VANIER COLLEGE – Computer Engineering Technology – Autumn 2021

Network Systems Design (247-509-VA)

LABORATORY EXPERIMENT 5

Examine Device Gateway and Routes

NOTE:
To be completed in one lab session of 3 hrs.

To be submitted at the end of the lab session.

This exercise is to be done individually except where specified in the procedure. **Each** student must submit this lab with answer, screen shots, and your original ***observations and conclusions.***

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OBJECTIVES:

After performing this experiment, the student will be able to:

1. Understand and explain the purpose of gateway address
2. Understand how network information is configured on a Windows computer.
3. Use the route command to modify a Windows computer routing table.
4. Use a Windows Telnet client command telnet to connect to a Cisco router.
5. Examine router routes using basic Cisco IOS commands.

THEORY

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 LAN, the host portion of the IP address is used as the host 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.

One popular windows command to display network gateway is **netstat –r**. In the following transcript, the netstat –r command is used to view the gateway addresses for this computer.

```
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:\>
```

- Top highlight : shows the 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.
- Second highlight : 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.

- Third hightlight : Any device on network 172.16.0.0 is accessed through gateway 172.16.1.2, the IP address for this Ethernet interface.
- Last highlight : displays the default gateway information in human-readable form. More specific networks are reached through other gateway addresses.

For packets to travel across a network, a device must know the route to the destination network. 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.

