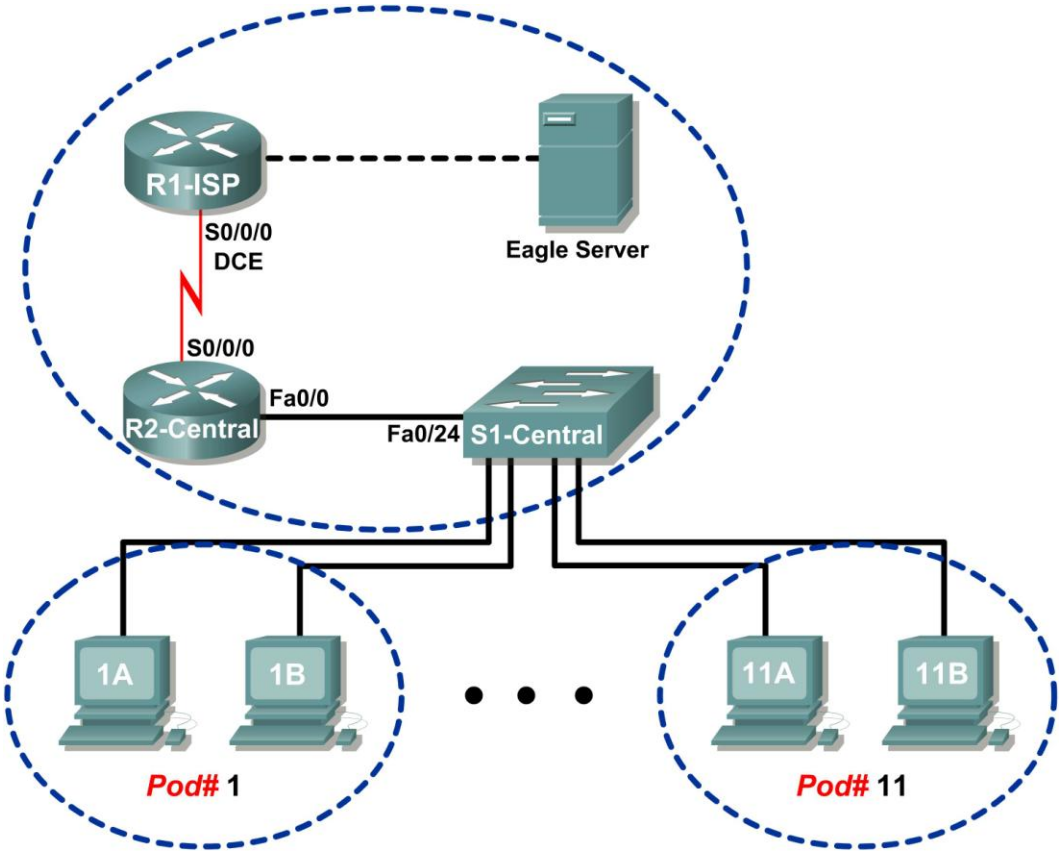
Lab 5.5.1: Examining a Device's Gateway

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
host*Pod#***A**	N/A	172.16.*Pod#*.1	255.255.0.0	172.16.255.254
host*Pod#***B**	N/A	172.16.*Pod#*.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Understand and explain the purpose of a gateway address.
- Understand how network information is configured on a Windows computer.
- Troubleshoot a hidden gateway address problem.

Background

An IP address is composed of a network portion and a host portion. A computer that communicates with another device must first know how to reach the device. For devices on the same local area network (LAN), the host portion of the IP address is used as the identifier. The network portion of the destination device is the same as the network portion of the host device.

However, devices on different networks have different source and destination network numbers. The network portion of the IP address is used to identify when a packet must be sent to a gateway address, which is assigned to a network device that forwards packets between distant networks.

A router is assigned the gateway address for all the devices on the LAN. One purpose of a router is to serve as an entry point for packets coming into the network and exit point for packets leaving the network.

Gateway addresses are very important to users. Cisco estimates that 80 percent of network traffic will be destined to devices on other networks, and only 20 percent of network traffic will go to local devices. This is called the 80/20 rule. Therefore, if a gateway cannot be reached by the LAN devices, users will not be able to perform their job.

