:17, Serial0/0/1
R    192.168.1.0/24 [120/1] via 10.10.10.9, 00:00:14, Serial0/0/0
R*   0.0.0.0/0 [120/1] via 10.10.10.9, 00:00:14, Serial0/0/0
```

Step 5: Examine the output from the R5 router.

```
R5#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 10.10.10.13 to network 0.0.0.0

     10.0.0.0/30 is subnetted, 4 subnets
R       10.10.10.0 [120/3] via 10.10.10.13, 00:00:21, Serial0/0/0
R       10.10.10.4 [120/2] via 10.10.10.13, 00:00:21, Serial0/0/0
R       10.10.10.8 [120/1] via 10.10.10.13, 00:00:21, Serial0/0/0
C       10.10.10.12 is directly connected, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 10 subnets, 5 masks
R       172.16.1.0/27 [120/2] via 10.10.10.13, 00:00:21, Serial0/0/0
C       172.16.1.32/28 is directly connected, FastEthernet0/1
R       172.16.1.192/26 [120/3] via 10.10.10.13, 00:00:21, Serial0/0/0
R       172.16.2.0/26 [120/4] via 10.10.10.13, 00:00:21, Serial0/0/0
R       172.16.2.64/27 [120/1] via 10.10.10.13, 00:00:21, Serial0/0/0
R       172.16.3.0/25 [120/2] via 10.10.10.13, 00:00:21, Serial0/0/0
R       172.16.3.128/26 [120/3] via 10.10.10.13, 00:00:21, Serial0/0/0
R       172.16.3.192/29 [120/4] via 10.10.10.13, 00:00:21, Serial0/0/0
R       172.16.4.0/27 [120/1] via 10.10.10.13, 00:00:21, Serial0/0/0
C       172.16.4.128/25 is directly connected, FastEthernet0/0
R    192.168.1.0/24 [120/2] via 10.10.10.13, 00:00:21, Serial0/0/0
R*   0.0.0.0/0 [120/2] via 10.10.10.13, 00:00:21, Serial0/0/0
```

Task 2: Create a diagram of the network based on the router outputs.

Step 1: Draw a diagram of the network based on your interpretation of the router outputs in the space provided below.

Step 2: Document the interface addresses in the Addressing Table.

Task 3: Build and Configure the Diagram using Packet Tracer.

Step 1: Build the topology diagram in Packet Tracer. Use 1841 or 2811 routers.

Step 2: Configure the interfaces with the appropriate IP address and subnet mask.

Step 3: Configure the appropriate routing protocol for each router and advertise all directly connected networks.

Step 4: Verify that configurations match the router outputs from Task 1.

Task 4: Identify Routing Processes.

Step 1: Examine the R1 routing table.

What are the IP addresses of the directly connected neighbors of the R1 router?

_____

_____

_____

Which routes did R1 learn from the directly connected neighbors?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Step 2: Examine the R2 routing table.

How many total networks/subnets did R2 learn from its neighbors?

_____

Where would R2 send packets to networks not currently in its routing table? Why?

_____

_____

_____

What does the statement " **R*   0.0.0.0/0 [120/2] via 10.10.10.2, 00:00:04, Serial0/0/0**" at the end of the R2 routing table represent?

_____

Step 3: Examine the R3 routing table.

Which Level 2 routes did R3 learn about from its neighbors?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Which networks are directly connect to R3?

_____

_____

_____

_____

Step 4: Examine the R4 routing table.

Which network is the furthest distance from R4 and how many hops away is it?

_____

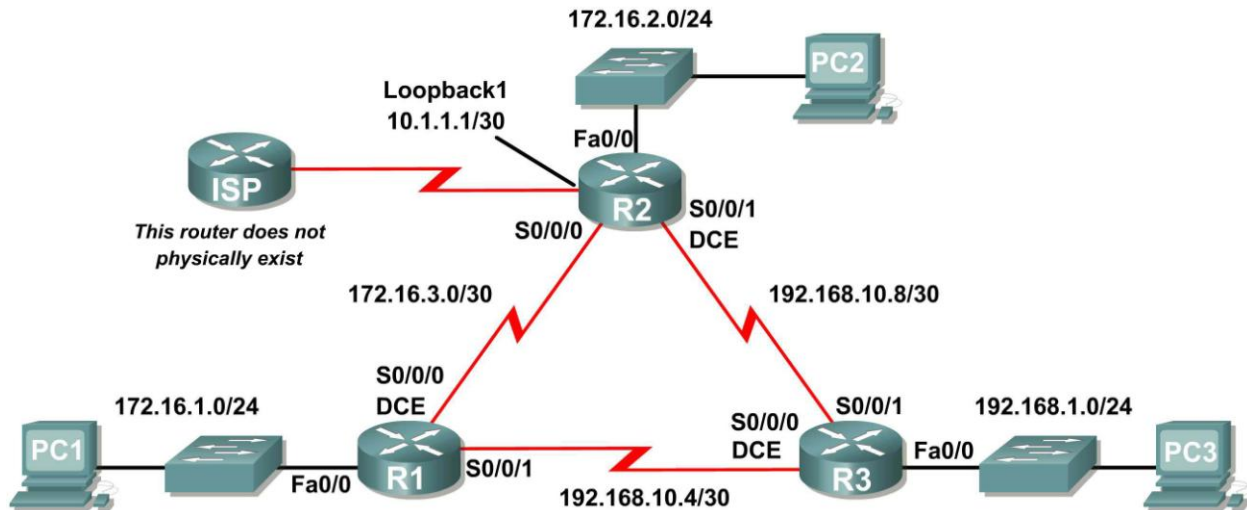How many usable host addresses are on the network furthest from R4? _____

Step 5: Examine the R5 routing table.

How many routers must a packet pass through to get from R5 to network 172.16.2.0/26? _____

Why is the "Gateway of last resort" for R5 listed as 10.10.10.13?

_____

Lab 9.6.1: Basic EIGRP Configuration Lab

Topology Diagram

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	172.16.1.1	255.255.255.0	N/A
	S0/0/0	172.16.3.1	255.255.255.252	N/A
	S0/0/1	192.168.10.5	255.255.255.252	N/A
R2	Fa0/0	172.16.2.1	255.255.255.0	N/A
	S0/0/0	172.16.3.2	255.255.255.252	N/A
	S0/0/1	192.168.10.9	255.255.255.252	N/A
	Lo1	10.1.1.1	255.255.255.252	N/A
R3	Fa0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0	192.168.10.6	255.255.255.252	N/A
	S0/0/1	192.168.10.10	255.255.255.252	N/A
PC1	NIC	172.16.1.10	255.255.255.0	172.16.1.1
PC2	NIC	172.16.2.10	255.255.255.0	172.16.2.1
PC3	NIC	192.168.1.10	255.255.255.0	192.168.1.1

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.
- Configure and activate interfaces.
- Configure EIGRP routing on all routers.
- Verify EIGRP routing using `show` commands.
- Disable automatic summarization.
- Configure manual summarization.
- Configure a static default route.
- Propagate default route to EIGRP neighbors.
- Document the EIGRP configuration.

Scenario

In this lab activity, you will learn how to configure the routing protocol EIGRP using the network shown in the Topology Diagram. A loopback address will be used on the R2 router to simulate a connection to an ISP, where all traffic that is not destined for the local network will be sent. Some segments of the network have been subnetted using VLSM. EIGRP 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: 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.

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 the interfaces on the R1, R2, and R3 routers.

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.

Task 4: Configure EIGRP on the R1 Router.

Step 1: Enable EIGRP.

Use the `router eigrp` command in global configuration mode to enable EIGRP on the R1 router. Enter a process ID of 1 for the *autonomous-system* parameter.

```
R1(config)#router eigrp 1
R1(config-router)#
```

Step 2: Configure classful network 172.16.0.0.

Once you are in the Router EIGRP configuration sub-mode, configure the classful network 172.16.0.0 to be included in the EIGRP updates that are sent out of R1.

```
R1(config-router)#network 172.16.0.0
R1(config-router)#
```

The router will begin to send EIGRP update messages out each interface belonging to the 172.16.0.0 network. EIGRP updates will be sent out of the FastEthernet0/0 and Serial0/0/0 interfaces because they are both on subnets of the 172.16.0.0 network.

Step 3: Configure the router to advertise the 192.168.10.4/30 network attached to the Serial0/0/1 interface.

Use the *wildcard-mask* option with the `network` command to advertise only the subnet and not the entire 192.168.10.0 classful network.

Note: Think of a wildcard mask as the inverse of a subnet mask. The inverse of the subnet mask 255.255.255.252 is 0.0.0.3. To calculate the inverse of the subnet mask, subtract the subnet mask from 255.255.255.255:

```
    255.255.255.255
 -  255.255.255.252        Subtract the subnet mask
 -------------------
      0.  0.  0.  3        Wildcard mask

R1(config-router)# network 192.168.10.4 0.0.0.3
R1(config-router)#
```

When you are finished with the EIGRP configuration for R1, 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#
```

Task 5: Configure EIGRP on the R2 and R3 Routers.

Step 1: Enable EIGRP routing on the R2 router using the `router eigrp` command.

Use a process ID of 1.

```
R2(config)#router eigrp 1
R2(config-router)#
```

Step 2: Use the classful address 172.16.0.0 to include the network for the FastEthernet0/0 interface.

```
R2(config-router)#network 172.16.0.0
R2(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 172.16.3.1 (Serial0/0/0) is up:
new adjacency
```

Notice that DUAL sends a notification message to the console stating that a neighbor relationship with another EIGRP router has been established.

What is the IP address of the EIGRP neighbor router?

_____

What interface on the R2 router is the neighbor adjacent to?

_____

Step 3: Configure the R2 router to advertise the 192.168.10.8/30 network attached to the Serial0/0/1 interface.

1. Use the *wildcard-mask* option with the **network** command to advertise only the subnet and not the entire 192.168.10.0 classful network.

2. When you are finished, return to privileged EXEC mode.

```
R2(config-router)#network 192.168.10.8 0.0.0.3
R2(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#
```

Step 4: Configure EIGRP on the R3 router using the `router eigrp` and `network` commands.

1. Use a process ID of 1.

2. Use the classful network address for the network attached to the FastEthernet0/0 interface.

3. Include the wildcard masks for the subnets attached to the Serial0/0/0 and Serial 0/0/1 interfaces.

4. When you are finished, return to privileged EXEC mode.

```
R3(config)#router eigrp 1
R3(config-router)#network 192.168.1.0
R3(config-router)#network 192.168.10.4 0.0.0.3
R3(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 192.168.10.5 (Serial0/0/0) is up:
new adjacency
R3(config-router)#network 192.168.10.8 0.0.0.3
R3(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 192.168.10.9 (Serial0/0/1) is up:
new adjacency
R3(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
```

```
R3#
```

Notice that when the networks for the serial links from R3 to R1 and R3 to R2 are added to the EIGRP configuration, DUAL sends a notification message to the console stating that a neighbor relationship with another EIGRP router has been established.

Task 6: Verify EIGRP Operation.

Step 1: View neighbors.

On the R1 router, use the `show ip eigrp neighbors` command to view the neighbor table and verify that EIGRP has established an adjacency with the R2 and R3 routers. You should be able to see the IP address of each adjacent router and the interface that R1 uses to reach that EIGRP neighbor.

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address          Interface     Hold Uptime   SRTT   RTO   Q    Seq
                                   (sec)         (ms)         Cnt  Num
0   172.16.3.2       Ser0/0/0      10   00:36:51  40     500   0    13
1   192.168.10.6     Ser0/0/1      11   00:26:51  40     500   0    4
R1#
```

Step 2: View routing protocol information.

On the R1 router, use `the show ip protocols` command to view information about the routing protocol operation. Notice that the information that was configured in Task 5, such as protocol, process ID, and networks, is shown in the output. The IP addresses of the adjacent neighbors are also shown.

```
R1#show ip protocols

Routing Protocol is "eigrp  1 "
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  EIGRP maximum hopcount 100
  EIGRP maximum metric variance 1
  Redistributing: eigrp 1
  Automatic network summarization is in effect
  Automatic address summarization:
  Maximum path: 4
  Routing for Networks:
      172.16.0.0
      192.168.10.4/30
  Routing Information Sources:
    Gateway          Distance      Last Update
    172.16.3.2       90            4811399
    192.168.10.6     90            5411677
  Distance: internal 90 external 170
```

Notice that the output specifies the process ID used by EIGRP. Remember, the process ID must be the same on all routers for EIGRP to establish neighbor adjacencies and share routing information.

Task7: Examine EIGRP Routes in the Routing Tables.

Step1: View the routing table on the R1 router.

EIGRP routes are denoted in the routing table with a **D**, which stands for DUAL (Diffusing Update Algorithm), which is the routing algorithm used by EIGRP.