Similarly on router, routing table is used to route packet. In this lab, you will examine Cisco router's routing table. Following is an example with explanation.

```
R2-Central#show ip route
Codes: ❶C - connected, ❷S - 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, ❸* - candidate default, U - per-user static
      route
       o - ODR, P - periodic downloaded static route

❹Gateway of last resort is 10.10.10.6 to network 0.0.0.0

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

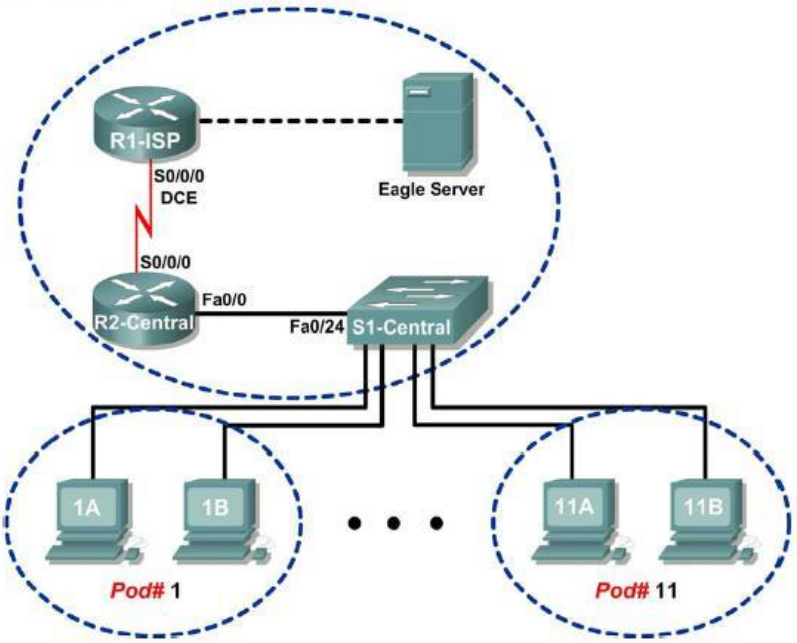
Explanation of Codes

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.

PROCEDURE

The lab will be using the same Eagle-server Topology Diagram as in our previous labs. If you have changed your computer, do modify your network IP address accordingly.

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

Part A: Examine Device Gateway

1) Initial check on host's gateway.

   a) Open a terminal window on your computer. What is the default gateway address?

   - The default gateway address of my computer was 172.16.255.254. This also happens to be one of the two IP addresses that reside on "R2-Central" (as shown in Eagle-Server Topology Diagram). Refer to screenshot below for further proof.

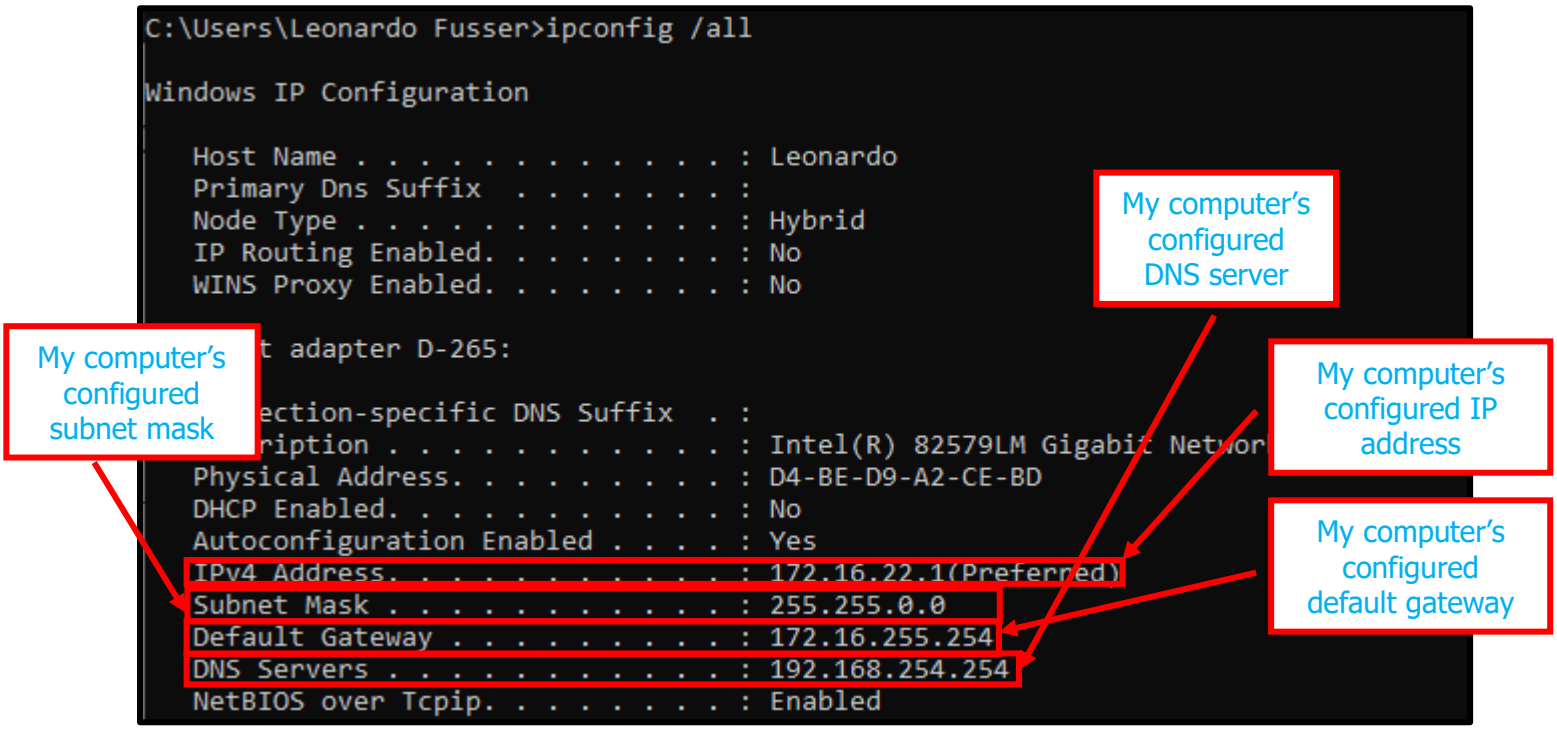


Figure 1. Output of "ipconfig /all" command in command prompt. It clearly indicates all the various configured networking parameters on my computer.

   b) Use the **ping** command to verify connectivity with IP address 127.0.0.1. Was the ping successful?