Scenario

Pod host computers must communicate with Eagle Server, but Eagle Server is located on a different network. If the pod host computer gateway address is not configured properly, connectivity with Eagle Server will fail.

Using several common utilities, network configuration on a pod host computer will be verified.

Task 1: Understand and Explain the Purpose of a Gateway Address.

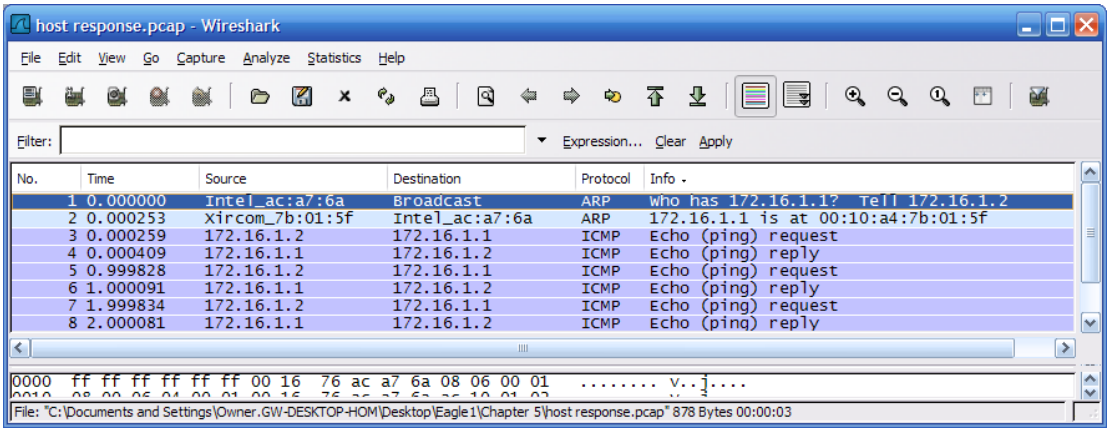


Figure 1. Communication Between LAN Devices

For local area network (LAN) traffic, the gateway address is the address of the Ethernet interface connected to the LAN. Figure 1 shows two devices on the same network communicating with the **`ping`**

command. Any device that has the same network address—in this example, 172.16.0.0—is on the same LAN.

Referring to Figure 1, what is the MAC address of the network device on IP address 172.16.1.1?

00:10:a4:7b:01:5f

There are several Windows commands that will display a network gateway address. One popular command is **netstat -r**. In the following transcript, the **netstat -r** command is used to view the gateway addresses for this computer. The top highlight shows what gateway address is used to forward all network packets destined outside of the LAN. The "quad-zero" Network Destination and Netmask values, 0.0.0.0 and 0.0.0.0, refer to *any* network not specifically known. For any non-local network, this computer will use 172.16.255.254 as the default gateway. The second yellow highlight displays the information in human-readable form. More specific networks are reached through other gateway addresses. A local interface, called the loopback interface, is automatically assigned to the 127.0.0.0 network. This interface is used to identify the local host to local network services. Refer to the gray highlighted entry. Finally, any device on network 172.16.0.0 is accessed through gateway 172.16.1.2, the IP address for this Ethernet interface. This entry is highlighted in green.

```
C:\>netstat -r

Route Table
===========================================================================
Interface List
0x1 ........................... MS TCP Loopback interface
0x20005 ...00 16 76 ac a7 6a  Intel(R) 82562V 10/100 Network Connection
===========================================================================
===========================================================================
Active Routes:
Network Destination        Netmask          Gateway       Interface  Metric
          0.0.0.0          0.0.0.0    172.16.255.254    172.16.1.2    1
        127.0.0.0        255.0.0.0        127.0.0.1    127.0.0.1    1
      172.16.0.0      255.255.0.0        172.16.1.2    172.16.1.2   20
      172.16.1.2  255.255.255.255        127.0.0.1    127.0.0.1   20
  172.16.255.255  255.255.255.255        172.16.1.2    172.16.1.2   20
255.255.255.255  255.255.255.255        172.16.1.2    172.16.1.2    1
Default Gateway:    172.16.255.254
===========================================================================
Persistent Routes:
  None
C:\>
```

Step 1: Open a terminal window on a pod host computer.

What is the default gateway address?

172.16.255.254

Step 2: Use the ping command to verify connectivity with IP address 127.0.0.1.