```
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

     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D       172.16.0.0/16 is a summary, 01:16:19, Null0
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/2172416] via 172.16.3.2, 01:16:20, Serial0/0/0
C       172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.1.0/24 [90/2172416] via 192.168.10.6, 01:06:18, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 01:06:07, Null0
C       192.168.10.4/30 is directly connected, Serial0/0/1
D       192.168.10.8/30 [90/2681856] via 192.168.10.6, 01:06:07, Serial0/0/1
R1#
```

Notice that the 172.16.0.0/16 parent network is variably subnetted with three child routes using either a /24 or /30 mask. Also notice that EIGRP has automatically included a summary route to Null0 for the 172.16.0.0/16 network. The 172.16.0.0/16 route does not actually represent a path to reach the parent network, 172.16.0.0/16. If a packet destined for 172.16.0.0/16 does not match one of the level 2 child routes, it is sent to the Null0 interface.

```
     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D       172.16.0.0/16 is a summary, 01:16:19, Null0
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/2172416] via 172.16.3.2, 01:16:20, Serial0/0/0
C       172.16.3.0/30 is directly connected, Serial0/0/0
```

The 192.168.10.0/24 Network is also variably subnetted and includes a Null0 route.

```
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 01:06:07, Null0
C       192.168.10.4/30 is directly connected, Serial0/0/1
D       192.168.10.8/30 [90/2681856] via 192.168.10.6, 01:06:07, Serial0/0/1
```

Step 2: View the routing table on the R3 router.

The routing table for R3 shows that both R1 and R2 are automatically summarizing the 172.16.0.0/16 network and sending it as a single routing update. Because of automatic summarization, R1 and R2 are not propagating the individual subnets. Because R3 is getting two equal cost routes for 172.16.0.0/16 from both R1 and R2, both routes are included in the routing table.

```
R3#show ip route

<output omitted>

D    172.16.0.0/16 [90/2172416] via 192.168.10.5, 01:15:35, Serial0/0/0
                   [90/2172416] via 192.168.10.9, 01:15:22, Serial0/0/1
C    192.168.1.0/24 is directly connected, FastEthernet0/0
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D        192.168.10.0/24 is a summary, 01:15:22, Null0
C        192.168.10.4/30 is directly connected, Serial0/0/0
C        192.168.10.8/30 is directly connected, Serial0/0/1
R3#
```

Task 8: Configure EIGRP Metrics.

Step 1: View the EIGRP metric information.

Use the **show interface serial0/0/0** command to view the EIGRP metric information for the
Serial0/0/0 interface on the R1 router. Notice the values that are shown for the bandwidth, delay,
reliability, and load.

```
R1#show interface serial0/0/0
Serial0/0/0 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 172.16.3.1/30
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)

<output omitted>
```

Step 2: Modify the bandwidth of the Serial interfaces.

On most serial links, the bandwidth metric will default to 1544 Kbits. If this is not the actual bandwidth of
the serial link, the bandwidth will need to be changed so that the EIGRP metric can be calculated
correctly.

For this lab, the link between R1 and R2 will be configured with a bandwidth of 64 kbps, and the link
between R2 and R3 will be configured with a bandwidth of 1024 kbps. Use the **bandwidth** command to
modify the bandwidth of the Serial interfaces of each router.

```
R1 router:
R1(config)#interface serial0/0/0
R1(config-if)#bandwidth 64

R2 router:
R2(config)#interface serial0/0/0
R2(config-if)#bandwidth 64
R2(config)#interface serial0/0/1
R2(config-if)#bandwidth 1024

R3 router:
R3(config)#interface serial0/0/1
R3(config-if)#bandwidth 1024
```

Note: The **bandwidth** command only modifies the bandwidth metric used by routing protocols, not the
physical bandwidth of the link.

Step 3: Verify the bandwidth modifications.

Use the **show ip interface** command to verify that the bandwidth value of each link has been changed.

```
R1#show interface serial0/0/0
Serial0/0/0 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 172.16.3.1/30
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)

<output omitted>

R2#show interface serial0/0/0
Serial0/0/0 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 172.16.3.2/30
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)

<output omitted>

R3#show interface serial0/0/1
Serial0/0/1 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 192.168.10.10/30
  MTU 1500 bytes, BW 1024 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)

<output omitted>
```

Note: Use the interface configuration command **no bandwidth** to return the bandwidth to its default value.

Task 9: Examine Successors and Feasible Distances.

Step 1: Examine the successors and feasible distances in the routing table on R2.

```
R2#show ip route

<output omitted>

     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Loopback1
     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D       172.16.0.0/16 is a summary, 00:00:52, Null0
D       172.16.1.0/24 [90/40514560] via 172.16.3.1, 00:00:52, Serial0/0/0
C       172.16.2.0/24 is directly connected, FastEthernet0/0
C       172.16.3.0/30 is directly connected, Serial0/0/0
D   192.168.1.0/24 [90/3014400] via 192.168.10.10, 00:00:11, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 00:00:11, Null0
D       192.168.10.4/30 [90/3523840] via 192.168.10.10, 00:00:11,
Serial0/0/1
C       192.168.10.8/30 is directly connected, Serial0/0/1
R2#
```

Step 2: Answer the following questions:

What is the best path to PC1?

_____

A successor is a neighboring router that is currently being used for packet forwarding. A successor is the least-cost route to the destination network. The IP address of a successor is shown in a routing table entry right after the word "via".

What is the IP address and name of the successor router in this route?

_____

Feasible distance (FD) is the lowest calculated metric to reach that destination. FD is the metric listed in the routing table entry as the second number inside the brackets.

What is the feasible distance to the network that PC1 is on?

_____

Task 10: Determine if R1 is a Feasible Successor for the Route from R2 to the 192.168.1.0 Network.

A feasible successor is a neighbor who has a viable backup path to the same network as the successor. In order to be a feasible successor, R1 must satisfy the feasibility condition. The feasibility condition (FC) is met when a neighbor's reported distance (RD) to a network is less than the local router's feasible distance to the same destination network.

Step 1: Examine the routing table on R1.

```
R1#show ip route

<output omitted>

      172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D        172.16.0.0/16 is a summary, 00:42:59, Null0
C        172.16.1.0/24 is directly connected, FastEthernet0/0
D        172.16.2.0/24 [90/40514560] via 172.16.3.2, 00:43:00, Serial0/0/0
C        172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.1.0/24 [90/2172416] via 192.168.10.6, 00:42:26, Serial0/0/1
      192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D        192.168.10.0/24 is a summary, 00:42:20, Null0
C        192.168.10.4/30 is directly connected, Serial0/0/1
D        192.168.10.8/30 [90/3523840] via 192.168.10.6, 00:42:20,
Serial0/0/1
R1#
```

What is the reported distance to the 192.168.1.0 network?

_____

Step 2: Examine the routing table on R2.

```
R2#show ip route

<output omitted>
```

```
          10.0.0.0/30 is subnetted, 1 subnets
C         10.1.1.0 is directly connected, Loopback1
       172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D         172.16.0.0/16 is a summary, 00:00:52, Null0
D         172.16.1.0/24 [90/40514560] via 172.16.3.1, 00:00:52, Serial0/0/0
C         172.16.2.0/24 is directly connected, FastEthernet0/0
C         172.16.3.0/30 is directly connected, Serial0/0/0
D     192.168.1.0/24 [90/3014400] via 192.168.10.10, 00:00:11, Serial0/0/1
       192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D         192.168.10.0/24 is a summary, 00:00:11, Null0
D         192.168.10.4/30 [90/3523840] via 192.168.10.10, 00:00:11, Serial0/0/1
C         192.168.10.8/30 is directly connected, Serial0/0/1
R2#
```

What is the feasible distance to the 192.168.1.0 network?

_____

Would R2 consider R1 to be a feasible successor to the 192.168.1.0 network? _____

Task 11: Examine the EIGRP Topology Table.

Step 1: View the EIGRP topology table.

Use the **show ip eigrp topology** command to view the EIGRP topology table on R2.

```
R2#show ip eigrp topology
IP-EIGRP Topology Table for AS 1

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - Reply status

P 172.16.2.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 172.16.3.0/30, 1 successors, FD is 40512000
        via Connected, Serial0/0/0
P 192.168.10.8/30, 1 successors, FD is 3011840
        via Connected, Serial0/0/1
P 172.16.0.0/16, 1 successors, FD is 28160
        via Summary (28160/0), Null0
P 192.168.10.0/24, 1 successors, FD is 3011840
        via Summary (3011840/0), Null0
P 172.16.1.0/24, 1 successors, FD is 40514560
        via 172.16.3.1 (40514560/28160), Serial0/0/0
P 192.168.1.0/24, 1 successors, FD is 3014400
        via 192.168.10.10 (3014400/28160), Serial0/0/1
        via 172.16.3.1 (41026560/2172416), Serial0/0/0
P 192.168.10.4/30, 1 successors, FD is 3523840
        via 192.168.10.10 (3523840/2169856), Serial0/0/1
R2#
```

Step 2: View detailed EIGRP topology information.

Use the [*network*] parameter of the **show ip eigrp topology** command to view detailed EIGRP topology information for the 192.16.0.0 network.

```
R2#show ip eigrp topology 192.168.1.0
IP-EIGRP (AS 1): Topology entry for 192.168.1.0/24
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 3014400
  Routing Descriptor Blocks:
  192.168.10.10 (Serial0/0/1), from 192.168.10.10, Send flag is 0x0
      Composite metric is (3014400/28160), Route is Internal
      Vector metric:
        Minimum bandwidth is 1024 Kbit
        Total delay is 20100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  172.16.3.1 (Serial0/0/0), from 172.16.3.1, Send flag is 0x0
      Composite metric is (41026560/2172416), Route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 40100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
R2#
```

How many successors are there for this network?

_____

What is the feasible distance to this network?

_____

What is the IP address of the feasible successor?

_____

What is the reported distance for 192.168.1.0 from the feasible successor?

_____

What would be the feasible distance to 192.168.1.0 if R1 became the successor?

_____

Task 12: Disable EIGRP Automatic Summarization.

Step 1: Examine the routing table of the R3 router.

Notice that R3 is not receiving individual routes for the 172.16.1.0/24, 172.16.2.0/24, and 172.16.3.0/24 subnets. Instead, the routing table only has a summary route to the classful network address of 172.16.0.0/16 through the R1 router. This will cause packets that are destined for the 172.16.2.0/24 network to be sent through the R1 router instead of being sent straight to the R2 router.

```
R3#show ip route

<output omitted>
```

```
D    172.16.0.0/16 [90/2172416] via 192.168.10.5, 01:21:54, Serial0/0/0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 01:21:47, Null0
C       192.168.10.4/30 is directly connected, Serial0/0/0
C       192.168.10.8/30 is directly connected, Serial0/0/1
R3#
```

Why is the R1 router (192.168.10.5) the only successor for the route to the 172.16.0.0/16 network?

_____

_____

_____

Notice that the reported distance from R2 is higher than the feasible distance from R1.

```
R3#show ip eigrp topology
IP-EIGRP Topology Table for AS 1

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - Reply status

P 192.168.1.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 192.168.10.4/30, 1 successors, FD is 2169856
        via Connected, Serial0/0/0
P 192.168.10.0/24, 1 successors, FD is 2169856
        via Summary (2169856/0), Null0
P 172.16.0.0/16, 1 successors, FD is 2172416
        via 192.168.10.5 (2172416/28160), Serial0/0/0
        via 192.168.10.9 (3014400/28160), Serial0/0/1
P 192.168.10.8/30, 1 successors, FD is 3011840
        via Connected, Serial0/0/1
```


Step 3: Disable automatic summarization on all three routers with the `no auto-summary` command.

```
R1(config)#router eigrp 1
R1(config-router)#no auto-summary

R2(config)#router eigrp 1
R2(config-router)#no auto-summary

R3(config)#router eigrp 1
R3(config-router)#no auto-summary
```


Step 4: View the routing table on R1 again.

Notice that individual routes for the 172.16.1.0/24, 172.16.2.0/24, and 172.16.3.0/24 subnets are now present and the summary Null route is no longer listed.

```
R3#show ip route

<output omitted>
```

```
     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D        172.16.1.0/24 [90/2172416] via 192.168.10.5, 00:02:37, Serial0/0/0
D        172.16.2.0/24 [90/3014400] via 192.168.10.9, 00:02:39, Serial0/0/1
D        172.16.3.0/30 [90/41024000] via 192.168.10.9, 00:02:39, Serial0/0/1
                       [90/41024000] via 192.168.10.5, 00:02:37, Serial0/0/0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
C        192.168.10.4/30 is directly connected, Serial0/0/0
C        192.168.10.8/30 is directly connected, Serial0/0/1
R3#
```

Task 13: Configure Manual Summarization.

Step 1: Add loopback addresses to R3 router.

Add two loopback addresses, 192.168.2.1/24 and 192.168.3.1/24, to the R3 router. These virtual interfaces will be used to represent networks to be manually summarized along with the 192.168.1.0/24 LAN.

```
R3(config)#interface loopback1

%LINK-5-CHANGED: Interface Loopback1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state
to upR3(config-if)#ip address 192.168.2.1 255.255.255.0
R3(config-if)#interface loopback2

%LINK-5-CHANGED: Interface Loopback2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2, changed state
to up
R3(config-if)#ip address 192.168.3.1 255.255.255.0
R3(config-if)#
```

Step 2: Add the 192.168.2.0 and 192.168.3.0 networks to the EIGRP configuration on R3.