   - The ping command issued to verify connectivity with the IP address "127.0.0.1" yielded successful. This means that the local IP stack on my computer is working as expected. Refer to screenshot below for further proof.

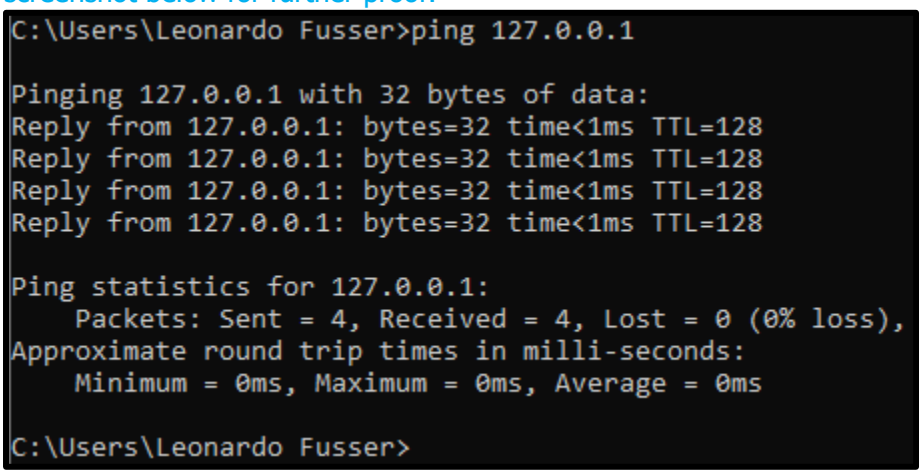


Figure 2. Output of ping command to loopback address ("127.0.0.1") in command prompt. It clearly shows that the local IP stack on my computer is working as expected.

c) 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?

Pinging "127.0.0.0": yields a "Transmit failed. General failure." message. This is because this IP address is not a usable address. It is a host address instead.

Pining "127.10.1.1": yields a transmit succeeded output. This is because this IP address is a usable address. Therefore, a ping command issued to this kind of IP address will result in a successful ping transmission.

Pinging "127.255.255.255": yields a "Transmit failed. General failure." message. This is because this IP address is not a usable address. It is a broadcast address instead.

d) Figure 1 below shows example of communication between devices on different networks. 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.

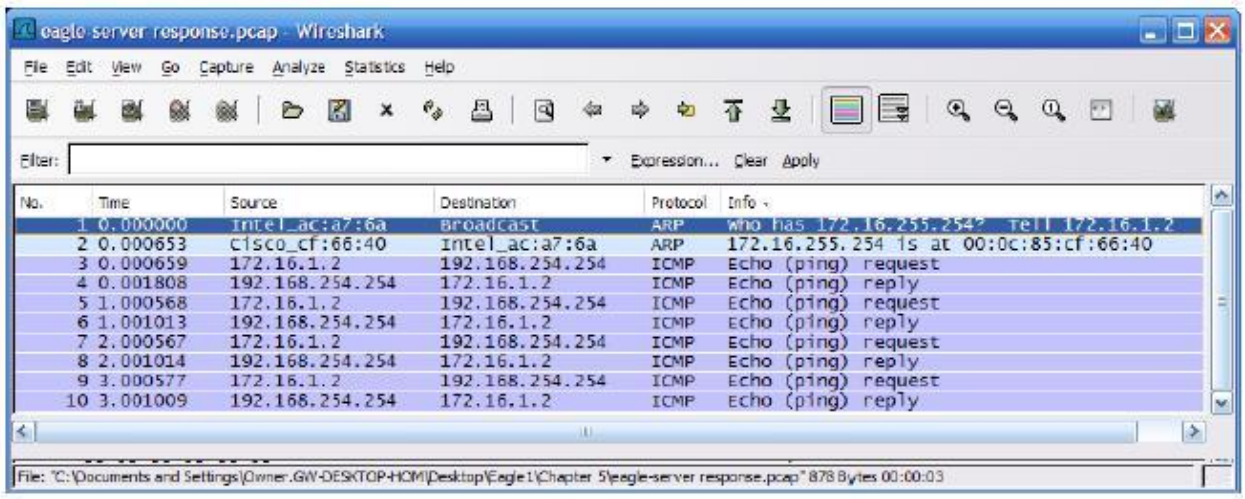


Figure 1: Communication between Devices on Different Networks

What is the MAC address of the gateway device?

- The MAC address of the gateway device is "00:19:56:6b:d2:88". Refer to the screenshot below for further proof.