Was the ping successful? yes

Step 3: Use the `ping` command to ping different IP addresses on the `127.0.0.0` network, `127.10.1.1`, and `127.255.255.255`.

Were responses successful? If not, why?

yes for 127.10.1.1

No for 127.255.255.255 that is the broadcast address

A default gateway address permits a network device to communicate with other devices on different networks. In essence, it is the door to other networks. All traffic destined to different networks must go through the network device that has the default gateway address.

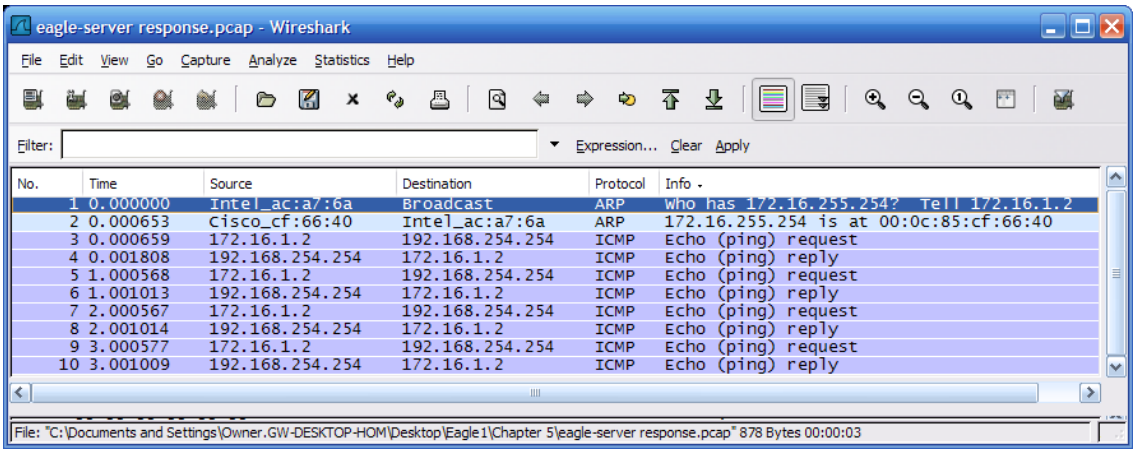


Figure 2. Communication Between Devices on Different Networks

As shown in Figure 2, communication between devices on different networks is different than on a LAN. Pod host computer #2, IP address `172.16.1.2`, initiates a ping to IP address `192.168.254.254`. Because network `172.16.0.0` is different from `192.168.254.0`, the pod host computer requests the MAC address of the default gateway device. This gateway device, a router, responds with its MAC address. The computer composes the Layer 2 header with the destination MAC address of the router and places frames on the wire to the gateway device.

Referring to Figure 2, what is the MAC address of the gateway device?

00:0c:85:cf:66:40

Referring to Figure 2, what is the MAC address of the network device with IP address 192.168.254.254?

Two different networks

Task 2: Understand how Network Information is Configured on a Windows Computer.

Many times connectivity issues are attributed to wrong network settings. In troubleshooting connectivity issues, several tools are available to quickly determine the network configuration for any Windows computer.

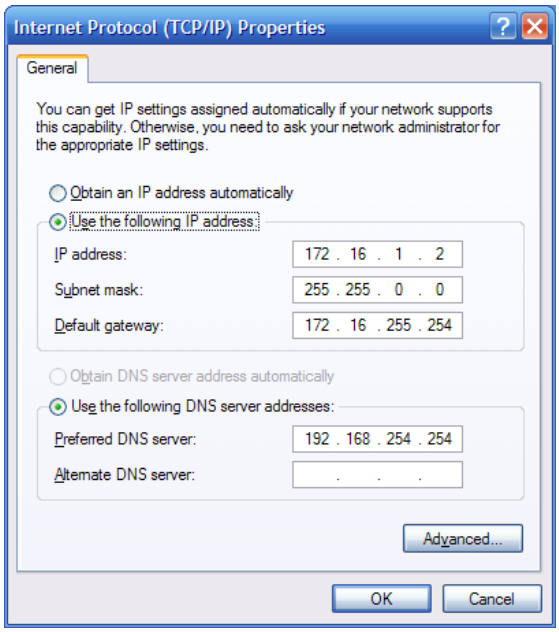


Figure 3. Network Interface with Static IP Address

Step 1: Examine network properties settings.

