Site-to-Site Network Design and Routing Lab Using Cisco Packet Tracer

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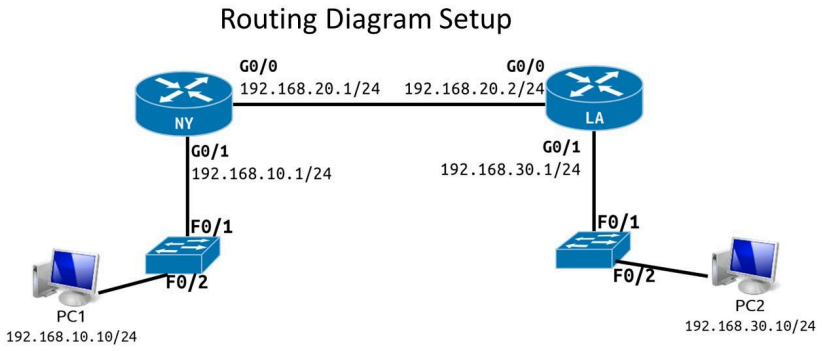
Home Lab: CompTIA Network+

Lab Description

This homelab demonstrates the design and configuration of a basic two-site network using Cisco Packet Tracer. The lab simulates a real-world scenario where two locations—Calgary and Edmonton—are connected through routing devices to enable end-to-end communication.

Each site consists of a PC connected to a switch, which then connects to a router. The routers are configured to route traffic between the two locations, allowing devices on different networks to communicate successfully. This lab focuses on fundamental networking concepts such as IP addressing, Layer 2 switching, Layer 3 routing, and basic network troubleshooting.



Example Routing Diagram Setup.

Lab Objectives

By completing this lab, the following objectives are achieved:

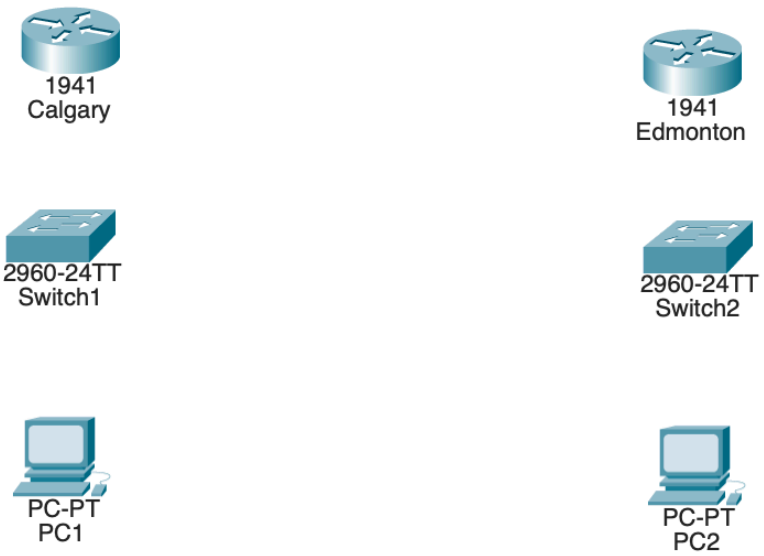
- Design a basic two-site network topology using Cisco Packet Tracer
- Configure end devices, switches, and routers to enable network connectivity
- Assign IPv4 addresses and subnet masks according to a defined addressing scheme
- Configure router interfaces to allow communication between different networks
- Verify end-to-end connectivity between devices using basic network testing tools such as ping
- Demonstrate understanding of Layer 2 and Layer 3 networking concepts aligned with CompTIA Network+ objectives

Lab Implementation

Step 1: place devices

The first step is to place all devices in Packet Tracer and arrange them according to the Calgary and Edmonton sites. This ensures a clear and organized topology before configuring IP addressing and routing.

1. Open Packet Tracer and go to the “End Devices” menu:
    - Drag PC1 to the left (Calgary site)
    - Drag PC2 to the right (Edmonton site)
2. Go to the “Switches” menu:
    - Drag Switch1 near PC1
    - Drag Switch2 near PC2
3. Go to the “Routers” menu:
    - Drag Router_Calgary near Switch1
    - Drag Router_Edmonton near Switch2



Step 2: Connect Devices

In this step, devices are physically connected using **copper straight-through cables**. The connections follow standard Layer 2 and Layer 3 networking practices.