```
C:\WINDOWS\system32>arp -a 172.16.255.254

Interface: 172.16.22.1 --- 0x12
  Internet Address      Physical Address      Type
  172.16.255.254        00-19-56-6b-d2-88     dynamic
```

Figure 3. Physical address (MAC) of the gateway device being retrieved by using the "arp -a 172.16255.254" command.

What is the MAC address of the network device with IP address 192.168.254.254?

- The MAC address of the network device associated with the IP address "192.168.254.254" (Eagle server) cannot be retrieved since that IP address resides way past the boundary that "R2-Central" can recognize and handle. That's why, when a "arp -a 192.168.254.254" command is executed, the result yields "unknown".

2) Using command **ipconfig /all**, fill in the table below with information from your computer.

Description	Address
IP address	172.16.22.1
Subnet mask	255.255.0.0
Default gateway	172.16.255.254
DNS server	192.168.254.254

- Refer to the screenshot under "Figure 1" for additional proof.

Part B: Examine a Route

3. Examine and modify a Windows computer routing table. Unlike the **netstat –r** command, the **route** command can be used to view, add, delete, or change routing table entries.
   a) To view detailed information about the route command, use the option **route /?.** Find out the *function and basic syntax* of the following **route** command.

`route PRINT:` prints a route.

`route ADD:` adds a route.

`route DELETE:` deletes a route.

`route CHANGE:` modifies an existing route.

   b) To view active routes, issue the command **route PRINT**. Verify that you can ping to Eagle Server. What is the gateway address used to reach `eagle-server.example.com`?

- A ping command issued to verify connectivity to the Eagle server yields a success. The gateway address used to reach "eagle-server.example.com" is the default gateway configured on my computer, which is "172.16.255.254" and is configured as a default route on my computer. This gateway address is used because a route to "eagle-server.example.com" does not exist on my computer's routing table, so the default route is taken instead. Refer to screenshot below for additional proof.