One method that may be useful in determining the network interface IP properties is to examine the pod host computer's Network Properties settings. To access this window:

1. Click **Start > Control Panel > Network Connections**.
2. Right-click **Local Area Connection**, and choose **Properties**.
3. On the **General** tab, scroll down the list of items in the pane, select **Internet Protocol (TCP/IP)**, and click the **Properties** button. A window similar to the one in Figure 3 will be displayed.

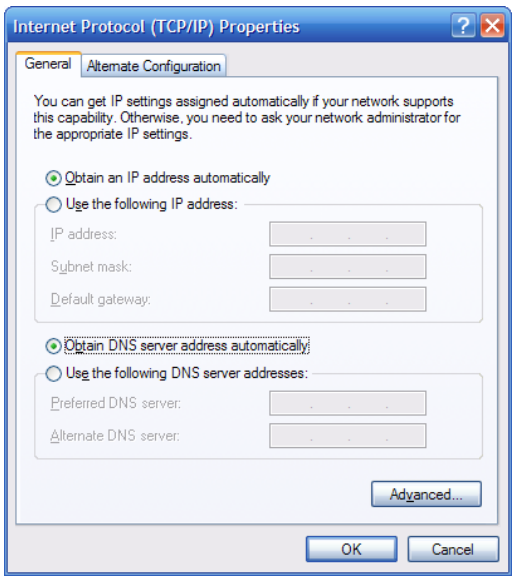


Figure 4. Network Interface with Dynamic IP Address

However, a dynamic IP address may be configured, as shown in Figure 4. In this case, the Network Properties settings window is not very useful for determining IP address information.

A more consistently reliable method for determining network settings on a Windows computer is to use the **ipconfig** command:

```
C:\ >ipconfig
Windows IP Configuration
Ethernet adapter Local Area Connection:
        Connection-specific DNS Suffix  . :
      1 IP Address. . . . . . . . . . . . : 172.16.1.2
      2 Subnet Mask . . . . . . . . . . . : 255.255.0.0
      3 Default Gateway . . . . . . . . . : 172.16.255.254
```

❶ IP address for this pod host computer
❷ Subnet mask
❸ Default gateway address

There are several options available with the **ipconfig** command, accessible with the command **ipconfig /?**. To show the most information about the network connections, use the command **ipconfig /all**.

```
C:\>ipconfig /all
Windows IP Configuration
        Host Name . . . . . . . . . . . . : GW-desktop-hom
        Primary Dns Suffix  . . . . . . . :
        Node Type . . . . . . . . . . . . : Unknown
        IP Routing Enabled. . . . . . . . : No
        WINS Proxy Enabled. . . . . . . . : No
Ethernet adapter Local Area Connection:
        Connection-specific DNS Suffix  . :
        Description . . . . . . . . . . . : Intel(R) 82562V 10/100
Network Connection
        Physical Address. . . . . . . . . : 00-16-76-AC-A7-6A
        Dhcp Enabled. . . . . . . . . . . : No
        IP Address. . . . . . . . . . . . : 172.16.1.2
        Subnet Mask . . . . . . . . . . . : 255.255.0.0
        Default Gateway . . . . . . . . . : 172.16.255.254
      1 DNS Servers . . . . . . . . . . . : 192.168.254.254
C:\ >
```

❶ Domain name server IP address

Step 2: Using the command ipconfig /all, fill in the following table with information from your pod host computer:

Description	Address
IP Address	10.100.8.72
Subnet Mask	255.255.0.0
Default Gateway	172.16.255.254
DNS Server	192.168.254.254

Task 3: Troubleshoot a Hidden Gateway Address Problem.