Calgary Site

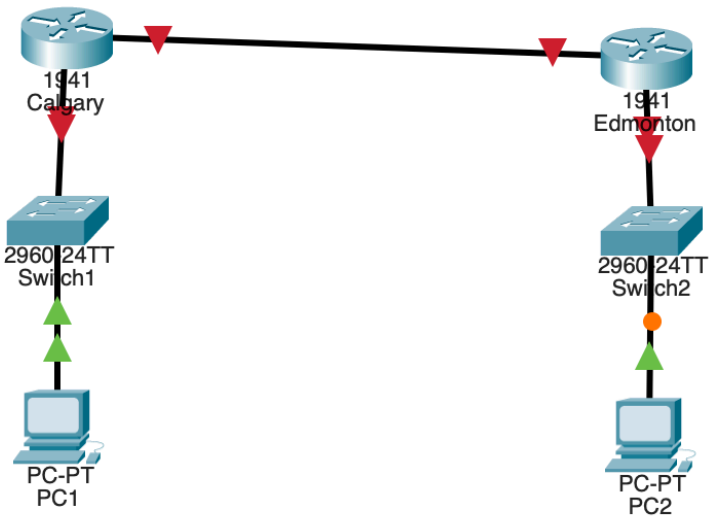
- **PC1 → Switch1:** `FastEthernet0` (PC1) → `FastEthernet0/2` (Switch1)
- **Switch1 → Router_Calgary:** `FastEthernet0/1` (Switch1) → `GigabitEthernet0/1` (Router_Calgary)

Edmonton Site

- **PC2 → Switch2:** `FastEthernet0` (PC2) → `FastEthernet0/2` (Switch2)
- **Switch2 → Router_Edmonton:** `FastEthernet0/1` (Switch2) → `GigabitEthernet0/1` (Router_Edmonton)

Router-to-Router Link

- **Router_Calgary → Router_Edmonton:** `GigabitEthernet0/0` (Calgary) → `GigabitEthernet0/0` (Edmonton)

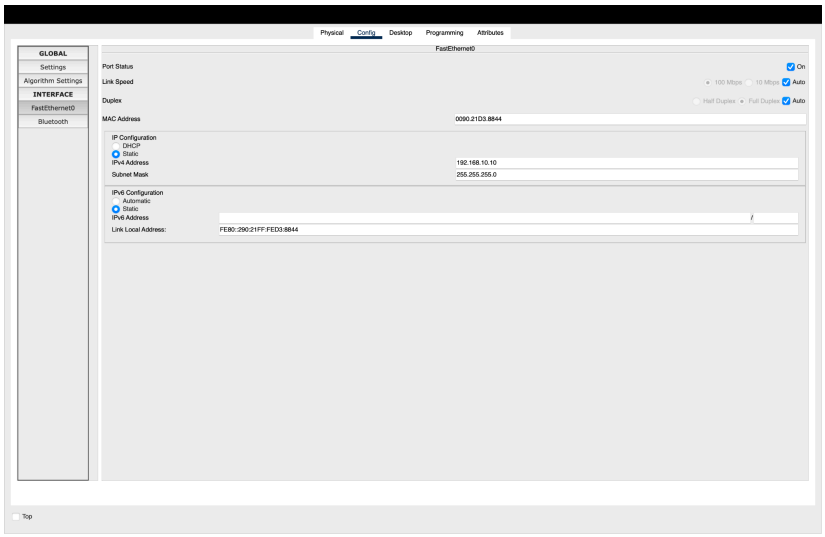


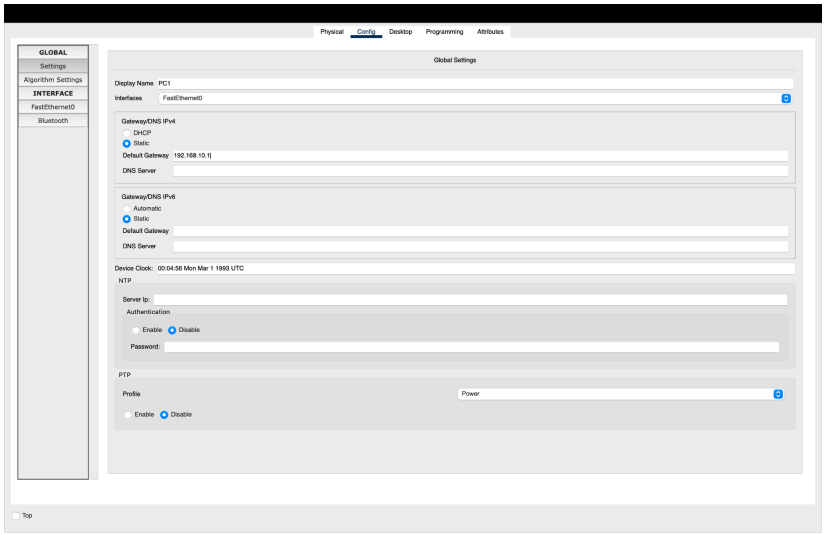
Step 3: Assign IP Addresses and Configure Default Gateways

In this step, IP addresses and default gateways are assigned to the PCs to enable communication within their local networks. This is a fundamental step in configuring Layer 3 connectivity.