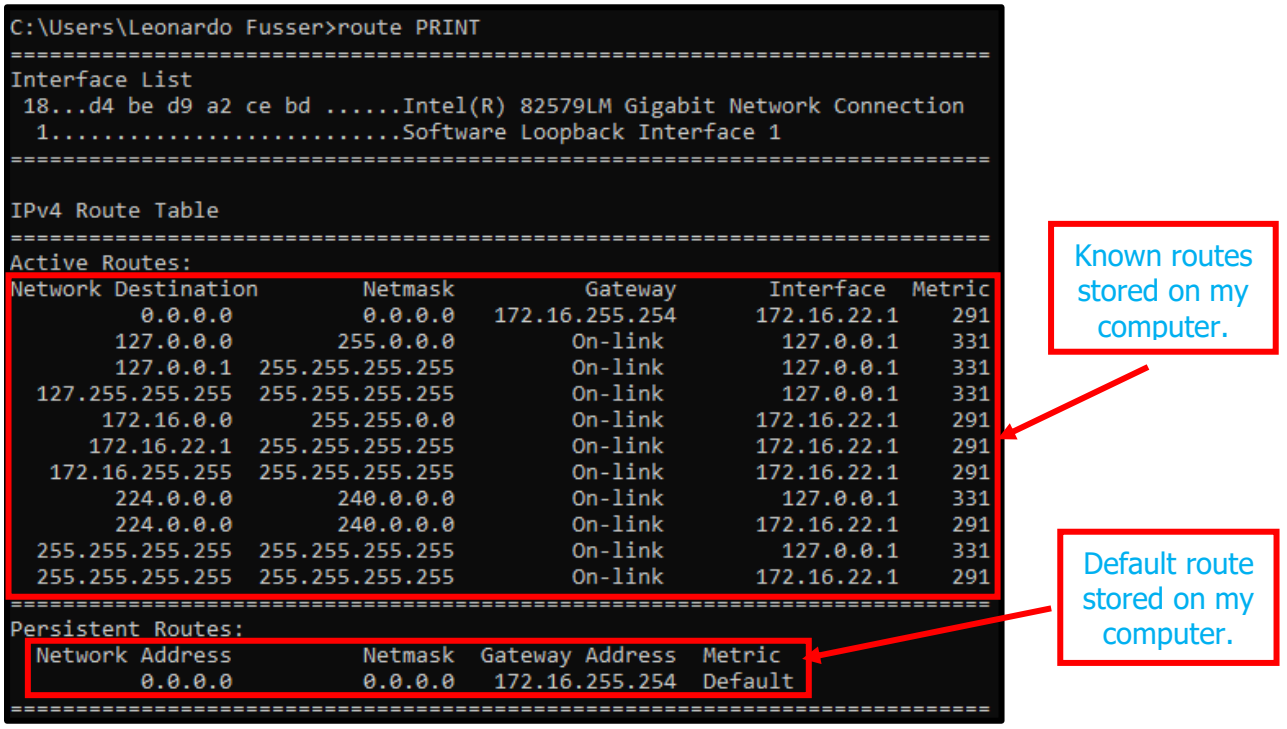


Figure 4. Routing table stored on my computer shown above (retrieved using "route PRINT" command).

c) Delete the default route from the Windows computer routing table using the following command: **`route DELETE 0.0.0.0`**

d) Examine the active routing table, and verify that the default gateway route has been removed. **Perform a screen shot**.

- After the above command has been executed, the default route stored on my computer is no longer there. This means, any communication that needs to go beyond the stored routes that are on my computer will not work. Refer to screenshot on next page for additional proof.

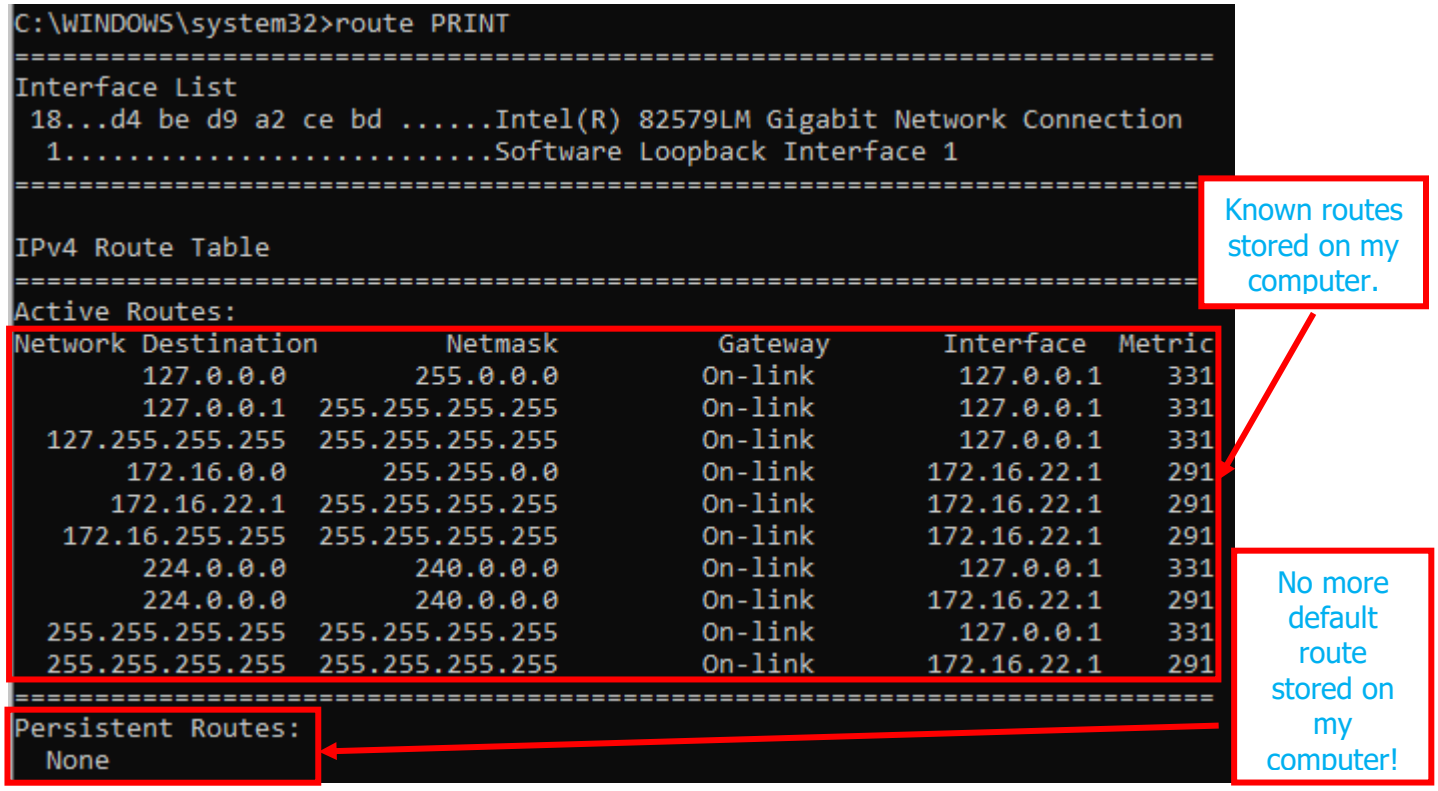


Figure 5. New routing table stored on my computer shown above (retrieved using "route PRINT" command).

e) Try to ping Eagle Server. What are the results?

- A ping to the Eagle Server yielded with no success. As mentioned before, this is because my computer does not have a default route anymore. When the ping to Eagle Server is issued, my computer checks its local routing table to see if a route to the Eagle Server exists. If there are no routes that correspond to the Eagle Server, then a default route will be taken (assuming if there is one) and most likely, with how our network is configured, the ping to the Eagle Server would yield successful. If there isn't a default route, then the ping to Eagle Server will result in what is shown in the screenshot below. When the default route is in place, the packet would go to "R2-Central", and then from there it would reach the Eagle Server and the ping to the Eagle Server would yield successful. Refer to screenshot below for additional proof.

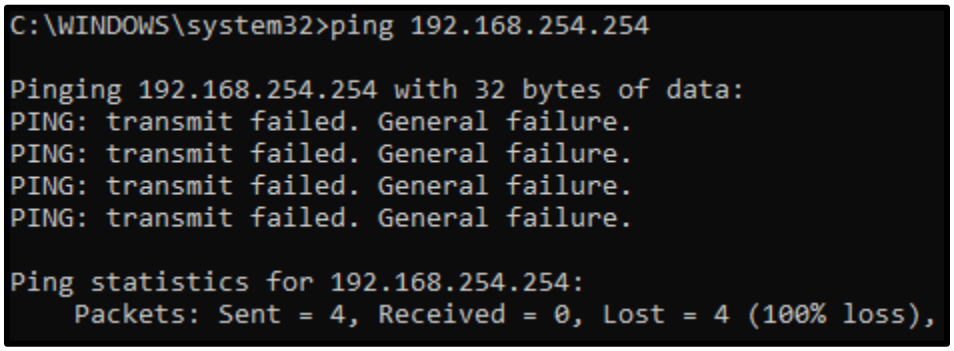


Figure 6. Result of ping command issued to Eagle Server after modifying my computer's routing table.

f) Can other LAN devices be reached, such as 172.16.255.254? Explain.