```
R3(config)#router eigrp 1
R3(config-router)#network 192.168.2.0
R3(config-router)#network 192.168.3.0
```

Step 3: Verify new routes.

View the routing table on the R1 router to verify that the new routes are being sent out in the EIGRP updates sent by R3.

```
R1#show ip route

<output omitted>

     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
C        172.16.1.0/24 is directly connected, FastEthernet0/0
D        172.16.2.0/24 [90/3526400] via 192.168.10.6, 00:15:07, Serial0/0/1
C        172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.1.0/24 [90/2172416] via 192.168.10.6, 00:15:07, Serial0/0/1
D    192.168.2.0/24 [90/2297856] via 192.168.10.6, 00:01:07, Serial0/0/1
D    192.168.3.0/24 [90/2297856] via 192.168.10.6, 00:00:57, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
C        192.168.10.4/30 is directly connected, Serial0/0/1
D        192.168.10.8/30 [90/3523840] via 192.168.10.6, 00:15:07, Serial0/0/1
R1#
```

Step 4: Apply manual summarization to outbound interfaces.

The routes to the 192.168.1.0/24, 192.168.2.0/24, and 192.168.3.0/24 networks can be summarized in the single network 192.168.0.0/22. Use the **ip summary-address eigrp** *as-number network-address subnet-mask* command to configure manual summarization on each of the outbound interfaces connected to EIGRP neighbors.

```
R3(config)#interface serial0/0/0
R3(config-if)#ip summary-address eigrp 1 192.168.0.0 255.255.252.0
R3(config-if)#interface serial0/0/1
R3(config-if)#ip summary-address eigrp 1 192.168.0.0 255.255.252.0
R3(config-if)#
```

Step 5: Verify the summary route.

View the routing table on the R1 router to verify that the summary route is being sent out in the EIGRP updates sent by R3.

```
R1#show ip route

<output omitted>

     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/3526400] via 192.168.10.6, 00:15:07, Serial0/0/1
C       172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.0.0/22 [90/2172416] via 192.168.10.6, 00:01:11, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
C       192.168.10.4/30 is directly connected, Serial0/0/1
D       192.168.10.8/30 [90/3523840] via 192.168.10.6, 00:15:07, Serial0/0/1
R1#
```

Task 14: Configure and Distribute a Static Default Route.

Step 1: Configure a static default route on the R2 router.

Use the loopback address that has been configured to simulate a link to an ISP as the exit interface.

```
R2(config)#ip route 0.0.0.0 0.0.0.0 loopback1
R2(config)#
```

Step 2: Include the static route in EIGRP updates.

Use the **redistribute static** command to include the static route in the EIGRP updates that are sent from the R2 router.

```
R2(config)#router eigrp 1
R2(config-router)#redistribute static
R2(config-router)#
```

Step 3: Verify the static default route.

View the routing table on the R1 router to verify that the static default route is being redistributed via EIGRP.

```
R1#show ip route

<output omitted>
```

```
Gateway of last resort is 192.168.10.6 to network 0.0.0.0

     192.168.10.0/30 is subnetted, 2 subnets
C       192.168.10.4 is directly connected, Serial0/0/1
D       192.168.10.8 [90/3523840] via 192.168.10.6, 01:06:01, Serial0/0/1
     172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/3526400] via 192.168.10.6, 01:05:39, Serial0/0/1
C       172.16.3.0/30 is directly connected, Serial0/0/0
D*EX 0.0.0.0/0 [170/3651840] via 192.168.10.6, 00:02:14, Serial0/0/1
D    192.168.0.0/22 [90/2172416] via 192.168.10.6, 01:05:38, Serial0/0/1
```

Task 15: 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**

Task 16: 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 9.6.2: Challenge EIGRP Configuration Lab
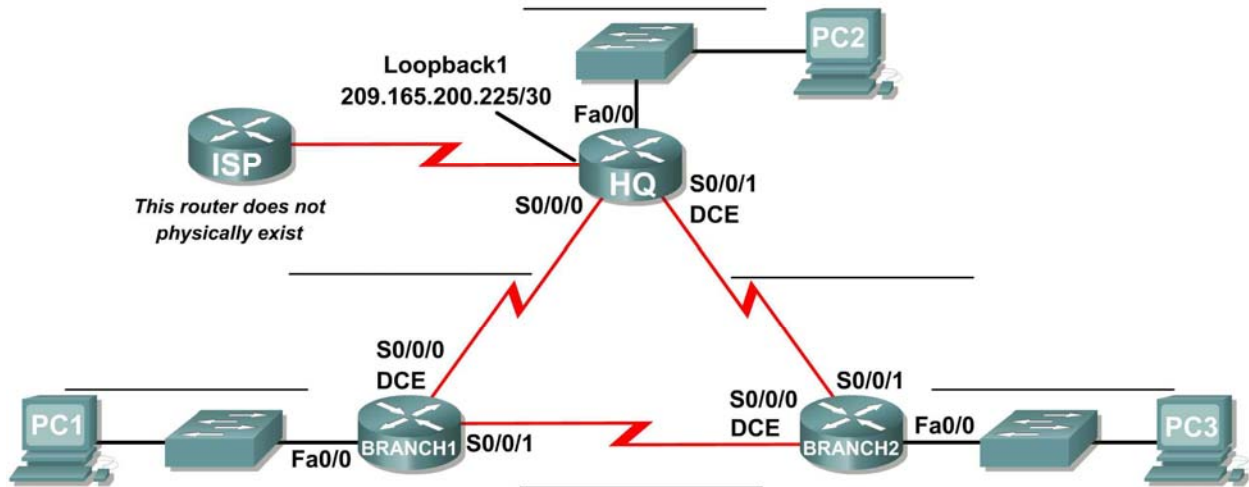
Topology Diagram

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
	Lo1			N/A
BRANCH1	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
BRANCH2	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
PC1	NIC			
PC2	NIC			
PC3	NIC			

Learning Objectives

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

- Create an efficient VLSM design given requirements.
- Assign appropriate addresses to interfaces and document.
- Cable a network according to the Topology Diagram.
- Erase the startup configuration and reload a router to the default state.
- Configure routers including EIGRP.
- Configure and propagate a static default route.
- Verify EIGRP operation.
- Test and verify full connectivity.
- Reflect upon and document the network implementation.

Scenario

In this lab activity, you will be given a network address that must be subnetted using VLSM to complete the addressing of the network shown in the Topology Diagram. A combination of EIGRP routing and static routing will be required so that hosts on networks that are not directly connected will be able to communicate with each other. EIGRP must be configured so that all IP traffic takes the shortest path to the destination address.

Task 1: Subnet the Address Space.

Step 1: Examine the network requirements.

The addressing for the network has the following requirements:

- The 172.16.0.0/16 network must be subnetted to provide addresses for the three LANs.
    - The HQ LAN will require 500 addresses.
    - The BRANCH1 LAN will require 200 addresses.
    - The Branch 2 LAN will require 100 addresses.
- The loopback address representing the link between the HQ router and the ISP will use the 209.165.200.224/30 network.
- The 192.168.1.16/28 address space must be subnetted to obtain the addresses for the links between the three routers.

Step 2: Consider the following questions when creating your network design:

How many subnets need to be created from the 172.16.0.0/16 network? _____

How many total IP addresses are required from the 172.16.0.0/16 network? _____

What subnet mask will be used for the HQ LAN subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the BRANCH1 LAN subnet?
_____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the BRANCH2 LAN subnet?
_____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the links between the three routers? _____

What is the maximum number of host addresses that could be used on each of these subnets? _____

Step 3: Assign subnetwork addresses to the Topology Diagram.

1. Assign subnet 0 of the 172.16.0.0/16 network to the HQ LAN subnet.
   What is the network address of this subnet? _____

2. Assign subnet 1 of the 172.16.0.0/16 network to the BRANCH1 LAN subnet.
   What is the network address of this subnet? _____

3. Assign subnet 2 of the 172.16.0.0/16 network to the BRANCH2 LAN subnet.
   What is the network address of this subnet? _____

4. Assign subnet 0 of the 192.168.1.16/28 network to the link between the HQ and BRANCH1
   routers.
   What is the network address of this subnet? _____

5. Assign subnet 1 of the 192.168.1.16/28 network to the link between the HQ and BRANCH2
   routers.
   What is the network address of this subnet? _____

6. Assign subnet 2 of the 192.168.1.16/28 network to the link between the BRANCH1 and
   BRANCH2 routers. What is the network address of this subnet?
   _____

Task 2: Determine Interface Addresses.

Step 1: Assign appropriate addresses to the device interfaces.

1. Assign the first valid host address of the 209.165.200.224/30 network to the Loopback interface
   on the HQ router.

2. Assign the first valid IP address of the HQ LAN network to the LAN interface of the HQ router.

3. Assign the last valid IP address of the HQ LAN network to PC2.

4. Assign the first valid IP address of the BRANCH1 LAN network to the LAN interface of the
   BRANCH1 router.

5. Assign the last valid IP address of the BRANCH1 LAN network to PC1.

6. Assign the first valid IP address of the BRANCH2 LAN network to the LAN interface of the
   BRANCH2 router.

7. Assign the last valid IP address of the BRANCH2 LAN network to PC3.

8. Assign the first valid IP address of the HQ to BRANCH1 link network to the Serial 0/0/0 interface
   of the HQ router.

9. Assign the last valid IP address of the HQ to BRANCH1 link network to the Serial0/0/0 interface
   of the Branch router.

10. Assign the first valid IP address of the HQ to BRANCH2 link network to the Serial 0/0/1 interface
    of the HQ router.

11. Assign the last valid IP address of the HQ to BRANCH2 link network to the Serial0/0/1 interface
    of the Branch router.

12. Assign the first valid IP address of the BRANCH1 to BRANCH2 link network to the Serial 0/0/1
    interface of the BRANCH1 router.

13. Assign the last valid IP address of the BRANCH1 to BRANCH2 link network to the Serial0/0/0
    interface of the BRANCH2 router.

Step 2: Document the addresses to be used in the table provided under the Topology Diagram.

Task 3: 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.

Step 2 Clear any existing configurations on the routers.

Task 4: Perform Basic Router Configurations.

Perform basic configuration of the BRANCH1, BRANCH2, HQ, and ISP 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.
7. Synchronize unsolicited messages and debug output with solicited output and prompts for the console and virtual terminal lines.
8. Configure an EXEC timeout of 15 minutes.

Task 5: Configure and Activate Serial and Ethernet Addresses.

Step 1: Configure the interfaces on the HQ, BRANCH1, and BRANCH2 routers.

Configure the interfaces on the HQ, BRANCH1, and BRANCH2 routers with the IP addresses from the table provided under the Topology Diagram.

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

Step 2: Configure the Ethernet interfaces.

Configure the Ethernet interfaces of PC1, PC2, and PC3 with the IP addresses from the Addressing Table provided under the Topology Diagram.

Task 6: Verify Connectivity to Next-Hop Device.

You should *not* have connectivity between end devices yet. However, you can test connectivity between two routers and between an end device and its default gateway.

Step 1: Verify connectivity of routers.

Verify that the HQ, BRANCH1, and BRANCH2 routers can ping each of the neighboring routers across the WAN links.

Step 2: Verify connectivity of PCs.

Verify that PC1, PC2, and PC3 can ping their respective default gateways.

Task 7: Configure EIGRP Routing on the BRANCH1 Router.

Consider the networks that need to be included in the EIGRP updates that are sent out by the BRANCH1 router.

What directly connected networks are present in the BRANCH1 routing table?

_____

_____

_____

Will these networks need to have the subnet mask information included in the network statements?
_____

What commands are required to enable EGIRP and include the connected networks in the routing updates?

_____

_____

_____

_____

What command is required to enable EGIRP to include the VLSM information instead of summarizing routes at the classful boundary?

_____

Are there any router interfaces that do not need to have EIGRP updates sent out? _____

What command is used to disable EIGRP updates on these interfaces?

_____

Task 8: Configure EIGRP and Static Routing on the HQ Router.

Consider the type of static routing that is needed on HQ.

A static default route will need to be configured to send all packets with destination addresses that are not in the routing table to the loopback address representing the link between the HQ router and the ISP. What command is needed to accomplish this?

_____

What directly connected networks are present in the HQ routing table?

_____

_____

_____

_____

Will the networks of the HQ LAN and the links between the BRANCH1 and BRANCH2 routers need to have the subnet mask information included in the network statements? _____

What commands are required to enable EGIRP and include the appropriate networks in the routing updates?

_____

_____

_____

_____

What command is required to enable EGIRP to include the VLSM information instead of summarizing routes at the classful boundary?

_____

Are there any router interfaces that do not need to have EIGRP updates sent out? _____

What command is used to disable EIGRP updates on this interface?

_____

The HQ router needs to send the default route information to the BRANCH1 and BRANCH2 routers in the EIGRP updates. What command is used to configure this?

_____

Task 9: Configure EIGRP Routing on the BRANCH2 Router.

Consider the networks that need to be included in the EIGRP updates that are sent out by the BRANCH2 router.

What directly connected networks are present in the BRANCH2 routing table?

_____

_____

_____

Will these networks need to have the subnet mask information included in the network statements? _____

What commands are required to enable EGIRP and include the connected networks in the routing updates?

_____

_____

_____

_____

What command is required to enable EGIRP to include the VLSM information instead of summarizing routes at the classful boundary?

_____

Are there any router interfaces that do not need to have EIGRP updates sent out? _____

What command is used to disable EIGRP updates on these interfaces?

_____

Task 10: Verify the Configurations.

Answer the following questions to verify that the network is operating as expected:

From PC1, is it possible to ping PC2? _____

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

The answer to the above questions should be **yes**. If any of the above pings failed, check your physical connections and configurations. Refer to your basic troubleshooting techniques used in the Chapter 1 labs.

What EIGRP routes are present in the routing table of the BRANCH1 router?

_____

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the BRANCH1 router?

_____

What EIGRP routes are present in the routing table of the HQ router?

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the HQ router?

_____

What EIGRP routes are present in the routing table of the BRANCH2 router?

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the BRANCH2 router?

_____

Task 11: Reflection

Why is it necessary to use disable automatic summarization with this network design?

_____

_____

_____

If the routes in the routing table are summarized at the classful network boundary 17.16.0.0, the paths between the three routers will all have an equal cost and packets may not be sent using the route with the least hops.

Task 12: Document the Router Configurations.

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

- **Running configuration**
- **Routing table**
- **Interface summarization**

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.

Lab 9.6.3: EIGRP Troubleshooting Lab

Topology Diagram
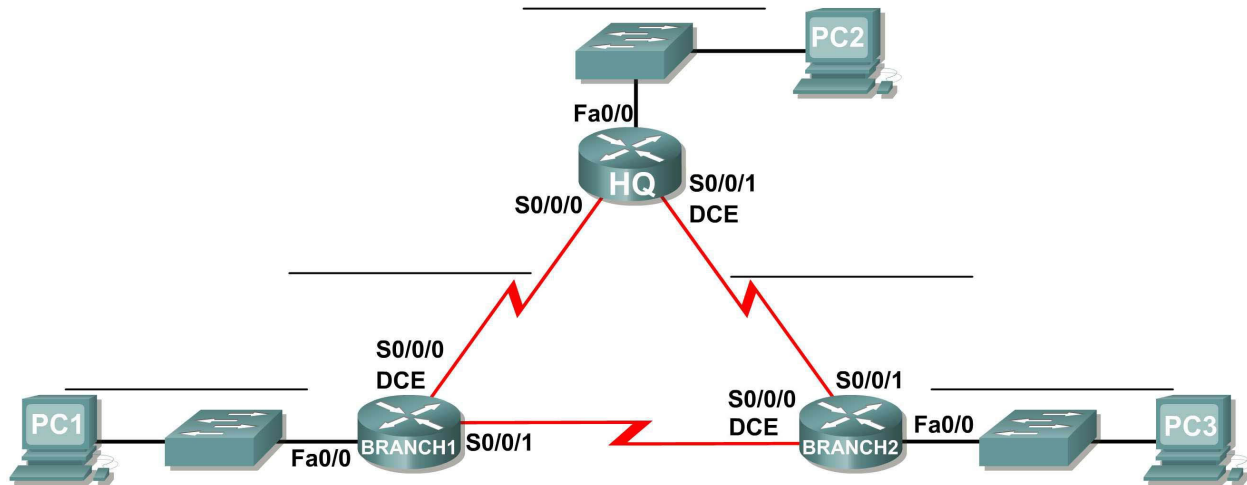
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0	172.18.64.1	255.255.192.0	N/A
	S0/0/0	209.165.202.129	255.255.255.252	N/A
	S0/0/1	209.165.202.133	255.255.255.252	N/A
BRANCH1	Fa0/0	172.18.129.1	255.255.255.240	N/A
	S0/0/0	209.165.202.130	255.255.255.252	N/A
	S0/0/1	209.165.202.137	255.255.255.252	N/A
BRANCH2	Fa0/0	172.18.128.1	255.255.255.0	N/A
	S0/0/0	209.165.202.138	255.255.255.252	N/A
	S0/0/1	209.165.202.134	255.255.255.252	N/A
PC1	NIC	172.18.129.14	255.255.255.240	172.18.129.1
PC2	NIC	172.18.100.100	255.255.192.0	172.18.64.1
PC3	NIC	172.18.128.10	255.255.255.0	172.18.128.1

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.
- Load the routers with supplied scripts.
- Discover where communication is not possible.
- Gather information about the misconfigured portion of the network along with any other errors.
- Analyze information to determine why communication is not possible.
- Propose solutions to network errors.
- Implement solutions to network errors.
- Document the corrected network.

Scenario

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

The network should also have the following requirements met:

- EIGRP routing is configured on the BRANCH1 router.
- EIGRP routing is configured on the BRANCH2 router.
- EIGRP routing is configured on the HQ router.
- EIGRP updates must be disabled on the BRANCH1, BRANCH2, and HQ LAN interfaces.
- All EIGRP routers must use a process ID of 1.

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 the routers using the e**rase 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 the BRANCH1 router:

```
hostname BRANCH1
!
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 172.18.129.1 255.255.255.240
 duplex auto
 speed auto
 !
```

```
interface Serial0/0/0
 ip address 209.165.202.130 255.255.255.252
 clock rate 64000
 no shutdown
!
interface Serial0/0/1
 ip address 209.165.202.137 255.255.255.252
 no shutdown
!
router eigrp 2
  passive-interface FastEthernet0/0
 network 209.165.202.128 0.0.0.3
 network 209.165.202.136 0.0.0.3
 network 172.18.129.0 0.0.0.7
 no auto-summary
!
ip classless
!
line con 0
line vty 0 4
 login
!
end
```

Step 2: Load the following script onto the BRANCH2 router:

```
hostname BRANCH2
!
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 172.18.128.1 255.255.255.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 209.165.202.138 255.255.255.252
 clock rate 64000
 no shutdown
!
interface Serial0/0/1
 ip address 209.165.202.134 255.255.255.252
 no shutdown
!
router eigrp 1
 passive-interface FastEthernet0/0
 network 172.18.128.0 0.0.0.255
 network 209.165.202.132 0.0.0.3
 network 209.165.202.136 0.0.0.3
 !
ip classless
!
line con 0
line vty 0 4
 login
```

```
 !
 end
```

Step 3: Load the following script onto the HQ router:

```
hostname HQ
!
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 172.18.64.1 255.255.192.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 209.165.202.129 255.255.255.252
 no shutdown
!
interface Serial0/0/1
 ip address 209.165.202.133 255.255.255.252
 clock rate 64000
 no shutdown
!
router eigrp 1
 passive-interface Serial0/0/0
  network 172.18.64.0
 network 209.165.202.128 0.0.0.3
 network 209.165.202.132 0.0.0.3
 no auto-summary
!
ip classless
!
line con 0
line vty 0 4
 login
!
end
```

Task 3: Troubleshoot the BRANCH1 Router.

Step 1: Begin troubleshooting at the Host connected to the BRANCH1 router.

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

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

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

Step 2: Examine the BRANCH1 router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the configuration of the interfaces?

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be
necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status
information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors on the BRANCH1
router? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the BRANCH1 router.

What routes are shown in the routing table?

_____

_____

Are there any problems with the routing table or the EIGRP configuration?

_____

_____

If there are any problems with the EIGRP configuration, record any commands that will be necessary to
correct the configuration errors.

_____

_____

_____

_____

_____

_____

_____

Are there any connectivity problems that could be due to errors on other parts of the network?

_____

_____

What connected networks are shown in the EIGRP topology table of the BRANCH1 router?

_____

_____

Are there any problems with the connected networks in the EIGRP topology table?

_____

_____

Step 6: If you have recorded any commands above, apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors on the BRANCH1 router? _____

Does the information in the EIGRP topology table indicate any configuration errors on the BRANCH1 router? _____

If the answer to either of these questions is **yes**, troubleshoot the routing configuration again.

What routes are shown in the routing table?

_____

_____

_____

_____

Step 8: Attempt to ping between the hosts again.

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

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

From the host PC1, is it possible to ping the Serial 0/0/0 interface of the HQ router? _____

From the host PC1, is it possible to ping the Serial 0/0/1 interface of the HQ router? _____

Task 4: Troubleshoot the HQ Router

Step 1: Begin troubleshooting at the host PC2.

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

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

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

Step 2: Examine the HQ router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the configuration of the interfaces?

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the configuration of the interfaces?

_____

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be
necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status
information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors on the HQ router?
_____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the HQ router.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table or the EIGRP configuration?

_____

_____

_____

_____

_____

_____

If there are any problems with the EIGRP configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

_____

_____

Are there any connectivity problems that could be due to errors on other parts of the network?

_____

_____

_____

What connected networks are shown in the EIGRP topology table of the HQ router?

_____

_____

_____

_____

Are there any problems with the connected networks in the EIGRP topology table?

_____

_____

Step 6: If you have recorded any commands above, apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors on the HQ router? _____

Does the information in the EIGRP topology table indicate any configuration errors on the HQ router? _____

If the answer to either of these questions is **yes**, troubleshoot the routing configuration again.

Step 8: Attempt to ping between the hosts again.

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

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

From the host PC2, is it possible to ping the Serial 0/0/0 interface of the BRANCH2 router? _____

From the host PC2, is it possible to ping the Serial 0/0/1 interface of the BRANCH2 router? _____

Task 5: Troubleshoot the BRANCH2 Router

Step 1: Begin troubleshooting at the Host PC3.

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

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

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

Step 2: Examine the BRANCH2 router to find possible configuration errors.

Are there any problems with the configuration of the interfaces?

_____

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors on the BRANCH2 router? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the BRANCH2 router.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table or the EIGRP configuration?

_____

_____

If there are any problems with the EIGRP configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Are there any connectivity problems that could be due to errors on other parts of the network?

_____

_____

_____

What connected networks are shown in the EIGRP topology table of the BRANCH2 router?

_____

_____

_____

Are there any problems with the connected networks in the EIGRP topology table?

_____

_____

Step 6: If you have recorded any commands above, apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors on the BRANCH2 router? _____

Does the information in the EIGRP topology table indicate any configuration errors on the BRANCH2 router? _____

If the answer to either of these questions is **yes**, troubleshoot the routing configuration again.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

Step 8: Attempt to ping between the hosts again.

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

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

From the host PC3, is it possible to ping the Serial 0/0/0 interface of the BRANCH1 router? _____

From the host PC3, is it possible to ping the Serial 0/0/1 interface of the BRANCH1 router? _____

Task 6: Reflection

There were a number of configuration errors in the scripts that were provided for this lab. Use the space below to write a brief description of the errors that you found.

_____

_____

_____

_____

_____

_____

_____

_____

Task 7: 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 8: 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 11.6.1: Basic OSPF Configuration Lab

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 OSPF routing on all routers
- Configure OSPF router IDs
- Verify OSPF routing using show commands
- Configure a static default route
- Propagate default route to OSPF neighbors
- Configure OSPF Hello and Dead Timers
- Configure OSPF on a Multi-access network
- Configure OSPF priority
- Understand the OSPF election process
- Document the OSPF configuration

Scenarios

In this lab activity, there are two separate scenarios. In the first scenario, you will learn how to configure the routing protocol OSPF using the network shown in the Topology Diagram in Scenario A. The segments of the network have been subnetted using VLSM. OSPF 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.

In the second scenario, you will learn to configure OSPF on a multi-access network. You will also learn to use the OSPF election process to determine the designated router (DR), backup designated router (BDR), and DRother states.

Scenario A: Basic OSPF Configuration

Topology Diagram
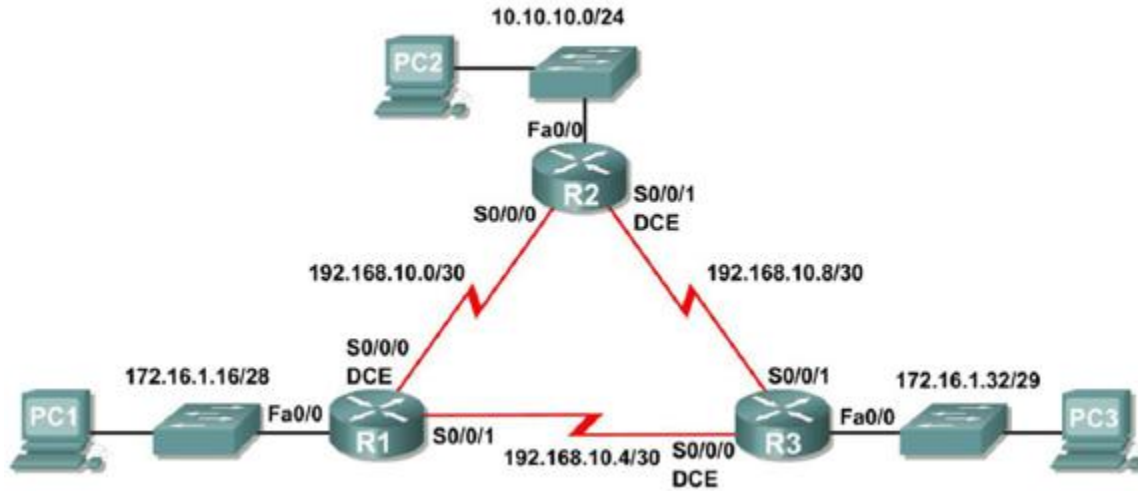
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	172.16.1.17	255.255.255.240	N/A
	S0/0/0	192.168.10.1	255.255.255.252	N/A
	S0/0/1	192.168.10.5	255.255.255.252	N/A
R2	Fa0/0	10.10.10.1	255.255.255.0	N/A
	S0/0/0	192.168.10.2	255.255.255.252	N/A
	S0/0/1	192.168.10.9	255.255.255.252	N/A
R3	Fa0/0	172.16.1.33	255.255.255.248	N/A
	S0/0/0	192.168.10.6	255.255.255.252	N/A
	S0/0/1	192.168.10.10	255.255.255.252	N/A
PC1	NIC	172.16.1.20	255.255.255.240	172.16.1.17
PC2	NIC	10.10.10.10	255.255.255.0	10.10.10.1
PC3	NIC	172.16.1.35	255.255.255.248	172.16.1.33

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 a privileged 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 OSPF on the R1 Router

Step 1: Use the router ospf command in global configuration mode to enable OSPF on the R1 router. Enter a process ID of 1 for the *process-ID* parameter.