Calgary Site – PC1

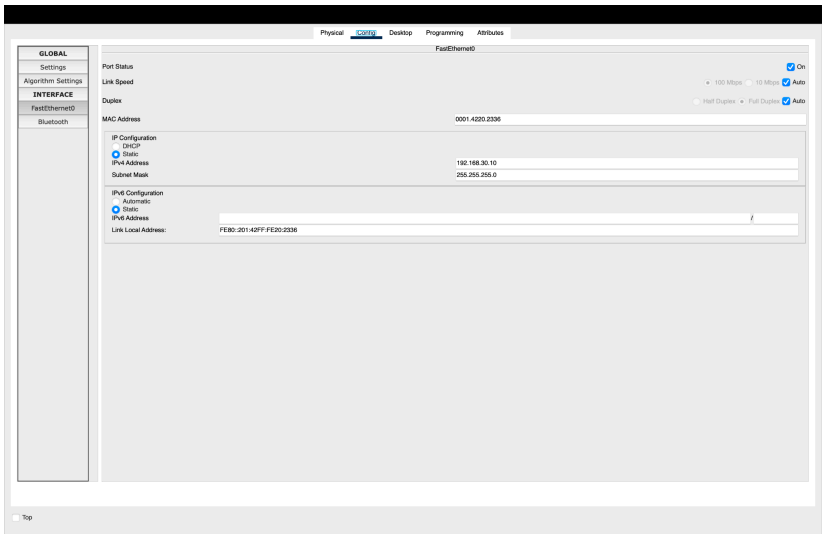
- **IPv4 Address:** `192.168.10.10`
- **Subnet Mask:** `255.255.255.0`
- **Default Gateway:** `192.168.10.1` (Router_Calgary LAN interface)

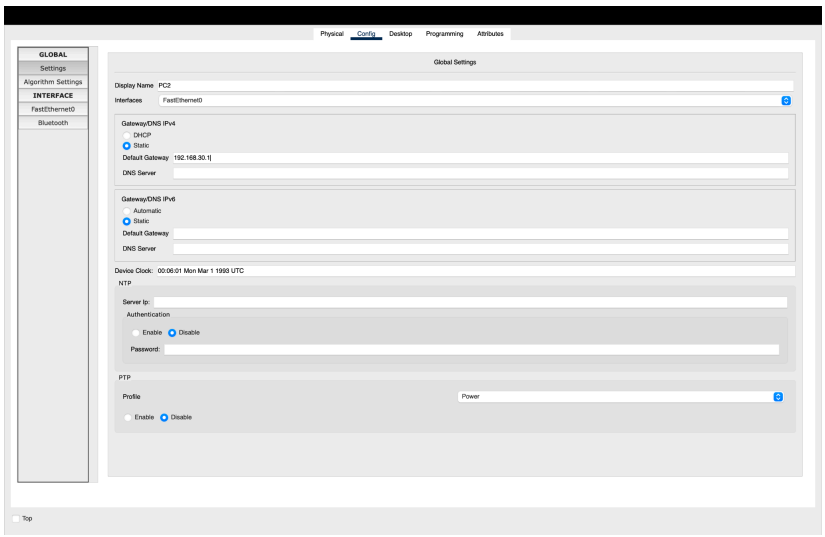




Edmonton Site – PC2

- **IPv4 Address:** `192.168.30.10`
- **Subnet Mask:** `255.255.255.0`
- **Default Gateway:** `192.168.30.1` (Router_Edmonton LAN interface)