- Other network devices, such as "R2-Central" (172.16.255.254), can still be reached even with the newly modified routing table. This is because a route to "R2-Central" exists in my computer's local routing table. If any communication needs to be done to any of the routes shown in the screenshot in "Figure 5" on the previous page, it will work because the route is there. Refer to screenshot below for further proof.

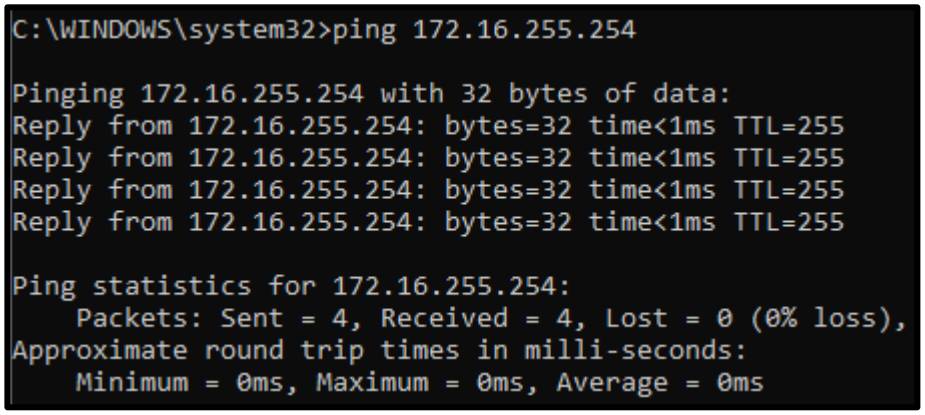


Figure 7. Result of ping command issued to "R2-Central" after modifying my computer's routing table.

g) Insert a default route into the Windows computer routing table. The generic command to add a route is:

route ADD <network> **MASK** <mask> <gateway-IP address>

h) Examine the active routing table. Has the default gateway route been restored? **Attach a screen shot of your routing table**. Try to ping Eagle Server. What are the results?

- After manually adding back the route to "R2-Central", a ping command to the Eagle Server yields successful. This is because the default route to "R2-Central" exists again. This also means that my computer can communicate with anything that is beyond any of the listed routes in its local routing table. This is especially important for network devices such as Eagle Server, since there is no route specified for it in my computer's local routing table (other than the default route). Refer to screenshot on next page for further proof.

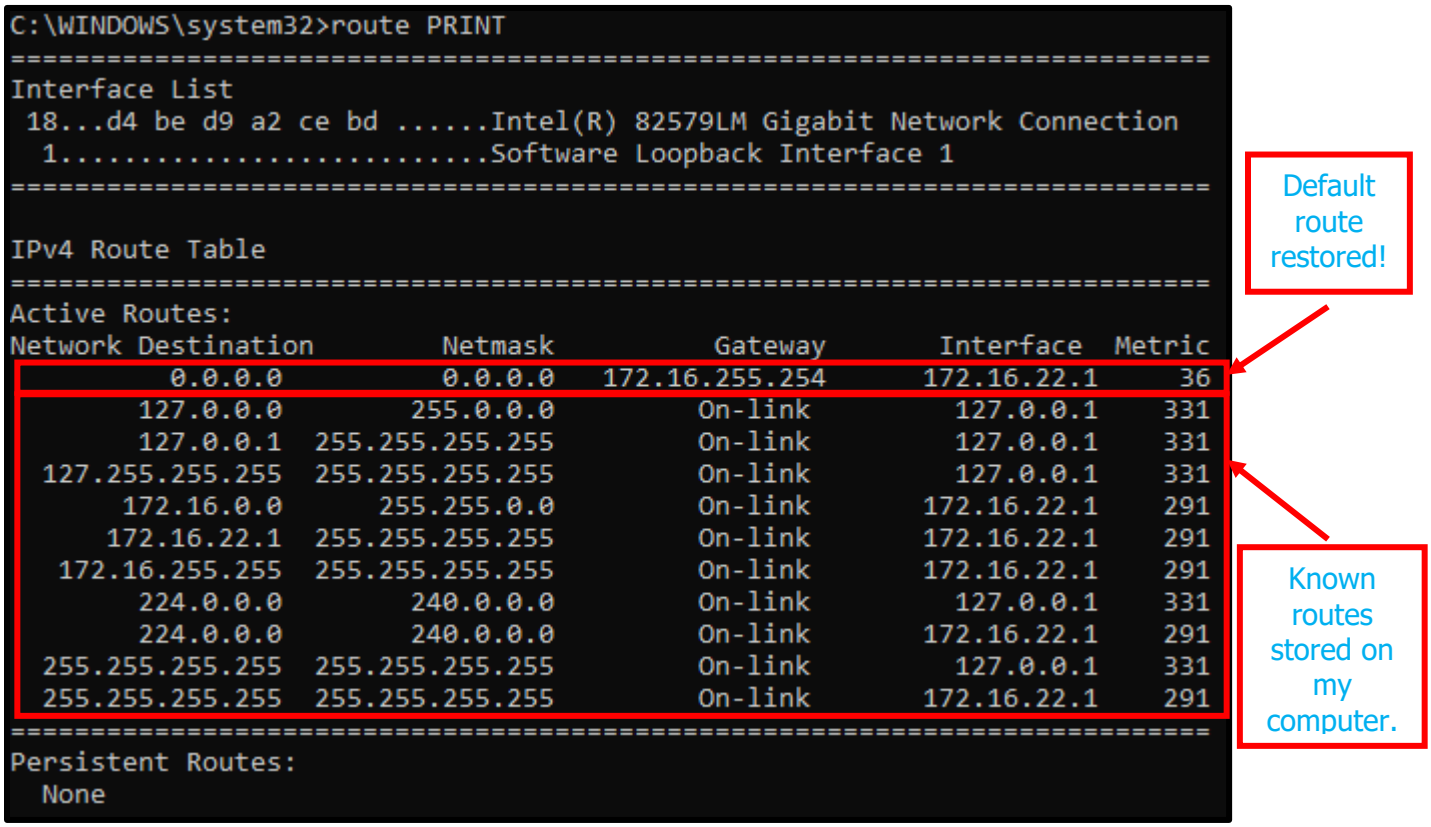


Figure 8. My computer's local routing table after manually adding back the default route.

4. Now, you are required to use Windows telnet client to examine Cisco Router.
   a) Start a telnet session with router R2-Central.

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

   b) Login with username (ccna*<#pod number>. Valid pod number range from 1-16*) and password assigned. The router prompt should be visible after a successful login as shown in the example below.

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

User Access Verification

Username: ccna1
Password: cisco
!The password is hidden when typed in
R2-Central>
```