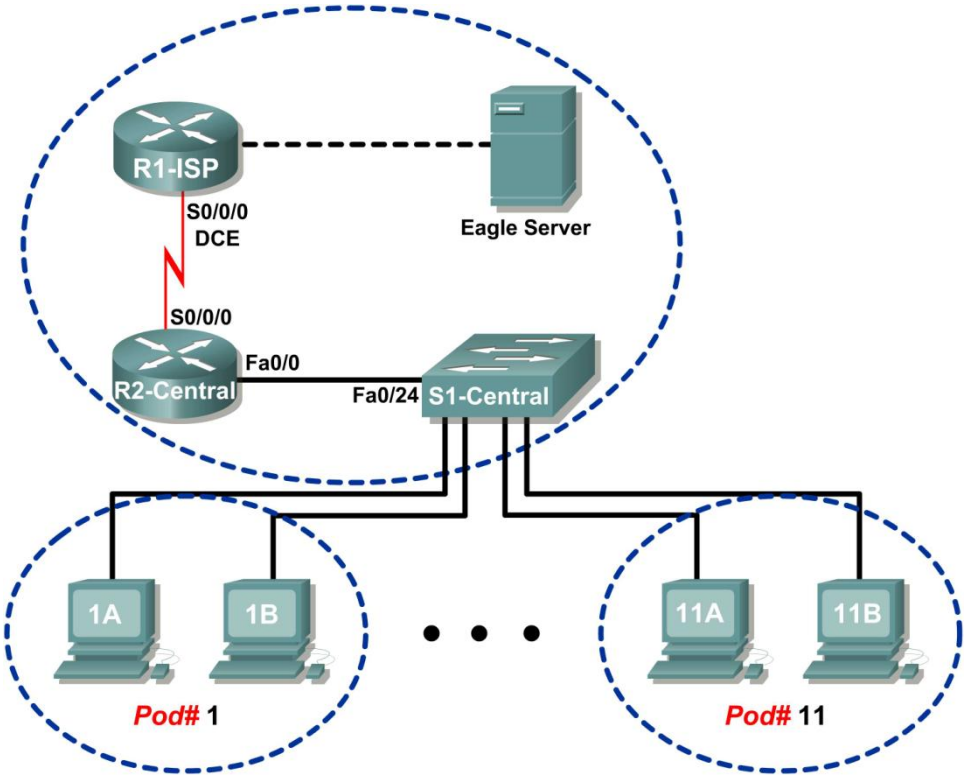


Figure 5. Topology Diagram

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
host*Pod#***A**	N/A	172.16.*Pod#*.1	255.255.0.0	172.16.255.254
host*Pod#***B**	N/A	172.16.*Pod#*.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Table 1. Logical Address Assignments

When troubleshooting network issues, a thorough understanding of the network can often assist in identifying the real problem. Refer to the network topology in Figure 5 and the logical IP address assignments in Table 1.

As the 3rd shift help desk Cisco engineer, you are asked for assistance from the help desk technician. The technician received a trouble ticket from a user on computer host-1A, complaining that computer host-11B, `host-11B.example.com`, does not respond to pings. The technician verified the cables and network settings on both computers, but nothing unusual was found. You check with the corporate network engineer, who reports that R2-Central has been temporarily brought down for a hardware upgrade.

Nodding your head in understanding, you ask the technician to ping the IP address for host-11B, `172.16.11.2` from host-1A. The pings are successful. Then, you ask the technician to ping the gateway IP address, `172.16.255.254`, and the pings fail.

What is wrong?

r2-central gateway is down. DNS server is needed and cannot be reached without r-2 gateway.

You instruct the help desk technician to tell the user to use the IP address for host-11B temporarily, and the user is able to establish connectivity with the computer. Within the hour the gateway router is back on line, and normal network operation resumes.

Task 4: Reflection

A gateway address is critical to network connectivity, and in some instances LAN devices require a default gateway to communicate with other devices on the LAN.

Using Windows command line utilities such as **`netstat -r`** and **`ipconfig /all`** will report gateway settings on host computers.