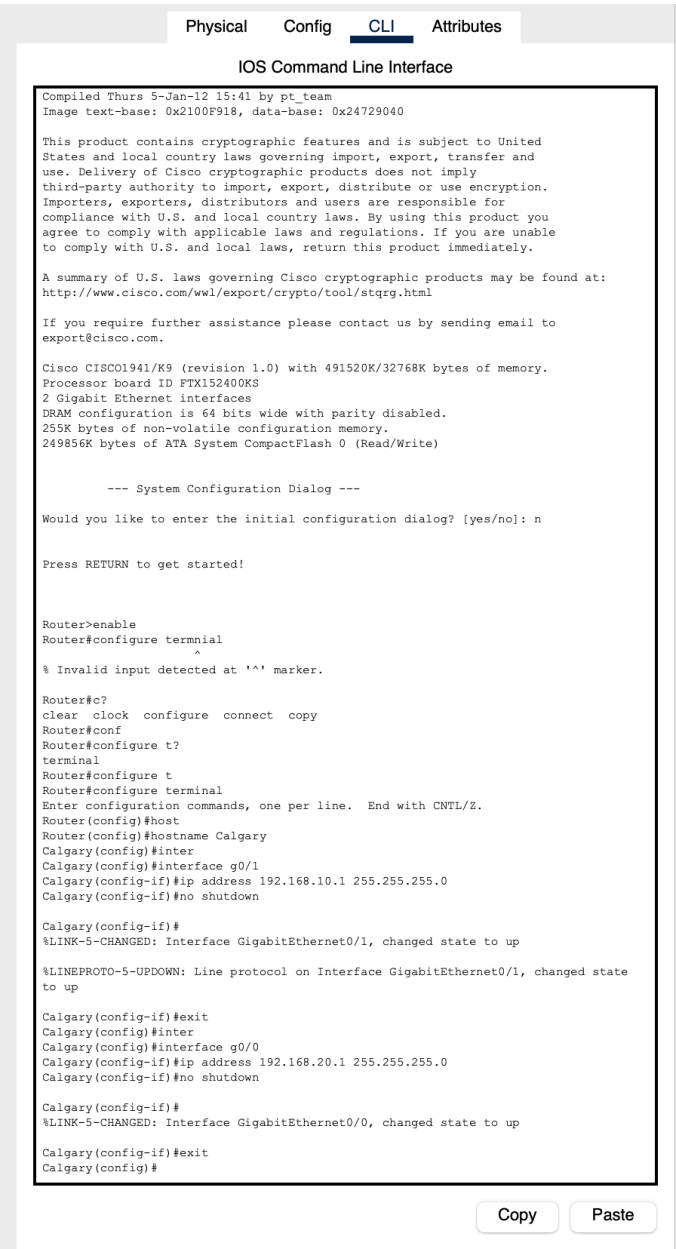




Step 4: Configure Router Interfaces

In this step, we configure the routers to enable Layer 3 routing and inter-network communication. Each router is assigned IP addresses on its LAN interface and on the point-to-point link connecting Calgary and Edmonton.

