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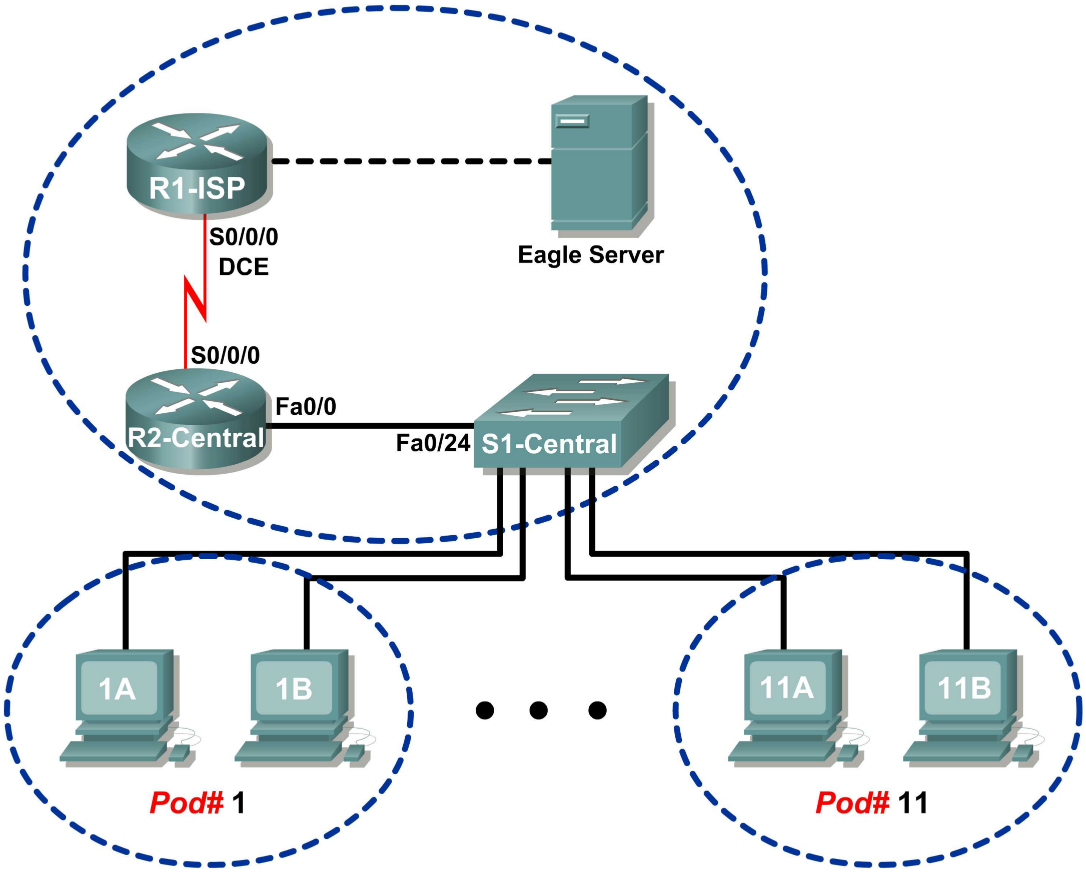
Lab 6.7.1: Ping and Traceroute

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	10.10.10.6
	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 **`ping`** command to verify simple TCP/IP network connectivity.
- Use the **`tracert/traceroute`** command to verify TCP/IP connectivity.

Background

Two tools that are indispensable when testing TCP/IP network connectivity are **`ping`** and **`tracert`**. The **`ping`** utility is available on Windows, Linux, and Cisco IOS, and tests network connectivity. The **`tracert`** utility is available on Windows, and a similar utility, **`traceroute`**, is available on Linux and Cisco IOS. In addition to testing for connectivity, **`tracert`** can be used to check for network latency.

For example, when a web browser fails to connect to a web server, the problem can be anywhere between client and the server. A network engineer may use the **`ping`** command to test for local network connectivity or connections where there are few devices. In a complex network, the **`tracert`** command would be used. Where to begin connectivity tests has been the subject of much debate; it usually depends on the experience of the network engineer and familiarity with the network.

The Internet Control Message Protocol (ICMP) is used by both **`ping`** and **`tracert`** to send messages between devices. ICMP is a TCP/IP Network layer protocol, first defined in RFC 792, September, 1981. ICMP message types were later expanded in RFC 1700.

Scenario

In this lab, the **`ping`** and **`tracert`** commands will be examined, and command options will be used to modify the command behavior. To familiarize the students with the use of the commands, devices in the Cisco lab will be tested.

Measured delay time will probably be less than those on a production network. This is because there is little network traffic in the Eagle 1 lab.

Task 1: Use the `ping` Command to Verify Simple TCP/IP Network Connectivity.

The **`ping`** command is used to verify TCP/IP Network layer connectivity on the local host computer or another device in the network. The command can be used with a destination IP address or qualified name, such as eagle-server.example.com, to test domain name services (DNS) functionality. For this lab, only IP addresses will be used.