Task 5: Challenge

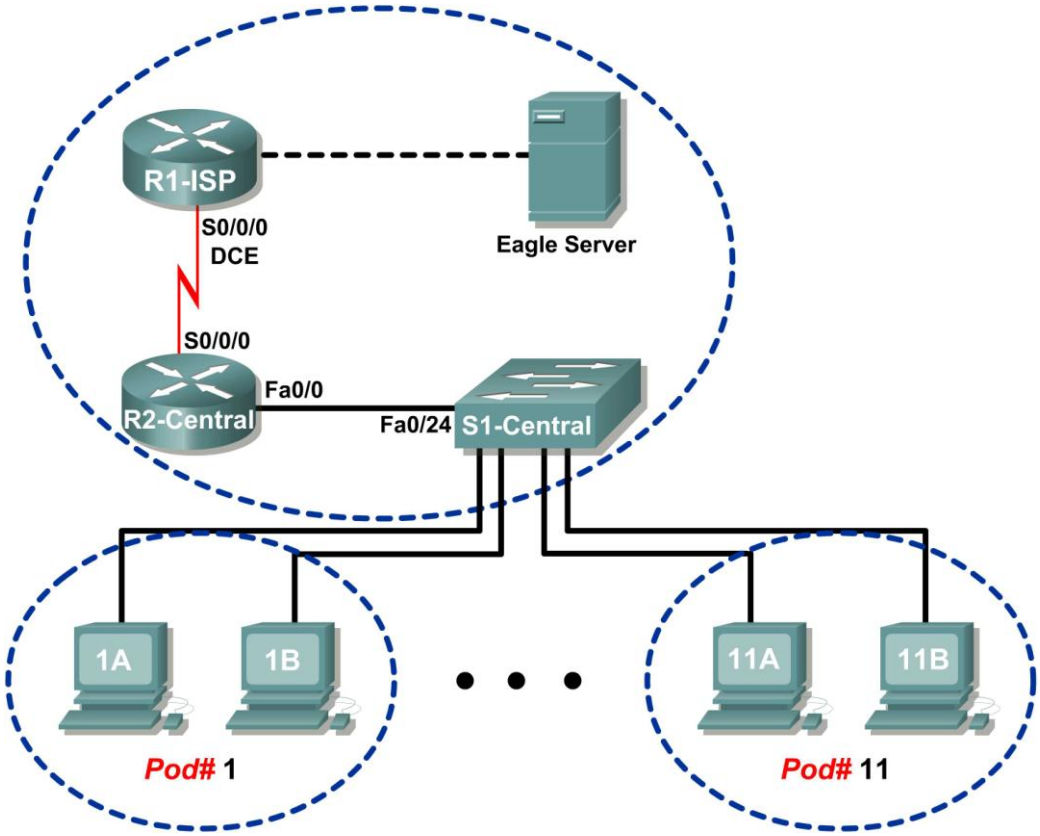
Use Wireshark to capture a ping between two pod host computers. It may be necessary to restart the host computer to flush the DNS cache. First, use the hostname of the destination pod computer for DNS to reply with the destination IP address. Observe the communication sequence between network devices, especially the gateway. Next, capture a ping between network devices using only IP addresses. The gateway address should not be needed.

Task 6: Clean Up.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 5.5.2: Examining a Route

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
host*Pod#***A**	N/A	172.16.*Pod#*.1	255.255.0.0	172.16.255.254
host*Pod#***B**	N/A	172.16.*Pod#*.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Use the **route** command to modify a Windows computer routing table.
- Use a Windows Telnet client command **telnet** to connect to a Cisco router.
- Examine router routes using basic Cisco IOS commands.

Background

For packets to travel across a network, a device must know the route to the destination network. This lab will compare how routes are used in Windows computers and the Cisco router.

Some routes are added to routing tables automatically, based upon configuration information on the network interface. The device considers a network directly connected when it has an IP address and network mask configured, and the network route is automatically entered into the routing table. For networks that are not directly connected, a default gateway IP address is configured that will send traffic to a device that should know about the network.

Scenario

Using a pod host computer, examine the routing table with the **route** command and identify the different routes and gateway IP address for the route. Delete the default gateway route, test the connection, and then add the default gateway route back to the host table.

Use a pod host computer to telnet into R2-Central, and examine the routing table.

Task 1: Use the route Command to Modify a Windows Computer Routing Table.

```
C:\>netstat -r

Route Table
===========================================================================
Interface List
0x1 ........................... MS TCP Loopback interface
0x20005 ...00 16 76 ac a7 6a  Intel(R) 82562V 10/100 Network Connection
===========================================================================
===========================================================================
Active Routes:
Network Destination     Netmask        Gateway     Interface  Metric
        0.0.0.0          0.0.0.0   172.16.255.254  172.16.1.2   1
      127.0.0.0        255.0.0.0        127.0.0.1   127.0.0.1   1
     172.16.0.0      255.255.0.0       172.16.1.2  172.16.1.2  20
     172.16.1.2  255.255.255.255        127.0.0.1   127.0.0.1  20
 172.16.255.255  255.255.255.255       172.16.1.2  172.16.1.2  20
255.255.255.255  255.255.255.255       172.16.1.2  172.16.1.2   1
Default Gateway:    172.16.255.254
===========================================================================
Persistent Routes:
  None
C:\>
```

Figure 1. Output of the netstat Command

Shown in Figure 1, output from the **netstat -r** command is useful to determine route and gateway information.