Calgary Router Configuration

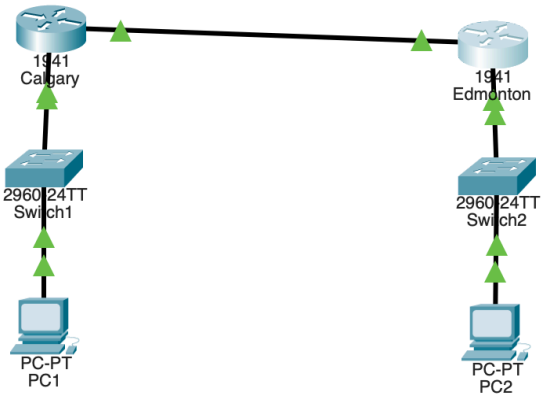


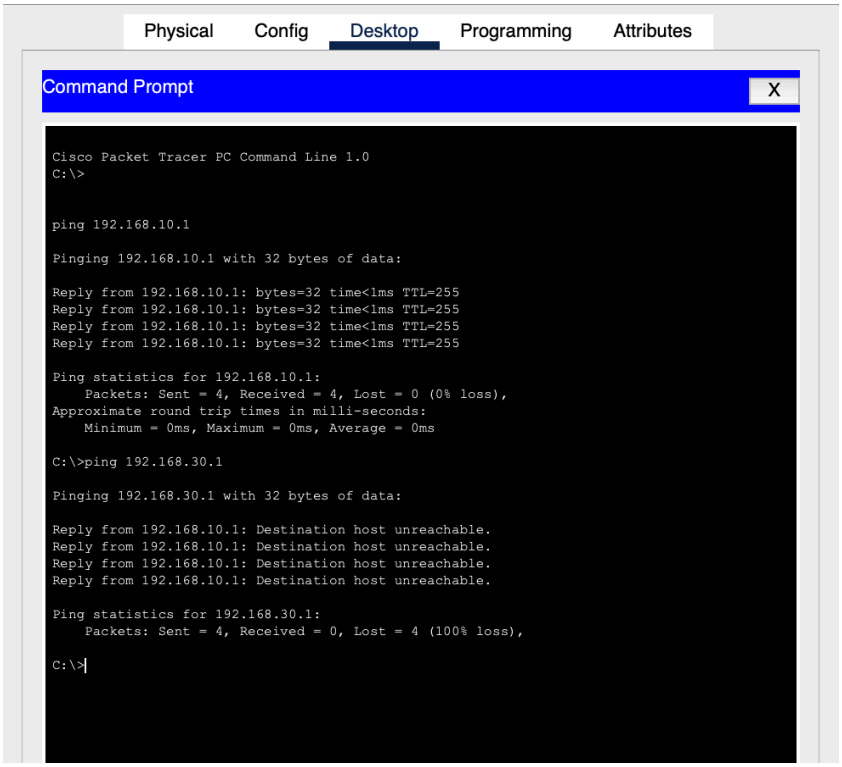
Edmonton Router Configuration

```
Cisco IOS Software, C1900 Software (C1900-UNIVERSALK9-M), Version 15.1(4)M4,
SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2012 by Cisco Systems, Inc.
Compiled Thurs 5-Jan-12 15:41 by pt_team
Image text-base: 0x2100F918, data-base: 0x24729040

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 a
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 CISCO1941/K9 (revision 1.0) with 491520K/32768K bytes of memory.
Processor board ID FTX152400KS
2 Gigabit Ethernet interfaces
DRAM configuration is 64 bits wide with parity disabled.
255K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)


         --- System Configuration Dialog ---

Would you like to enter the initial configuration dialog? [yes/no]: n


Press RETURN to get started!



Router>enable
Router#conf
Router#configure t
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#host
Router(config)#hostname Edmonton
Edmonton(config)#inter
Edmonton(config)#interface g0/1
Edmonton(config-if)#ip address 192.168.30.1 255.255.255.0
Edmonton(config-if)#no shutdown

Edmonton(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed

Edmonton(config-if)#exit
Edmonton(config)#inter
Edmonton(config)#interface g0/0
Edmonton(config-if)#192.168.20.2 255.255.255.0
                   ^
% Invalid input detected at '^' marker.

Edmonton(config-if)#no shutdown

Edmonton(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed

Edmonton(config-if)#exit
```

After configuring the router interfaces:

- LAN interfaces are active and communication within each site works properly.
- Router-to-router links are up, indicated by green arrows in Packet Tracer.
- End-to-end connectivity between Calgary and Edmonton PCs is not yet established, as routing between networks still needs to be configured.





Step 5.1: Configure Static Routing Between Calgary and Edmonton

In this step, **static routes** are configured on both routers to enable communication between the Calgary and Edmonton networks.

Verify Routing Table (Before Configuration)