5. You will examine router routes using basic Cisco IOS commands

   a) Enter the command to display the router routing table. **Attach a screen shot of your router routing table**.

      `show ip route`

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

      - In the case of Cisco routers, the IP subnet mask is shown in slash notation, compared to how the IP subnet mask is shown in Windows "route PRINT", where there it is shown in full decimal format (4-byte value). Refer to screenshot below for additional proof.

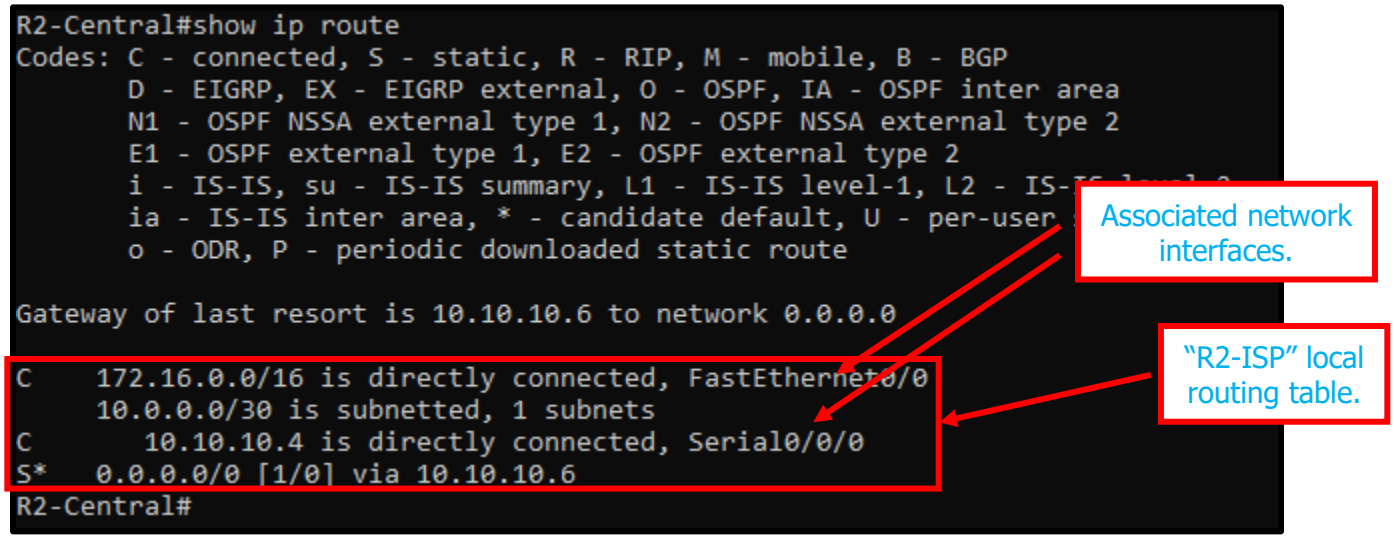


Figure 9. Routing table stored on "R2-Central" shown above.

   c) What would the router do with packets destined to 192.168.254.254?

      - The router would forward any packets destined to Eagle Server ("192.168.254.254") to the specified default route that is stored in its local routing table, in this case it is "10.10.10.6" (R1-ISP). This is because there are no other routes defined that correspond to Eagle Server, so the default route has to be taken. If this default route was not specified, then any packets that need to reach Eagle Server will not be able to reach to it. The router will discard these packets instead.