Step 1: Examine the active routes on a Windows computer.

A useful command to modify the routing table is the **route** command. Unlike the **netstat –r** command, the **route** command can be used to view, add, delete, or change routing table entries. To view detailed information about the **route command,** use the option **route /?**.

An abbreviated option list for the **route** command is shown below:

```
route PRINT       Prints active routes
route ADD         Adds a route:
                  route ADD network MASK mask gateway
route DELETE      Deletes a route:
                  route DELETE network
route CHANGE      Modifies an existing route
```

To view active routes, issue the command **route PRINT**:

```
C:\ >route PRINT
===========================================================================
Interface List
0x1 ........................... MS TCP Loopback interface
0x70003 ...00 16 76 ac a7 6a .Intel(R) 82562V 10/100 Network Connection
===========================================================================
===========================================================================
Active Routes:
Network Destination    Netmask          Gateway       Interface  Metric
        0.0.0.0          0.0.0.0  172.16.255.254      172.16.1.2     1
      127.0.0.0        255.0.0.0       127.0.0.1       127.0.0.1     1
     172.16.0.0      255.255.0.0      172.16.1.2      172.16.1.2    20
     172.16.1.2  255.255.255.255       127.0.0.1       127.0.0.1    20
 172.16.255.255  255.255.255.255      172.16.1.2      172.16.1.2    20
255.255.255.255  255.255.255.255      172.16.1.2      172.16.1.2     1
Default Gateway:    172.16.255.254
===========================================================================
Persistent Routes:
  None
C:\>
```

Verify network connectivity to Eagle Server:

```
C:\> ping eagle-server.example.com
Pinging eagle-server.example.com [192.168.254.254] with 32 bytes
of data:

Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63

Ping statistics for 192.168.254.254:
   Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
   Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>
```

What is the gateway address to `eagle-server.example.com`?

172.16.255.254

Step 2: Delete a route from the Windows computer routing table.

How important is the default gateway route? Delete the gateway route, and try to ping Eagle Server. The syntax to remove the default gateway route is:

```
route DELETE network

C:/> route DELETE 0.0.0.0
```

Examine the active routing table and verify that the default gateway route has been removed:

What is the default gateway IP address?

There is no default route

Try to ping Eagle Server. What are the results?

eagle server cannot be reached

If the default gateway IP address is removed, how can the DNS server be reached to resolve `eagle-server.example.com`?

Can other LAN devices be reached, such as `172.16.255.254`?

yes as long as they are on the same lan

Step 3: Insert a route into the Windows computer routing table.

In the following configuration, use the IP address assigned to your host pod interface. The syntax to add a route to the Windows computer routing table is:

```
route ADD network MASK mask gateway-IP address

C:/> route ADD 0.0.0.0 MASK 0.0.0.0 172.16.255.254
```

Examine the active routing table, and verify that the default gateway route has been restored:

Has the default gateway route been restored? yes:

Try to ping Eagle Server. What are the results?

successful

Task 2: Use a Windows Telnet Client Command `telnet` to Connect to a Cisco Router.

In this task, you will telnet into the R2-Central router and use common IOS commands to examine the router routing table. Cisco devices have a Telnet server and, if properly configured, will permit remote logins. Access to the router is restricted, however, and requires a username and password. The password for all usernames is `cisco`. The username depends on the pod. Username `ccna1` is for users on pod 1 computer, `ccna2` is for students on pod 2 computers, and so on.

Step 1: Using the Windows Telnet client, log in to a Cisco router.

Open a terminal window by clicking **Start > Run**. Type `cmd`, and click **OK**. A terminal window and prompt should be available. The Telnet utility has several options and can be viewed with the **`telnet /?`** command. A username and password will be required to log in to the router. For all usernames, the corresponding password is `cisco`.