```
R1(config)#router ospf 1
R1(config-router)#
```

Step 2: Configure the **network** statement for the LAN network.

Once you are in the Router OSPF configuration sub-mode, configure the LAN network
172.16.1.16/28 to be included in the OSPF updates that are sent out of R1.

The OSPF **network** command uses a combination of *network-address* and *wildcard-mask*
similar to that which can be used by EIGRP. Unlike EIGRP, the wildcard mask in OSPF is
required.

Use an area ID of 0 for the OSPF *area-id* parameter. 0 will be used for the OSPF area ID in all
of the **network** statements in this topology.

```
R1(config-router)#network 172.16.1.16 0.0.0.15 area 0
R1(config-router)#
```

**Step 3: Configure the router to advertise the 192.168.10.0/30 network attached to the
Serial0/0/0 interface.**

```
R1(config-router)# network 192.168.10.0 0.0.0.3 area 0
R1(config-router)#
```

**Step 4: Configure the router to advertise the 192.168.10.4/30 network attached to the
Serial0/0/1 interface.**

```
R1(config-router)# network 192.168.10.4 0.0.0.3 area 0
R1(config-router)#
```

**Step 5: When you are finished with the OSPF configuration for R1, return to privileged
EXEC mode.**

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

Task 5: Configure OSPF on the R2 and R3 Routers

Step 1: Enable OSPF routing on the R2 router using the router ospf command.
Use a process ID of 1.

```
R2(config)#router ospf 1
R2(config-router)#
```

**Step 2: Configure the router to advertise the LAN network 10.10.10.0/24 in the OSPF
updates.**

```
R2(config-router)#network 10.10.10.0 0.0.0.255 area 0
R2(config-router)#
```

**Step 3: Configure the router to advertise the 192.168.10.0/30 network attached to the
Serial0/0/0 interface.**

```
R2(config-router)#network 192.168.10.0 0.0.0.3 area 0
R2(config-router)#
00:07:27: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.5 on Serial0/0/0
from EXCHANGE to FULL, Exchange Done
```

Notice that when the network for the serial link from R1 to R2 is added to the OSPF configuration, the router sends a notification message to the console stating that a neighbor relationship with another OSPF router has been established.

Step 4: Configure the router to advertise the 192.168.10.8/30 network attached to the Serial0/0/1 interface.
When you are finished, return to privileged EXEC mode.

```
R2(config-router)#network 192.168.10.8 0.0.0.3 area 0
R2(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#
```

Step 5: Configure OSPF on the R3 router using the `router ospf` and `network` commands.
Use a process ID of 1. Configure the router to advertise the three directly connected networks. When you are finished, return to privileged EXEC mode.

```
R3(config)#router ospf 1
R3(config-router)#network 172.16.1.32 0.0.0.7 area 0
R3(config-router)#network 192.168.10.4 0.0.0.3 area 0
R3(config-router)#
00:17:46: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.5 on Serial0/0/0
from LOADING to FULL, Loading Done
R3(config-router)#network 192.168.10.8 0.0.0.3 area 0
R3(config-router)#
00:18:01: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.9 on Serial0/0/1
from EXCHANGE to FULL, Exchange Done
R3(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R3#
```

Notice that when the networks for the serial links from R3 to R1 and R3 to R2 are added to the OSPF configuration, the router sends a notification message to the console stating that a neighbor relationship with another OSPF router has been established.

Task 6: Configure OSPF Router IDs

The OSPF router ID is used to uniquely identify the router in the OSPF routing domain. A router ID is an IP address. Cisco routers derive the Router ID in one of three ways and with the following precedence:

1. IP address configured with the OSPF `router-id` command.
2. Highest IP address of any of the router's loopback addresses.
3. Highest active IP address on any of the router's physical interfaces.

Step 1: Examine the current router IDs in the topology.

Since no router IDs or loopback interfaces have been configured on the three routers, the router ID for each router is determined by the highest IP address of any active interface.

What is the router ID for R1? _____
What is the router ID for R2? _____
What is the router ID for R3? _____

The router ID can also be seen in the output of the **show ip protocols**, **show ip ospf**, and **show ip ospf interfaces** commands.

```
R3#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.10.10
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4

<output omitted>


R3#show ip ospf
 Routing Process "ospf 1" with ID 192.168.10.10
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs

<output omitted>

R3#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 172.16.1.33/29, Area 0
  Process ID 1, Router ID 192.168.10.10, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.10.10, Interface address 172.16.1.33
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:00
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)

<output omitted>

R3#
```

Step 2: Use loopback addresses to change the router IDs of the routers in the topology.

```
R1(config)#interface loopback 0
R1(config-if)#ip address 10.1.1.1 255.255.255.255

R2(config)#interface loopback 0
R2(config-if)#ip address 10.2.2.2 255.255.255.255

R3(config)#interface loopback 0
R3(config-if)#ip address 10.3.3.3 255.255.255.255
```

Step 3: Reload the routers to force the new Router IDs to be used.

When a new Router ID is configured, it will not be used until the OSPF process is restarted. Make sure that the current configuration is saved to NRAM, and then use the **reload** command to restart each of the routers..

When the router is reloaded, what is the router ID for R1? _____
When the router is reloaded, what is the router ID for R2? _____
When the router is reloaded, what is the router ID for R3? _____

Step 4: Use the `show ip ospf neighbors` command to verify that the router IDs have changed.

R1#**show ip ospf neighbor**

```
Neighbor ID     Pri   State          Dead Time   Address
Interface
10.3.3.3         0   FULL/  -        00:00:30    192.168.10.6
Serial0/0/1
10.2.2.2         0    FULL/  -        00:00:33    192.168.10.2
Serial0/0/0
```

R2#**show ip ospf neighbor**

```
Neighbor ID     Pri   State          Dead Time   Address
Interface
10.3.3.3         0   FULL/  -        00:00:36    192.168.10.10
Serial0/0/1
10.1.1.1         0    FULL/  -        00:00:37    192.168.10.1
Serial0/0/0
```

R3#**show ip ospf neighbor**

```
Neighbor ID     Pri   State          Dead Time   Address
Interface
10.2.2.2         0   FULL/  -        00:00:34    192.168.10.9
Serial0/0/1
10.1.1.1         0    FULL/  -        00:00:38    192.168.10.5
Serial0/0/0
```

Step 5: Use the `router-id` command to change the router ID on the R1 router.

Note: Some IOS versions do not support the **router-id** command. If this command is not available, continue to Task 7.

```
R1(config)#router ospf 1
R1(config-router)#router-id 10.4.4.4
Reload or use "clear ip ospf process" command, for this to take effect
```

If this command is used on an OSPF router process which is already active (has neighbors), the new router-ID is used at the next reload or at a manual OSPF process restart. To manually restart the OSPF process, use the **clear ip ospf process** command.

```
R1#(config-router)#end
R1# clear ip ospf process
Reset ALL OSPF processes? [no]:yes
R1#
```

Step 6: Use the `show ip ospf neighbor` command on router R2 to verify that the router ID of R1 has been changed.

```
R2#show ip ospf neighbor

Neighbor ID     Pri   State          Dead Time    Address
Interface
10.3.3.3          0   FULL/  -       00:00:36     192.168.10.10
Serial0/0/1
10.4.4.4          0   FULL/  -       00:00:37     192.168.10.1
Serial0/0/0
```

Step 7: Remove the configured router ID with the `no` form of the `router-id` command.

```
R1(config)#router ospf 1
R1(config-router)#no router-id 10.4.4.4
Reload or use "clear ip ospf process" command, for this to take effect
```

Step 8: Restart the OSPF process using the `clear ip ospf process` command.

Restarting the OSPF process forces the router to use the IP address configured on the Loopback 0 interface as the Router ID.

```
R1(config-router)#end
R1# clear ip ospf process
Reset ALL OSPF processes? [no]:yes
R1#
```

Task 7: Verify OSPF Operation

Step 1: On the R1 router, Use the `show ip ospf neighbor` command to view the information about the OSPF neighbor routers R2 and R3. You should be able to see the neighbor ID and IP address of each adjacent router, and the interface that R1 uses to reach that OSPF neighbor.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State          Dead Time    Address
Interface
10.2.2.2          0   FULL/-         00:00:32     192.168.10.2
Serial0/0/0
10.3.3.3          0   FULL/-         00:00:32     192.168.10.6
Serial0/0/1
R1#
```

Step 2: On the R1 router, use the `show ip protocols` command to view information about the routing protocol operation.

Notice that the information that was configured in the previous Tasks, such as protocol, process ID, neighbor ID, and networks, is shown in the output. The IP addresses of the adjacent neighbors are also shown.

```
R1#show ip protocols

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 10.1.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    172.16.1.16 0.0.0.15 area 0
    192.168.10.0 0.0.0.3 area 0
    192.168.10.4 0.0.0.3 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.2.2.2          110         00:11:43
    10.3.3.3          110         00:11:43
  Distance: (default is 110)

R1#
```

Notice that the output specifies the process ID used by OSPF. Remember, the process ID must
be the same on all routers for OSPF to establish neighbor adjacencies and share routing
information.

Task8: Examine OSPF Routes in the Routing Tables

View the routing table on the R1 router. OSPF routes are denoted in the routing table with an "O".

```
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

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.1.1.1/32 is directly connected, Loopback0
O       10.10.10.0/24 [110/65] via 192.168.10.2, 00:01:02, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.1.16/28 is directly connected, FastEthernet0/0
O       172.16.1.32/29 [110/65] via 192.168.10.6, 00:01:12, Serial0/0/1
     192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/128] via 192.168.10.6, 00:01:12, Serial0/0/1
                     [110/128] via 192.168.10.2, 00:01:02, Serial0/0/0
R1#
```

Notice that unlike RIPv2 and EIGRP, OSPF does not automatically summarize at major network boundaries.

Task 9: Configure OSPF Cost

Step 1: Use the `show ip route` command on the R1 router to view the OSPF cost to reach the 10.10.10.0/24 network.

```
R1#show ip route

<output omitted>

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.1.1.1/32 is directly connected, Loopback0
O       10.10.10.0/24 [110/65] via 192.168.10.2, 00:16:56, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.1.16/28 is directly connected, FastEthernet0/0
O       172.16.1.32/29 [110/65] via 192.168.10.6, 00:17:06, Serial0/0/1
     192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/128] via 192.168.10.6, 00:17:06, Serial0/0/1
                     [110/128] via 192.168.10.2, 00:16:56, Serial0/0/0
R1#
```

Step 2: Use the `show interfaces serial0/0/0` command on the R1 router to view the bandwidth of the Serial 0/0/0 interface.

```
R1#show interfaces serial0/0/0
Serial0/0/0 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 192.168.10.1/30
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load
1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
```

<output omitted>

On most serial links, the bandwidth metric will default to 1544 Kbits. If this is not the actual bandwidth of the serial link, the bandwidth will need to be changed so that the OSPF cost can be calculated correctly.

Step 3: Use the bandwidth command to change the bandwidth of the serial interfaces of the R1 and R2 routers to the actual bandwidth, 64 kbps.

```
R1 router:
R1(config)#interface serial0/0/0
R1(config-if)#bandwidth 64
R1(config-if)#interface serial0/0/1
R1(config-if)#bandwidth 64
```

R2 router:
```
R2(config)#interface serial0/0/0
R2(config-if)#bandwidth 64
R2(config)#interface serial0/0/1
R2(config-if)#bandwidth 64
```

Step 4: Use the `show ip ospf interface` command on the R1 router to verify the cost of the serial links.