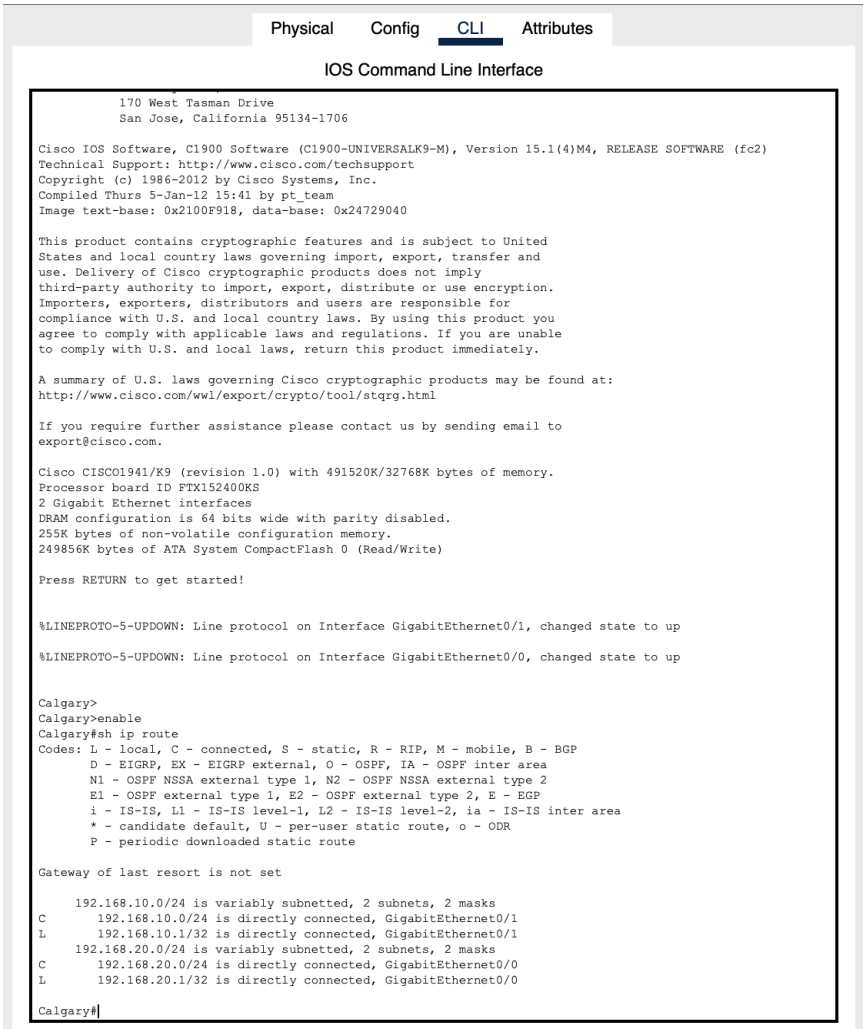
Before adding static routes, the routing table is checked to confirm that the remote network is not reachable.

Command used:

```
sh ip route
```

Observation:

- The **192.168.30.0/24** network is **not present** in the Calgary router's routing table.
- This confirms that the router does not yet know how to reach the Edmonton LAN.



Configure Static Route on Calgary Router

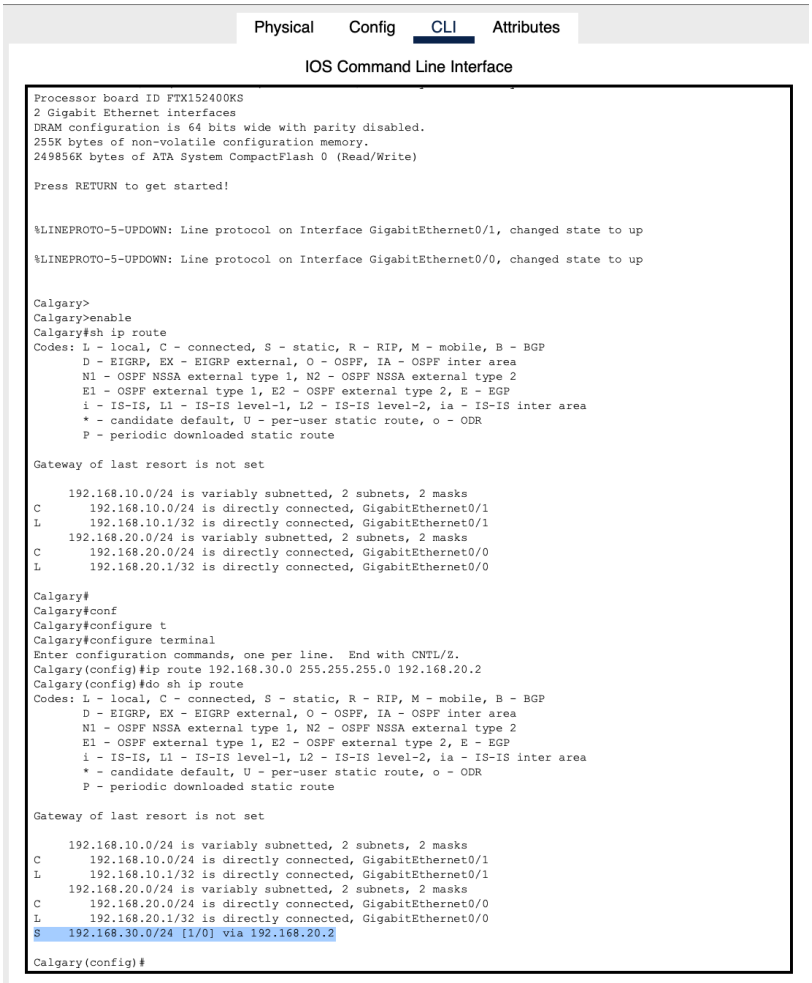
```
Calgary#
Calgary#conf
Calgary#configure t
Calgary#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Calgary(config)#ip route 192.168.30.0 255.255.255.0 192.168.20.2
```

Verify the routing table:

```
do sh ip route
```

Observation:

- The 192.168.30.0/24 network now appears in the routing table as a static route.
- This confirms the route has been successfully added.