6. You can use other Cisco IOS commands to view IP address information on a router. Similar to the Windows ipconfig command, the Cisco IOS command **`show ip interface brief`** displays IP address assignments. Examine and explain the interfaces of the router.\

   - After executing the "show ip interface brief" command on "R2-Central" (Cisco router), a complete table that shows all the physical network adapters are shown (aside from console port). Looking at this table, we can see that "R2-Central" has two fast-ethernet ports (Ethernet) and two serial ports (DCEs). We can also see other things such as status for each of these physical network adapters. "172.16.255.254" is the default gateway used on my computer (and is connected directly to "S1-Central") and "10.10.10.5" is used as one of the two IP addresses for the WAN link between "R2-Central" and "R1-ISP". Refer to screenshot below for additional proof and "Eagle-Server network Topology" diagram.

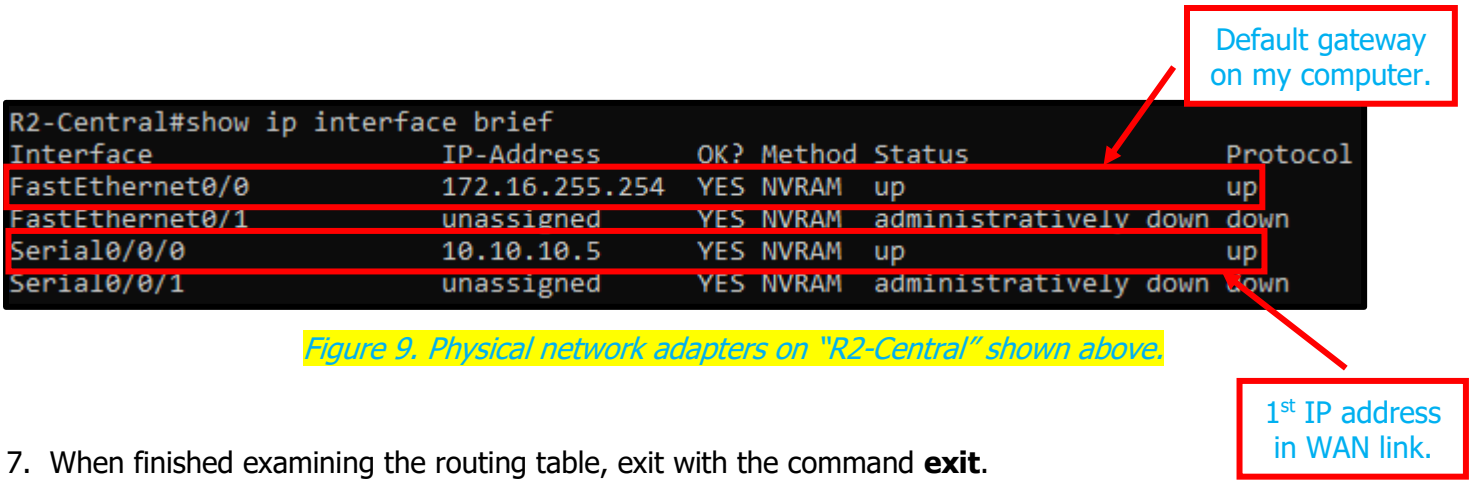


Figure 9. Physical network adapters on "R2-Central" shown above.

7. When finished examining the routing table, exit with the command **exit**.

Discussion:

- The first part of the lab consisted of examining various configured computer networking information. First, we examined the local IP configuration on our computer using the "ipconfig /all" command in command prompt. Details such as "default gateway" and "DNS server" were examined. Tests were also done in order to verify if the computer's local IP stack was working correctly by pinging the loopback address on the computer (ping tests were also done to similar loopback addresses to see which would work or not). The last thing that was done was to see if we could determine the physical address (MAC address) of various networking devices such as "R2-Central" and the Eagle server.

  Secondly, the last part of the lab consisted of examining the routing table on our computer and "R2-Central". First, we got familiar with the "route" command used in Microsoft Windows OS. We observed the basic syntax of this command and how we could use this command in Microsoft Windows OS. Next, we observed our computer's local routing table to see what was stored in it. We also observed how routes were handled on our computer by observing the local routing table and testing network communication by deleting and adding routes to our computer's local routing table. We verified the communication between our computer and Eagle server when a route was deleted and added back. We also verified the communication between our computer and various networking devices such as "R2-Central" when a route was deleted and added back. Lastly, we observed how a local routing table looked like on a Cisco router and compared it to how the "route" command in Microsoft Windows OS displays local routing information. We also viewed how physical network adapters are viewed on a Cisco router.

  The overall outcome of this lab was successful.

Conclusion:

- Successfully understood the purpose of a gateway address.
- Successfully understood how network information is configured in Microsoft Windows OS.
- Successfully used route command to modify a local routing table in Microsoft Windows OS.
- Successfully used Telnet client in Microsoft Windows OS to remotely connect to a Cisco router.
- Successfully examined local routing table on a Cisco router using basic Cisco IOS commands.