The cost of each of the Serial links is now 1562, the result of the calculation: $10^8/64{,}000$ bps.

```
R1#show ip ospf interface

<output omitted>

Serial0/0/0 is up, line protocol is up
  Internet address is 192.168.10.1/30, Area 0
  Process ID 1, Router ID 10.1.1.1, Network Type POINT-TO-POINT, Cost:
1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:05
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1 , Adjacent neighbor count is 1
    Adjacent with neighbor 10.2.2.2
  Suppress hello for 0 neighbor(s)
Serial0/0/1 is up, line protocol is up
  Internet address is 192.168.10.5/30, Area 0
  Process ID 1, Router ID 10.1.1.1, Network Type POINT-TO-POINT, Cost:
1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,

<output omitted>
```

Step 5: Use the `ip ospf cost` command to configure the OSPF cost on the R3 router.
An alternative method to using the `bandwidth` command is to use the `ip ospf cost` command, which allows you to directly configure the cost. Use the `ip ospf cost` command to change the bandwidth of the serial interfaces of the R3 router to 1562.

```
R3(config)#interface serial0/0/0
R3(config-if)#ip ospf cost 1562
R3(config-if)#interface serial0/0/1
R3(config-if)#ip ospf cost 1562
```

Step 6: Use the `show ip ospf interface` command on the R3 router to verify that the cost of the link the cost of each of the Serial links is now 1562.

```
R3#show ip ospf interface

<output omitted>
```

```
Serial0/0/1 is up, line protocol is up
  Internet address is 192.168.10.10/30, Area 0
  Process ID 1, Router ID 10.3.3.3, Network Type POINT-TO-POINT, Cost:
1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:06
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1 , Adjacent neighbor count is 1
    Adjacent with neighbor 10.2.2.2
  Suppress hello for 0 neighbor(s)
Serial0/0/0 is up, line protocol is up
  Internet address is 192.168.10.6/30, Area 0
  Process ID 1, Router ID 10.3.3.3, Network Type POINT-TO-POINT, Cost:
1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
```

<output omitted>

Task 10: Redistribute an OSPF Default Route

Step 1: Configure a loopback address on the R1 router to simulate a link to an ISP.

```
R1(config)#interface loopback1

%LINK-5-CHANGED: Interface Loopback1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed
state to up

R1(config-if)#ip address 172.30.1.1 255.255.255.252
```

Step 2: Configure a static default route on the R1 router.

Use the loopback address that ha been configured to simulate a link to an ISP as the exit interface.

```
R1(config)#ip route 0.0.0.0 0.0.0.0 loopback1
R1(config)#
```

Step 3: Use the default-information originate command to include the static route in the OSPF updates that are sent from the R1 router.

```
R1(config)#router ospf 1
R1(config-router)#default-information originate
R1(config-router)#
```

Step 4: View the routing table on the R2 router to verify that the static default route is being redistributed via OSPF.

```
R2#show ip route

<output omitted>

Gateway of last resort is 192.168.10.1 to network 0.0.0.0

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.2.2.2/32 is directly connected, Loopback0
C       10.10.10.0/24 is directly connected, FastEthernet0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
O       172.16.1.16/28 [110/1563] via 192.168.10.1, 00:29:28,
Serial0/0/0
O       172.16.1.32/29 [110/1563] via 192.168.10.10, 00:29:28,
Serial0/0/1
     192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
O       192.168.10.4 [110/3124] via 192.168.10.10, 00:25:56,
Serial0/0/1
                    [110/3124] via 192.168.10.1, 00:25:56, Serial0/0/0
C       192.168.10.8 is directly connected, Serial0/0/1
O*E2 0.0.0.0/0 [110/1] via 192.168.10.1, 00:01:11, Serial0/0/0
R2#
```

Task 11: Configure Additional OSPF Features

Step 1: Use the `auto-cost reference-bandwidth` command to adjust the reference bandwidth value.
Increase the reference bandwidth to 10000 to simulate 10GigE speeds. Configure this command on all routers in the OSPF routing domain.

```
R1(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all
routers.

R2(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all
routers.


R3(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all
routers.
```
Step 2: Examine the routing table on the R1 router to verify the change in the OSPF cost metric.
Notice that the values are much larger cost values for OSPF routes.

```
R1#show ip route

<output omitted>
```

```
Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.1.1.1/32 is directly connected, Loopback0
O       10.10.10.0/24 [110/65635] via 192.168.10.2, 00:01:01,
Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.1.16/28 is directly connected, FastEthernet0/0
O       172.16.1.32/29 [110/65635] via 192.168.10.6, 00:00:51,
Serial0/0/1
     172.30.0.0/30 is subnetted, 1 subnets
C       172.30.1.0 is directly connected, Loopback1
     192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/67097] via 192.168.10.2, 00:01:01,
Serial0/0/0
S*   0.0.0.0/0 is directly connected, Loopback1
R1#
```

Step 3: Use the `show ip ospf neighbor` command on R1 to view the Dead Time counter.
The Dead Time counter is counting down from the default interval of 40 seconds.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time    Address
Interface
10.2.2.2          0   FULL/-          00:00:34     192.168.10.2
Serial0/0/0
10.3.3.3          0   FULL/-          00:00:34     192.168.10.6
Serial0/0/1
```

Step 4: Configure the OSPF Hello and Dead intervals.
The OSPF Hello and Dead intervals can be modified manually using the `ip ospf hello-interval` and `ip ospf dead-interval` interface commands. Use these commands to change the hello interval to 5 seconds and the dead interval to 20 seconds on the Serial 0/0/0 interface of the R1 router.

```
R1(config)#interface serial0/0/0
R1(config-if)#ip ospf hello-interval 5
R1(config-if)#ip ospf dead-interval 20
R1(config-if)#
01:09:04: %OSPF-5-ADJCHG: Process 1, Nbr 10.2.2.2 on Serial0/0/0 from
FULL to DOWN, Neighbor Down: Dead timer expired
01:09:04: %OSPF-5-ADJCHG: Process 1, Nbr 10.2.2.2 on Serial0/0/0 from
FULL to Down: Interface down or detached
```

After 20 seconds the Dead Timer on R1 expires. R1 and R2 loose adjacency because the Dead Timer and Hello Timers must be configured identically on each side of the serial link between R1 and R2.

Step 5: Modify the Dead Timer and Hello Timer intervals.
Modify the Dead Timer and Hello Timer intervals on the Serial 0/0/0 interface in the R2 router to match the intervals configured on the Serial 0/0/0 interface of the R1 router.

```
R2(config)#interface serial0/0/0
R2(config-if)#ip ospf hello-interval 5
R2(config-if)#ip ospf dead-interval 20
R2(config-if)#
01:12:10: %OSPF-5-ADJCHG: Process 1, Nbr 10.1.1.1 on Serial0/0/0 from
EXCHANGE to FULL, Exchange Done
```

Notice that the IOS displays a message when adjacency has been established with a state of Full.

Step 5: Use the `show ip ospf interface serial0/0/0` command to verify that the Hello Timer and Dead Timer intervals have been modified.

```
R2#show ip ospf interface serial0/0/0
Serial0/0/0 is up, line protocol is up
  Internet address is 192.168.10.2/30, Area 0
  Process ID 1, Router ID 10.2.2.2, Network Type POINT-TO-POINT, Cost:
1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 5, Dead 20, Wait 20, Retransmit 5
    Hello due in 00:00:00
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1 , Adjacent neighbor count is 1
    Adjacent with neighbor 10.1.1.1
  Suppress hello for 0 neighbor(s)
R2#
```

Step 6: Use the `show ip ospf neighbor` command on R1 to verify that the neighbor adjacency with R2 has been restored.
Notice that the Dead Time for Serial 0/0/0 is now much lower since it is counting down from 20 seconds instead of the default 40 seconds. Serial 0/0/1 is still operating with default timers.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State          Dead Time    Address
Interface
10.2.2.2          0   FULL/-         00:00:19     192.168.10.2
Serial0/0/0
10.3.3.3          0   FULL/-         00:00:34     192.168.10.6
Serial0/0/1
R1#
```

Task 12: Document the Router Configurations.

On each router, capture the following command output to a text file and save for future reference:
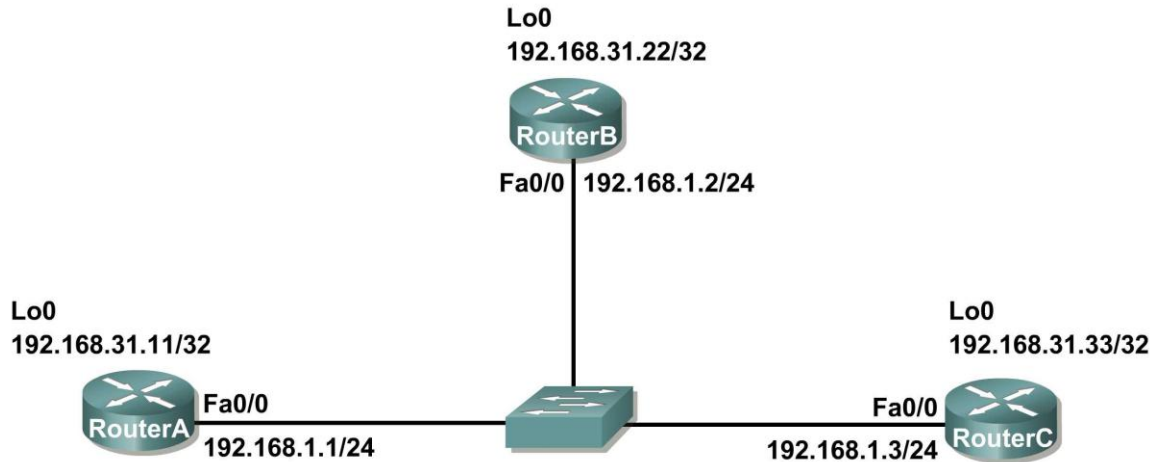
- Running configuration
- Routing table
- Interface summarization
- Output from **`show ip protocols`**

Task 11: 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.

Scenario B: Configure OSPF on a Multi-access Network

Topology Diagram

Lo0
192.168.31.22/32

RouterB

Fa0/0 | 192.168.1.2/24

Lo0
192.168.31.11/32

Lo0
192.168.31.33/32

Fa0/0
RouterA
192.168.1.1/24

Fa0/0
192.168.1.3/24 **RouterC**

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.1	255.255.255.0	N/A
	Loopback1	192.168.31.11	255.255.255.255	N/A
R2	Fa0/0	192.168.1.2	255.255.255.0	N/A
	Loopback1	192.168.31.22	255.255.255.255	N/A
R3	Fa0/0	192.168.1.3	255.255.255.0	N/A
	Loopback1	192.168.31.33	255.255.255.255	N/A

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.

In this topology we have three routers sharing a common Ethernet multiaccess network, 192.168.1.0/24. Each router will be configured with an IP address on the Fast Ethernet interface and a loopback address for the router ID.

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 a privileged 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 Ethernet and Loopback Addresses

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

Configure the Ethernet and Loopback interfaces on the R1, R2, and R3 routers with the IP addresses from the table under the Topology Diagram. Use the **`show ip interface brief`** command to verify that the IP addressing is correct. When you have finished, be sure to save the running configuration to the NVRAM of the router.

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.

Task 4: Configure OSPF on the DR Router

The DR and BDR election process takes place as soon as the first router has its interface enabled on the multiaccess network. This can happen as the routers are powered-on or when the OSPF **`network`** command for that interface is configured. If a new router enters the network after the DR and BDR have already been elected, it will not become the DR or BDR even if it has a higher OSPF interface priority or router ID than the current DR or BDR. Configure the OSPF process on the router with the highest router ID first to ensure that this router becomes the DR.

Step 1: Use the **`router ospf`** command in global configuration mode to enable OSPF on the R3 router.

Enter a process ID of 1 for the *`process-ID`* parameter. Configure the router to advertise the 192.168.1.0/24 network. Use an area ID of 0 for the OSPF *`area-id`* parameter in the **`network`** statement.

```
R3(config)#router ospf 1
R3(config-router)#network 192.168.1.0 0.0.0.255 area 0
R3(config-router)#end
R3#
```

Step 2: Use the **`show ip ospf interface`** command to verify that the OSPF has been configured correctly and that R3 is the DR.

```
R3#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.1.3/24, Area 0
```

```
    Process ID 1, Router ID 192.168.31.33, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.31.33, Interface address 192.168.1.3
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:07
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
R3#
```

Task 5: Configure OSPF on the BDR Router

Configure the OSPF process on the router with the second highest router ID next to ensure that
this router becomes the BDR.

Step 1: Use the `router ospf` command in global configuration mode to enable OSPF on the R2 router.