The **`ping`** operation is straightforward. The source computer sends an ICMP echo request to the destination. The destination responds with an echo reply. If there is a break between the source and destination, a router may respond with an ICMP message that the host is unknown or the destination network is unknown.

Step 1: Verify TCP/IP Network layer connectivity on the local host computer.

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

Figure 1. Local TCP/IP Network Information

1. Open a Windows terminal and determine IP address of the pod host computer with the **`ipconfig`** command, as shown in Figure 1.

   The output should look the same except for the IP address. Each pod host computer should have the same network mask and default gateway address; only the IP address may differ. If the information is missing or if the subnet mask and default gateway are different, reconfigure the TCP/IP settings to match the settings for this pod host computer.

2. Record information about local TCP/IP network information:

TCP/IP Information	**Value**
IP Address	
Subnet Mask	
Default Gateway	

```
C:\> ping 172.16.1.2
Pinging 172.16.1.1 with 32 bytes of data:
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128

Ping statistics for 172.16.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>
```

Figure 2. Output of the `ping` Command on the Local TCP/IP Stack

3. Use the **`ping`** command to verify TCP/IP Network layer connectivity on the local host computer.

   By default, four ping requests are sent to the destination and reply information is received. Output should look similar to that shown in Figure 2.

   ❶ Destination address, set to the IP address for the local computer.

   ❷ Reply information:

   bytes—size of the ICMP packet.

   time—elapsed time between transmission and reply.

   TTL—default TTL value of the DESTINATION device, minus the number of routers in the path. The maximum TTL value is 255, and for newer Windows machines the default value is 128.

   ❸ Summary information about the replies:

   ❹ Packets Sent—number of packets transmitted. By default, four packets are sent.

   ❺ Packets Received—number of packets received.

   ❻ Packets Lost —difference between number of packets sent and received.

   ❼ Information about the delay in replies, measured in milliseconds. Lower round trip times indicate faster links. A computer timer is set to 10 milliseconds. Values faster than 10 milliseconds will display 0.

4. Fill in the results of the **ping** command on your computer:

Field	Value
Size of packet	
Number of packets sent	
Number of replies	
Number of lost packets	
Minimum delay	
Maximum delay	
Average delay	

Step 2: Verify TCP/IP Network layer connectivity on the LAN.

```
C:\> ping 172.16.255.254
Pinging 172.16.255.254 with 32 bytes of data:
Reply from 172.16.255.254: bytes=32 time=1ms TTL=255
Reply from 172.16.255.254: bytes=32 time<1ms TTL=255
Reply from 172.16.255.254: bytes=32 time<1ms TTL=255
Reply from 172.16.255.254: bytes=32 time<1ms TTL=255
Ping statistics for 172.16.255.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
C:\>
```

Figure 3. Output of the ping Command to the Default Gateway

1. Use the **ping** command to verify TCP/IP Network layer connectivity to the default gateway. Results should be similar to those shown in Figure 3.

   Cisco IOS default TTL value is set to 255. Because the router was not crossed, the TTL value returned is 255.

2. Fill in the results of the **ping** command to the default Gateway:

Field	Value
Size of packet	
Number of packets sent	
Number of replies	
Number of lost packets	
Minimum delay	
Maximum delay	
Average delay	

What would be the result of a loss of connectivity to the default gateway?

____

Step 3: Verify TCP/IP Network layer connectivity to a remote network.

```
C:\> ping 192.168.254.254
Pinging 192.168.254.254 with 32 bytes of data:
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
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:\>
```

Figure 4. Output of the `ping` Command to Eagle Server

1. Use the **`ping`** command to verify TCP/IP Network layer connectivity to a device on a remote network. In this case, Eagle Server will be used. Results should be similar to those shown in Figure 4.

   Linux default TTL value is set to 64. Two routers were crossed to reach Eagle Server, therefore the returned TTL value is 62.

2. Fill in the results of the **`ping`** command on your computer:

Field	Value
Size of packet	
Number of packets sent	
Number of replies	
Number of lost packets	
Minimum delay	
Maximum delay	
Average delay	

```
C:\ > ping 192.168.254.254
Pinging 192.168.254.254 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Ping statistics for 192.168.254.254:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
C:\>
```

Figure 5. Output of a `ping` Command with Lost Packets

The **`ping`** command is extremely useful when troubleshooting network connectivity. However, there are limitations. In Figure 5, the output shows that a user cannot reach Eagle Server. Is the problem with Eagle Server or a device in the path? The **`tracert`** command, examined next, can display network latency and path information.

Task 2: Use the `tracert` Command to Verify TCP/IP Connectivity.

The **`tracert`** command is useful for learning about network latency and path information. Instead of using the **`ping`** command to test connectivity of each device to the destination, one by one, the **`tracert`** command can be used.