Configure Static Route on Edmonton Router

Repeat the same process on the Edmonton router to reach the Calgary network.

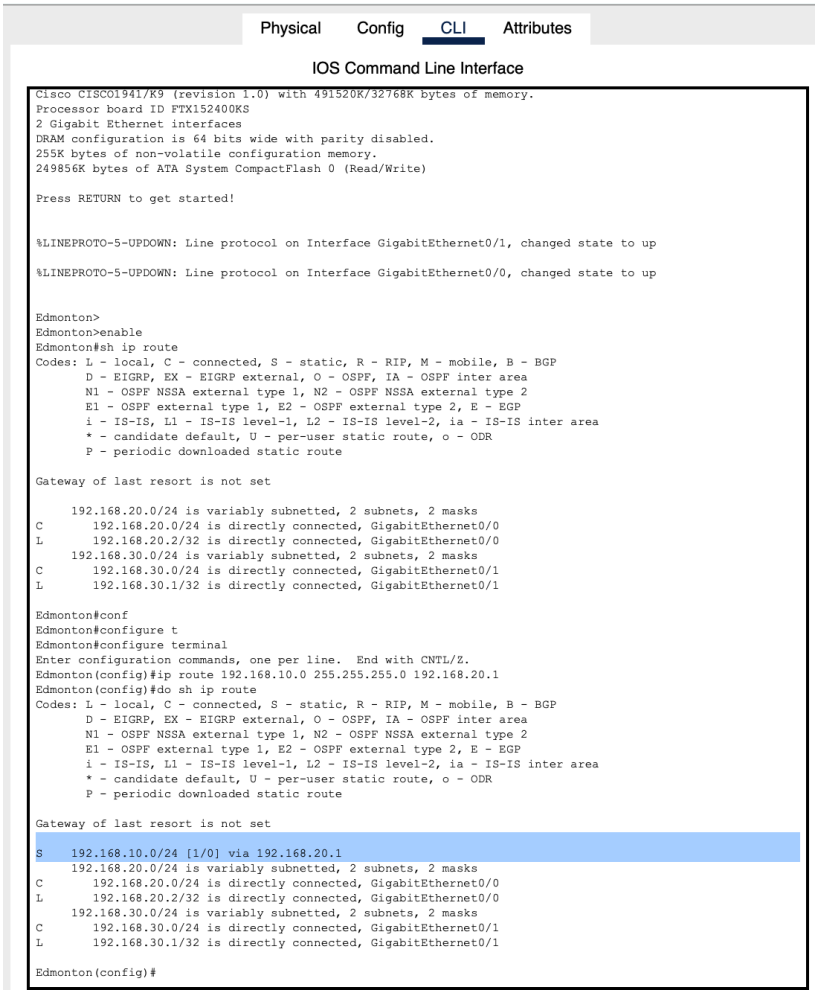
```
Edmonton#conf
Edmonton#configure t
Edmonton#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Edmonton(config)#ip route 192.168.10.0 255.255.255.0 192.168.20.1
```