Pod Number	Username
1	ccna1
2	ccna2
3	ccna3
4	ccna4
5	ccna5
6	ccna6
7	ccna7
8	ccna8
9	Ccna9
10	ccna10
11	ccna11

To start a Telnet session with router R2-central, type the command:

```
C:/> telnet 172.16.255.254 <ENTER>
```

A login window will prompt for a username, as shown below. Enter the applicable username, and press **<ENTER>**. Enter the password, `cisco`, and press **<ENTER>**. The router prompt should be visible after a successful login.

```
**************************************************************
                This is Eagle 1 lab router R2-Central.
                Authorized access only.
**************************************************************

User Access Verification

Username: ccna1
Password: cisco (hidden)
R2-Central#
```

At the prompt, `R2-Central#`, a successful Telnet login has been created. Only limited permissions for `ccnax` usernames are available; therefore, it is not possible to modify router settings or view the configuration. The purpose of this task was to establish a Telnet session, which has been accomplished. In the next task, the router routing table will be examined.

Task 3: Examine Router Routes using Basic Cisco IOS Commands.

As with any network device, gateway addresses instruct the device about how to reach other networks when no other information is available. Similar to the host computer default gateway IP address, a router may also employ a default gateway. Also similar to a host computer, a router is knowledgeable about directly connected networks.

This task will not examine Cisco IOS commands in detail but will use a common IOS command to view the routing table. The syntax to view the routing table is:

```
show ip route <ENTER>
```


Step 1: Enter the command to display the router routing table.

The route information displayed is much more detailed than the route information on a host computer. This is to be expected, because the job of a router is to route traffic between networks. The information required of this task, however, is not difficult to glean. Figure 2 shows the routing table for `R2-Central`.

```
R2-Central#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 10.10.10.6 to network 0.0.0.0

C    172.16.0.0/16 is directly connected, FastEthernet0/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.10.10.4 is directly connected, Serial0/2/0
S*   0.0.0.0/0 [1/0] via 10.10.10.6
R2-Central#
```

Figure 2. Output of the Cisco IOS `show ip route` Command

The `Codes` section shown in Figure 3 provides an explanation for the symbols to the left of each route entry.

```
R2-Central#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 10.10.10.6 to network 0.0.0.0

C    172.16.0.0/16 is directly connected, FastEthernet0/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.10.10.4 is directly connected, Serial0/2/0
S*   0.0.0.0/0 [1/0] via 10.10.10.6
R2-Central#
```

Figure 3. Explanation of Codes

- ❶ `C` denotes directly connected networks and the interface that supports the connection.
- ❷ `S` denotes a static route, which is manually entered by the Cisco network engineer.
- ❸ Because the route is ”quad-zero,” it is a `candidate default` route.
- ❹ If there is no other route in the routing table, use this `gateway of last resort` IP address to forward packets.

How is IP mask information displayed in a router routing table?

/**

What would the router do with packets destined to 192.168.254.254?

Send them to the appropriate LAN

When finished examining the routing table, exit the router with the command **exit <ENTER>.** The telnet client will also close the connection with the telnet escape sequence **<CTRL>]** and **quit**. Close the terminal window.

Task 4: Reflection

Two new Windows commands were used in this lab. The **route** command was used to view, delete, and add route information on the pod host computer.

The Windows Telnet client, **telnet**, was used to connect to a lab router, R2-Central. This technique will be used in other labs to connect to Cisco network devices.

The router routing table was examined with the Cisco IOS command **show ip route**. Routes for directly connected networks, statically assigned routes, and gateway of last resort information are displayed.

Task 5: Challenge

Other Cisco IOS commands can be used to view IP address information on a router. Similar to the Windows **ipconfig** command, the Cisco IOS command **show ip interface brief** will display IP address assignments.

```
R2-Central#show ip interface brief
Interface         IP-Address      OK? Method Status                Protocol
FastEthernet0/0   172.16.255.254  YES manual up                    up
FastEthernet0/1   unassigned      YES unset  administratively down down
Serial0/2/0       10.10.10.5      YES manual up                    up
Serial0/2/1       unassigned      YES unset  administratively down down
R2-Central#
```

Using Windows commands and the Cisco IOS commands in this lab, compare network information output. What was missing? What critical network information was similar?

Task 6: Clean Up.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