Enter a process ID of 1 for the *process-ID* parameter. Configure the router to advertise the
192.168.1.0/24 network. Use an area ID of 0 for the OSPF *area-id* parameter in the **network**
statement.

```
R2(config)#router ospf 1
R2(config-router)#network 192.168.1.0 0.0.0.255 area 0
R2(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#
00:08:51: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.33 on
FastEthernet0/0 from LOADING to FULL, Loading Done
```

Notice that an adjacency is formed with the R3 router. It may take up to 40 seconds for the R3
router to send a hello packet. When this packet is received, the neighbor relationship is formed.

Step 2: Use the `show ip ospf interface` command to verify that the OSPF has been configured correctly and that R2 is the BDR.

```
R2#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.1.2/24, Area 0
  Process ID 1, Router ID 192.168.31.22, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.31.33, Interface address 192.168.1.3
  Backup Designated Router (ID) 192.168.31.22, Interface address
192.168.1.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:03
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
```

```
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.1.3  (Designated Router)
  Suppress hello for 0 neighbor(s)
R2#
```

Step 3: Use the `show ip ospf neighbors` command in global configuration mode to view information about the other routers in the OSPF area.

Notice that R3 is the DR.

```
R2#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time    Address
Interface
192.168.31.33    1    FULL/DR         00:00:33     192.168.1.3
FastEthernet0/0
```

Task 6: Configure OSPF on the DRother Router

Configure the OSPF process on the router with the lowest router ID last. This router will be designated as DRother instead of DR or BDR.

Step 1: Use the `router ospf` command in global configuration mode to enable OSPF on the R1 router.
Enter a process ID of 1 for the *process-ID* parameter. Configure the router to advertise the 192.168.1.0/24 network. Use an area ID of 0 for the OSPF *area-id* parameter in the **network** statement.

```
R1(config)#router ospf 1
R1(config-router)#network 192.168.1.0 0.0.0.255 area 0
R1(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R1#
00:16:08: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from LOADING to FULL, Loading Done
00:16:12: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.33 on
FastEthernet0/0 from EXCHANGE to FULL, Exchange Done
```

Notice that an adjacency is formed with the R2 and R3 routers. It may take up to 40 seconds for both the R2 and R3 routers to each send a hello packet.

Step 2: Use the `show ip ospf interface` command to verify that the OSPF has been configured correctly and that R1 is a DRother.

```
R1#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.1.1/24, Area 0
  Process ID 1, Router ID 192.168.31.11, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State DROTHER, Priority 1
  Designated Router (ID) 192.168.31.33, Interface address 192.168.1.3
  Backup Designated Router (ID) 192.168.31.22, Interface address
192.168.1.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```

```
   Hello due in 00:00:00
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 2, Adjacent neighbor count is 2
    Adjacent with neighbor 192.168.31.33  (Designated Router)
    Adjacent with neighbor 192.168.31.22  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
R1#
```

Step 3: Use the `show ip ospf neighbors` command in global configuration mode to view information about the other routers in the OSPF area.

Notice that R3 is the DR and R2 is the BDR.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State          Dead Time   Address
Interface
192.168.31.22    1    FULL/BDR        00:00:35    192.168.1.2
FastEthernet0/0
192.168.31.33    1    FULL/DR         00:00:30    192.168.1.3
FastEthernet0/0
```

Task 7: Use the OSPF Priority to Determine the DR and BDR

Step 1: Use the `ip ospf priority interface` command to change the OSPF priority of the R1 router to 255.

This is the highest possible priority.

```
R1(config)#interface fastEthernet0/0
R1(config-if)#ip ospf priority 255
R1(config-if)#end
```

Step 2: Use the `ip ospf priority interface` command to change the OSPF priority of the R3 router to 100.

```
R3(config)#interface fastEthernet0/0
R3(config-if)#ip ospf priority 100
R3(config-if)#end
```

Step 3: Use the `ip ospf priority interface` command to change the OSPF priority of the R2 router to 0. A priority of 0 causes the router to be ineligible to participate in an OSPF election and become a DR or BDR.

```
R2(config)#interface fastEthernet0/0
R2(config-if)#ip ospf priority 0
R2(config-if)#end
```

Step 4: Shut down and re-enable the FastEthernet0/0 interfaces to force an OSPF election.
The FastEthernet0/0 interfaces of each of the routers can be shut down and re-enabled to force an OSPF election. Shut down the FastEthernet0/0 interface on each of the three routers. Notice that as the interfaces are shut down the OSPF adjacencies are lost.

R1:
```
R1(config)#interface fastethernet0/0
R1(config-if)#shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to
administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to down
02:17:22: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from FULL to Down: Interface down or detached
02:17:22: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.33 on
FastEthernet0/0 from FULL to Down: Interface down or detached
```

R2:
```
R2(config)#interface fastethernet0/0
R2(config-if)#shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to
administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to down
02:17:06: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.33 on
FastEthernet0/0 from FULL to Down: Interface down or detached
02:17:06: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.11 on
FastEthernet0/0 from FULL to Down: Interface down or detached
```

R3:
```
R3(config)#interface fastethernet0/0
R3(config-if)#shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to
administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to down
02:17:22: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from FULL to Down: Interface down or detached
02:17:22: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.11 on
FastEthernet0/0 from FULL to Down: Interface down or detached
```

Step 5: Re-enable the FastEthernet0/0 interface on the R2 router.

```
R2(config-if)#no shut
R2(config-if)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#
```

Step 6: Re-enable the FastEthernet0/0 interface on the R1 router.

Notice that an adjacency is formed with the R2 router. It may take up to 40 seconds for the R2 router to send a hello packet.

```
R1(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
```

```
R1(config-if)#end
%SYS-5-CONFIG_I: Configured from console by console
R1#
02:31:43: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from EXCHANGE to FULL, Exchange Done
```

Step 7: Use the `show ip ospf neighbor` command on the R1 router to view the OSPF neighbor information for that router.

Notice that even though the R2 router has a higher router ID than R1, the R2 router has been set to a state of DRother because the OSPF priority has been set to 0.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State            Dead Time    Address
Interface
192.168.31.22    0    FULL/DROTHER     00:00:33     192.168.1.2
FastEthernet0/0
R1#
```

Step 8: Re-enable the FastEthernet0/0 interface on the R3 router.

Notice that an adjacency is formed with the R1 and R2 routers. It may take up to 40 seconds for both the R1 and R2 routers to each send a hello packet.

```
R3(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
R3(config-if)#end
%SYS-5-CONFIG_I: Configured from console by console
02:37:32: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.11 on
FastEthernet0/0 from LOADING to FULL, Loading Done
02:37:36: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from EXCHANGE to FULL, Exchange Done
```

Step 9: Use the `show ip ospf interface` command on the R3 router to verify that R3 has become the BDR.

```
R3#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.1.3/24, Area 0
  Process ID 1, Router ID 192.168.31.33, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State BDR, Priority 100
  Designated Router (ID) 192.168.31.11, Interface address 192.168.1.1