On Linux and Cisco IOS devices, the equivalent command is **`traceroute`**.

Step 1: Verify TCP/IP Network layer connectivity with the `tracert` command.

1. Open a Windows terminal and issue the following command:

   `C:\> tracert 192.168.254.254`

```
C:\> tracert 192.168.254.254
Tracing route to 192.168.254.254 over a maximum of 30 hops
  1    <1 ms    <1 ms    <1 ms  172.16.255.254
  2    <1 ms    <1 ms    <1 ms  10.10.10.6
  3    <1 ms    <1 ms    <1 ms  192.168.254.254
Trace complete.
C:\>
```

Figure 6. Output of the `tracrt` command to Eagle Server.

   Output from the **`tracert`** command should be similar to that shown in Figure 6.

2. Record your result in the following table:

Field	Value
Maximum number of hops	
First router IP address	
Second router IP address	
Destination reached?	

Step 2: Observe `tracert` output to a host that lost network connectivity.

If there is a loss of connectivity to an end device such as Eagle Server, the **`tracert`** command can give valuable clues as to the source of the problem. The **`ping`** command would show the failure but not any other kind of information about the devices in the path. Referring to the Eagle 1 lab Topology Diagram, both R2-Central and R1-ISP are used for connectivity between the pod host computers and Eagle Server.

```
C:\> tracert -w 5 -h 4 192.168.254.254
Tracing route to 192.168.254.254 over a maximum of 4 hops
  1    <1 ms    <1 ms    <1 ms  172.16.255.254
  2    <1 ms    <1 ms    <1 ms  10.10.10.6
  3     *        *        *     Request timed out.
  4     *        *        *     Request timed out.

Trace complete.
C:\>
```

Figure 7. Output of the `tracert` Command

Refer to Figure 7. Options are used with the **`tracert`** command to reduce wait time (in milliseconds), **`-w 5`**, and maximum hop count, **`-h 4`**. If Eagle Server was disconnected from the network, the default gateway would respond correctly, as well as R1-ISP. The problem must be on the `192.168.254.0/24` network. In this example, Eagle Server has been turned off.

What would the **tracert** output be if R1-ISP failed?

What would the **tracert** output be if R2-Central failed?

Task 3: Challenge

The default values for the **ping** command normally work for most troubleshooting scenarios. There are times, however, when fine tuning **ping** options may be useful. Issuing the **ping** command without any destination address will display the options shown in Figure 8:

```
C:\> ping

Usage: ping [-t] [-a] [-n count] [-l size] [-f] [-i TTL] [-v TOS]
            [-r count] [-s count] [[-j host-list] | [-k host-list]]
            [-w timeout] target_name

Options:
    -t             Ping the specified host until stopped.
                   To see statistics and continue - type Control-
Break;
                   To stop - type Control-C.
    -a             Resolve addresses to hostnames.
    -n count       Number of echo requests to send.
    -l size        Send buffer size.
    -f             Set Don't Fragment flag in packet.
    -i TTL         Time To Live.
    -v TOS         Type Of Service.
    -r count       Record route for count hops.
    -s count       Timestamp for count hops.
    -j host-list   Loose source route along host-list.
    -k host-list   Strict source route along host-list.
    -w timeout     Timeout in milliseconds to wait for each reply.
C:\>
```

Figure 8. Output of a ping Command with no Destination Address

The most useful options are highlighted in yellow. Some options do not work together, such as the **-t** and **-n** options. Other options can be used together. Experiment with the following options:

To **ping** the destination address until stopped, use the **-t** option. To stop, press `<CTRL> C`:

```
C:\> ping -t 192.168.254.254
Pinging 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
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 = 6, Received = 6, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
Control-C
^C
C:\>
```

Figure 9. Output of a `ping` Command using the `-t` Option

To **ping** the destination once, and record router hops, use the **-n** and **-r** options, as shown in Figure 10.
Note: Not all devices will honor the **-r** option.

```
C:\> ping -n 1 -r 9 192.168.254.254
Pinging 192.168.254.254 with 32 bytes of data:
Reply from 192.168.254.254: bytes=32 time=1ms TTL=63
    Route:      10.10.10.5 ->
           192.168.254.253 ->
           192.168.254.254 ->
                10.10.10.6 ->
            172.16.255.254
Ping statistics for 192.168.254.254:
    Packets: Sent = 1, Received = 1, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
C:\>
```

Figure 10. Output of a `ping` Command using the `-n` and `-r` Options

Task 4: Reflection

Both **ping** and **tracert** are used by network engineers to test network connectivity. For basic network connectivity, the **ping** command works best. To test latency and the network path, the **tracert** command is preferred.

The ability to accurately and quickly diagnose network connectivity issues is a skill expected from a network engineer. Knowledge about the TCP/IP protocols and practice with troubleshooting commands will build that skill.

Task 5: 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.