<output omitted>
```

Task 8: 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 9: 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 11.6.2: Challenge OSPF Configuration Lab
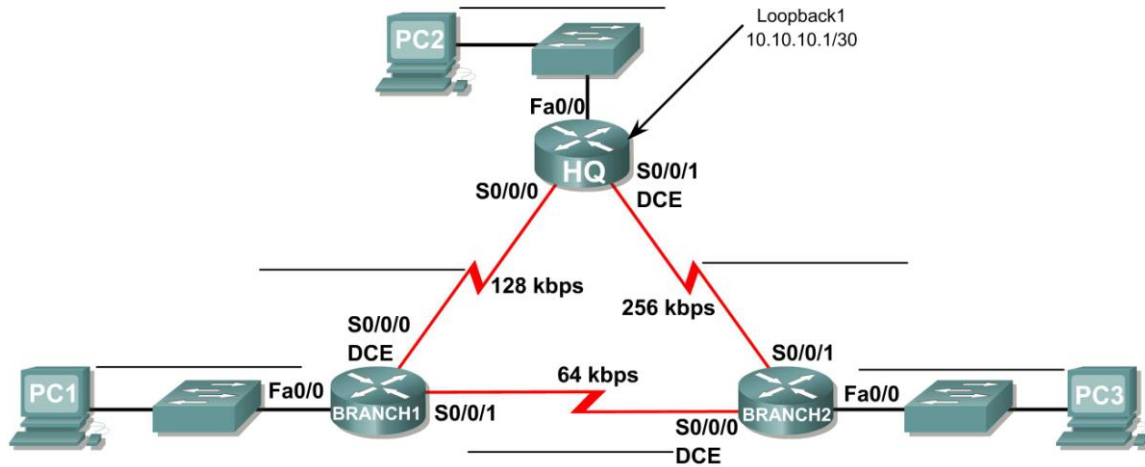
Topology Diagram

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
	Lo1	10.10.10.1	255.255.255.252	N/A
Branch1	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
Branch2	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
PC1	NIC			
PC2	NIC			
PC3	NIC			

Learning Objectives

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

- Create an efficient VLSM design given requirements
- Assign appropriate addresses to interfaces and document
- Cable a network according to the Topology Diagram
- Erase the startup configuration and reload a router to the default state
- Configure routers including OSPF
- Configure and propagate a static default route
- Verify OSPF operation
- Test and verify full connectivity
- Reflect upon and document the network implementation

Scenario

In this lab activity, you will be given a network address that must be subnetted using VLSM to complete the addressing of the network shown in the Topology Diagram. A combination OSPF routing and static routing will be required so that hosts on networks that are not directly connected will be able to communicate with each other. OSPF area ID of 0 and process ID of 1 will be used in all OSPF configurations.

Task 1: Subnet the Address Space.

Step 1: Examine the network requirements.

The addressing for the Network has the following requirements.

- The 172.20.0.0/16 network must be subnetted to provide addresses for the LANs and serial links.
  - The HQ LAN will require 8000 addresses
  - The Branch1 LAN will require 4000 addresses
  - The Branch2 LAN will require 2000 addresses
  - The links between the routers will require two addresses for each link
- The loopback address representing the link between the HQ router and the ISP will use the 10.10.10.0/30 network.

Step 2: Consider the following questions when creating your network design.

How many subnets need to be created from the 172.20.0.0/16 network? _____

How many total IP addresses are required from the 172.20.0.0/16 network? _____

What subnet mask will be used for the HQ LAN subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the Branch1 LAN subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the Branch2 LAN subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the links between the three routers? _____

What is the maximum number of host addresses that could be used on each of these subnets? _____

Step 3: Assign subnetwork addresses to the Topology Diagram.

1. Assign subnet 0 of the 172.20.0.0/16 network to the HQ LAN subnet. What is the network address of this subnet? _____

2. Assign subnet 1 of the 172.20.0.0/16 network to the Branch1 LAN subnet. What is the network address of this subnet? _____

3. Assign subnet 2 of the 172.20.0.0/16 network to the Branch2 LAN subnet. What is the network address of this subnet? _____

4. Assign subnet 3 of the 172.20.0.0/16 network to the link between the HQ and Branch1 routers. What is the network address of this subnet? _____

5. Assign subnet 4 of the 172.20.0.0/16 network to the link between the HQ and Branch2 routers. What is the network address of this subnet? _____

6. Assign subnet 5 of the 172.20.0.0/16 network to the link between the Branch1 and Branch2 routers. What is the network address of this subnet? _____

Task 2: Determine Interface Addresses.

Assign appropriate addresses to the device interfaces.

1. Assign the first valid host address in the 10.10.10.0/30 network to the Loopback 1 interface on the HQ router.

2. Assign the first valid IP address of the HQ LAN network to the LAN interface of the HQ router.

3. Assign the last valid IP address of the HQ LAN network to PC2.

4. Assign the first valid IP address of the Branch1 LAN network to the LAN interface of the Branch1 router.

5. Assign the last valid IP address of the Branch1 LAN network to PC1.
6. Assign the first valid IP address of the Branch2 LAN network to the LAN interface of the Branch2 router.

7. Assign the last valid IP address of the Branch2 LAN network to PC3.

8. Assign the first valid IP address of the HQ to Branch1 link network to the Serial 0/0/0 interface of the HQ router.

9. Assign the last valid IP address of the HQ to Branch1 link network to the Serial0/0/0 interface of the Branch router.

10. Assign the first valid IP address of the HQ to Branch2 link network to the Serial 0/0/1 interface of the HQ router.

11. Assign the last valid IP address of the HQ to Branch2 link network to the Serial0/0/1 interface of the Branch2 router.

12. Assign the first valid IP address of the Branch1 to Branch2 link network to the Serial 0/0/1 interface of the Branch1 router.

13. Assign the last valid IP address of the Branch1 to Branch2 link network to the Serial0/0/0 interface of the Branch2 router.

Document the addresses to be used in the table provided under the Topology Diagram.

Task 3: 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 as shown in the topology.

Step 2: Clear any existing configurations on the routers.

Task 4: Perform Basic Router Configurations.

Perform basic configuration of the BRANCH, HQ, and ISP 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.
7. Synchronize unsolicited messages and debug output with solicited output and prompts for the console and virtual terminal lines.
8. Configure an EXEC timeout of 15 minutes.

Task 5: Configure and Activate Serial and Ethernet Addresses.

Step 1: Configure the interfaces on the HQ, Branch1, and Branch2 routers with the IP addresses from the table provided under the Topology Diagram.

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

Step 2: Configure the Ethernet interfaces of PC1, PC2, and PC3 with the IP addresses from the table provided under the Topology Diagram.

Step 3: Configure the correct bandwidth for the serial interfaces on the Branch 1 router.

What commands are required to accomplish this?

_____

_____

_____

_____

_____

_____

Step 4: Configure the correct bandwidth for the serial interfaces on the Branch 2 router.

What commands are required to accomplish this?

_____

_____

_____

_____

_____

_____

Step 5: Configure the correct bandwidth for the serial interfaces on the HQ router.

What commands are required to accomplish this?

_____

_____

_____

_____

_____

_____

Task 6: Verify Connectivity to Next Hop Device.

You should NOT have connectivity between end devices yet. However, you can test connectivity between two routers and between and end device and its default gateway.

Step 1: Verify that the HQ, Branch1, and Branch2 routers can ping each of the neighboring routers across the WAN links.

Step 2: Verify that PC1, PC2, and PC3 can ping their respective default gateway.

Task 7: Configure OSPF Routing on the Branch1 Router.

Step 1: Consider the networks that need to be included in the OSPF updates that are sent out by the Branch1 router.

What directly connected networks are present in the Branch1 routing table?

_____

_____

_____

What commands are required to enable OSPF and include the connected networks in the routing updates?

_____

_____

_____

_____

_____

Are there any router interfaces that do not need to have OSPF updates sent out? _____

What command is used to disable OSPF updates on these interfaces?

_____

Task 8: Configure OSPF and Static Routing on the HQ Router.

Step 1: Consider the type of static routing that is needed on HQ.

A static default route will need to be configured to send all packets with destination addresses that are not in the routing table to the loopback address representing the link between the HQ router and the ISP. What command is needed to accomplish this?

_____

What directly connected networks are present in the HQ routing table?

_____

_____

_____

_____

_____

Will the networks of the HQ LAN and the links between the Branch 1 and Branch2 routers need to have the subnet mask information included in the network statements? _____

What commands are required to enable OSPF and include the appropriate networks in the routing updates?

_____

_____

_____

_____

_____

_____

Are there any router interfaces that do not need to have OSPF updates sent out? _____

What command is used to disable OSPF updates on these interfaces?

_____

_____

The HQ router needs to send the default route information to the Branch1 and Branch2 routers in the OSPF updates. What command is used to configure this?

_____

Task 9: Configure OSPF Routing on the Branch2 Router.

Step 1: Consider the networks that need to be included in the OSPF updates that are sent out by the Branch2 router.

What directly connected networks are present in the Branch2 routing table?

_____

_____

_____

What commands are required to enable OSPF and include the connected networks in the routing updates?

_____

_____

_____

_____

_____

Are there any router interfaces that do not need to have OSPF updates sent out? _____

What command is used to disable OSPF updates on these interfaces?

_____

Task 10: Verify the Configurations

Answer the following questions to verify that the network is operating as expected.

From PC1, is it possible to ping PC2? _____

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

The answer to the above questions should be 'yes'. If any of the above pings failed, check your physical connections and configurations. Refer to your basic troubleshooting techniques used in the [Chapter 1] labs.

What OSPF routes are present in the routing table of the Branch1 router?

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the Branch1 router?

_____

What OSPF routes are present in the routing table of the HQ router?

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the HQ router?

_____

What OSPF routes are present in the routing table of the Branch2 router?

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the Branch2 router?

_____

Task 11: Reflection

On PC1, use the **tracert** command to examine the route that is used between PC1 and PC3.

What are the hops in the route to PC3?

_____

_____

_____

_____

Is this the least number of hops that can be used to reach PC3? _____

If the answer is no, why is a path with more than the minimum amount of hops used?

_____

_____

_____

_____

_____

_____

Task 12: 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 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.

Lab 11.6.3: OSPF Troubleshooting Lab

Topology Diagram
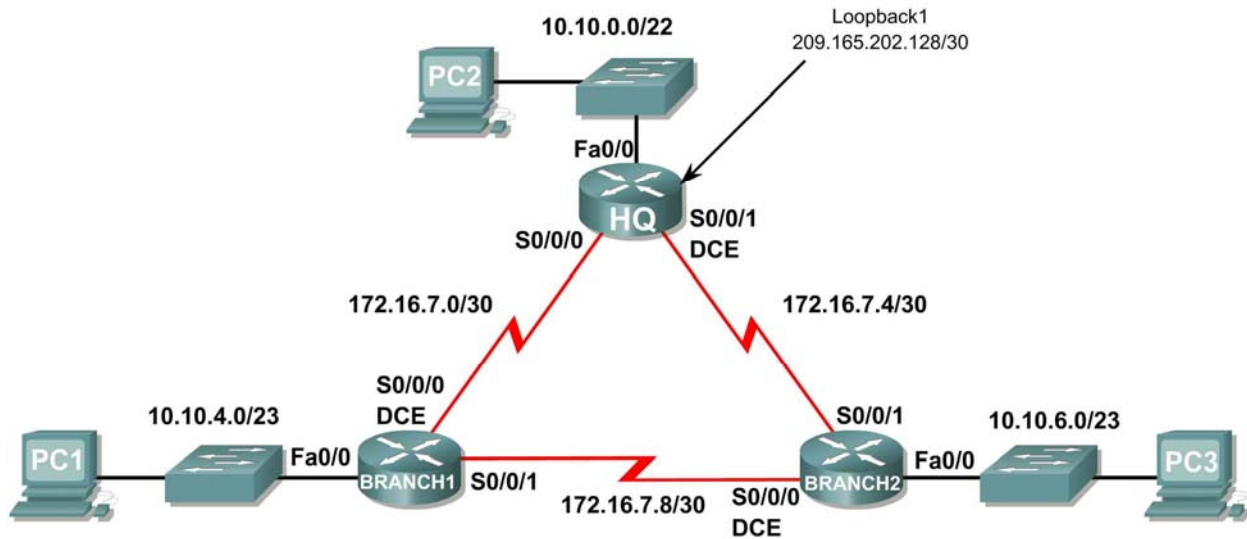
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0	10.10.0.1	255.255.252.0	N/A
	S0/0/0	172.16.7.1	255.255.255.252	N/A
	S0/0/1	172.16.7.5	255.255.255.252	N/A
	Lo1	209.165.202.129	255.255.255.252	N/A
Branch1	Fa0/0	10.10.4.1	255.255.254.0	N/A
	S0/0/0	172.16.7.2	255.255.255.252	N/A
	S0/0/1	172.16.7.9	255.255.255.252	N/A
Branch2	Fa0/0	10.10.6.1	255.255.254.0	N/A
	S0/0/0	172.16.7.10	255.255.255.252	N/A
	S0/0/1	172.16.7.6	255.255.255.252	N/A
PC1	NIC	10.10.5.254	255.255.254.0	10.10.4.1
PC2	NIC	10.10.3.254	255.255.252.0	10.10.0.1
PC3	NIC	10.10.7.254	255.255.254.0	10.10.6.1

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.
- Load the routers with supplied scripts.
- Discover where communication is not possible.
- Gather information about the misconfigured portion of the network along with any other errors.
- Analyze information to determine why communication is not possible.
- Propose solutions to network errors.
- Implement solutions to network errors.
- Document the corrected network.

Scenario

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

The network should also have the following requirements met:

- OSPF routing is configured on the Branch1 router.
- OSPF routing is configured on the Branch2 router.
- OSPF routing is configured on the HQ router.
- OSPF updates must be disabled on the LAN and Loopback interfaces.
- The HQ router must redistribute the default route to the Loopback interface in the routing updates.
- All OSPF routers must use a process ID of 1.
- All OSPF routers must be in area 0.

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 the 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 the Branch1 router:

```
hostname Branch1
!
no ip domain-lookup
!
```

```
interface FastEthernet0/0
ip address 10.10.4.1 255.255.254.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
ip address 172.16.7.2 255.255.255.252
 no shutdown
!
interface Serial0/0/1
 ip address 172.16.7.9 255.255.255.252
 no shutdown
!
router ospf 1
 passive-interface FastEthernet0/0
 network 10.10.4.0 0.0.1.255 area 0
 network 172.16.7.0 0.0.0.3 area 0
 network 172.16.7.8 0.0.0.3 area 0
!
ip classless
!
line con 0
line vty 0 4
 login
!
end
```

Step 2: Load the following script onto the Branch2 router.

```
hostname Branch2
!
interface FastEthernet0/0
 ip address 10.10.6.1 255.255.254.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 172.16.7.10 255.255.255.252
 clock rate 64000
 no shutdown
!
interface Serial0/0/1
 ip address 172.16.7.6 255.255.255.252
!
router ospf 1
 log-adjacency-changes
 passive-interface Serial0/0/1
 network 172.16.7.4 0.0.0.3 area 0
 network 172.16.7.8 0.0.0.3 area 0
 network 10.10.6.0 0.0.3.255 area 0
!
ip classless
!
line con 0
```

```
line vty 0 4
 login
!
end
```

Step 3: Load the following script onto the HQ router.

```
hostname HQ
!
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 10.10.10.1 255.255.252.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 172.16.7.1 255.255.255.252
 no shutdown
!
interface Serial0/0/1
 ip address 172.16.7.5 255.255.255.252
 clock rate 64000
 no shutdown
!
interface Loopback1
 ip address 209.165.202.129 255.255.255.252
!
router ospf 1
 log-adjacency-changes
 passive-interface FastEthernet0/0
 passive-interface Loopback1
 network 172.16.7.0 0.0.0.3 area 0
 network 172.16.7.4 0.0.0.3 area 0
 network 10.10.0.0 0.0.7.255 area 0
!
ip classless
ip route 0.0.0.0 0.0.0.0 loopback1
!
line con 0
line vty 0 4
 login
!
end
```

Task 3: Troubleshoot the Branch1 Router

Step 1: Begin troubleshooting at the Host connected to the Branch1 router.

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

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

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

Step 2: Examine the Branch1 router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors on the Branch1 router? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the Branch1 router.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

_____

Does the information in routing table indicate any configuration errors on the Branch1 router, or will it be necessary to troubleshoot the configurations on the other two routers to correct the errors?

_____

_____

Step 6: Attempt to ping between the hosts again.

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

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

From the host PC1, is it possible to ping the Serial 0/0/0 interface of the HQ router? _____

From the host PC1, is it possible to ping the Serial 0/0/1 interface of the HQ router? _____

Task 4: Troubleshoot the HQ Router

Step 1: Begin troubleshooting at the host PC2.

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

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

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

Step 2: Examine the HQ router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

_____

Are there any problems with the interface status that could be due to errors on other parts of the network?

_____

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors on the HQ router? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the HQ router.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

_____

Use the `show running-configuration`, `show ip protocols`, and `show ip ospf neighbor`
commands to view information about the OSPF configuration on the HQ router. Are there any additional
problems with the OSPF configuration?

_____

_____

_____

_____

If there are any problems with the OSPF configuration, record any commands that will be necessary to
correct the configuration errors.

_____

_____

_____

_____

_____

_____

Are there any problems on the HQ router that could be due to errors on other parts of the network?

_____

_____

_____

_____

Step 6: If you have recorded any commands above; apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors on the HQ router? _____

If the answer to either of this is **yes**, troubleshoot the routing configuration again.

Step 8: Attempt to ping between the hosts again.

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

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

From the host PC2, is it possible to ping the Serial 0/0/0 interface of the Branch2 router? _____

From the host PC2, is it possible to ping the Serial 0/0/1 interface of the Branch2 router? _____

Task 5: Troubleshoot the Branch2 Router

Step 1: Begin troubleshooting at the Host PC3.

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

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

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

From the host PC3, is it possible to ping the Serial0/0/1 interface of the Branch 2 router? _____

Step 2: Examine the Branch2 router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors on the Branch router? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the Branch2 router.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table?

_____

_____

Use the `show running-configuration`, `show ip protocols`, and `show ip ospf neighbor`
commands to view information about the OSPF configuration on the Branch2 router. Are there any
problems with the OSPF configuration?

_____

_____

_____

_____

If there are any problems with the OSPF configuration, record any commands that will be necessary to
correct the configuration errors.

_____

_____

_____

_____

_____

_____

Step 6: If you have recorded any commands above; apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors on the Branch2 router? _____

If the answer to this question is **yes**, troubleshoot the routing configuration again.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

_____

Step 8: Attempt to ping between the hosts again.

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

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

From the host PC3, is it possible to ping the Serial 0/0/0 interface of the Branch1 router? _____

From the host PC3, is it possible to ping the Serial 0/0/1 interface of the Branch1 router? _____

Task 6: Reflection

There were a number of configuration errors in the scripts that were provided for this lab. Use the space below to write a brief description of the errors that you found.

_____

_____

_____

_____

_____

_____

_____

_____

Task 7: 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 8: 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.