Verify the routing table:

```
do sh ip route
```

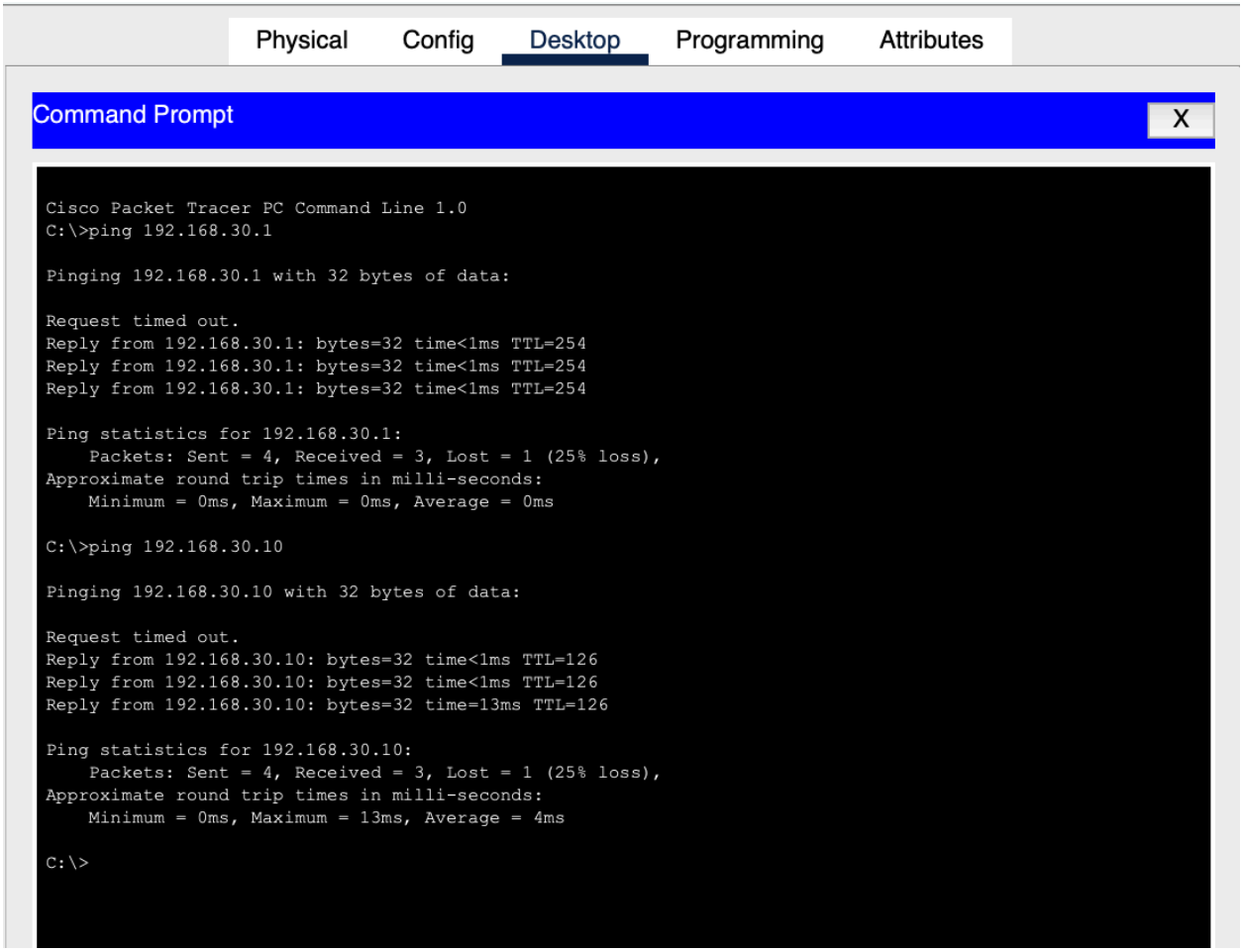
Observation:

- The **192.168.10.0/24** network appears in the Edmonton router's routing table.



Result

- Both routers now have static routes to each other's LAN networks.
- The routing tables confirm reachability between Calgary and Edmonton.
- End-to-end connectivity between **PC1 and PC2** is now possible.



Conclusion: Static Routing

Static routing is suitable for small networks where the topology rarely changes. While simple and easy to control, static routes require manual configuration, making them difficult to manage as networks grow.

For larger or more complex networks, **dynamic routing protocols** such as **RIPv2, OSPF, and EIGRP** automatically learn and update routes, improving scalability, efficiency, and fault tolerance.

Step 5.2: Configure RIP Version 2 Between Calgary and Edmonton

Distance-vector routing protocols, such as RIPv2, determine the best path based on metrics like hop count and periodically share routing information with neighboring routers. While simple to configure, these protocols may experience slower convergence in larger networks. This step demonstrates how RIPv2 enables dynamic routing between the Calgary and Edmonton sites.

Configure RIPv2 on Calgary Router

```
Calgary>
Calgary>enable
Calgary#config
Calgary#configure t
Calgary#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Calgary(config)#router rip
Calgary(config-router)#version 2
Calgary(config-router)#network 192.168.20.0
Calgary(config-router)#network 192.168.10.0
Calgary(config-router)#exit
Calgary(config)#
```

Configure RIPv2 on Edmonton Router

```
Edmonton>
Edmonton>enable
Edmonton#conf
Edmonton#configure t
Edmonton#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Edmonton(config)#router rip
Edmonton(config-router)#version 2
Edmonton(config-router)#network 192.168.20.0
Edmonton(config-router)#network 192.168.30.0
Edmonton(config-router)#exit
Edmonton(config)#
```

Verify RIP Routing

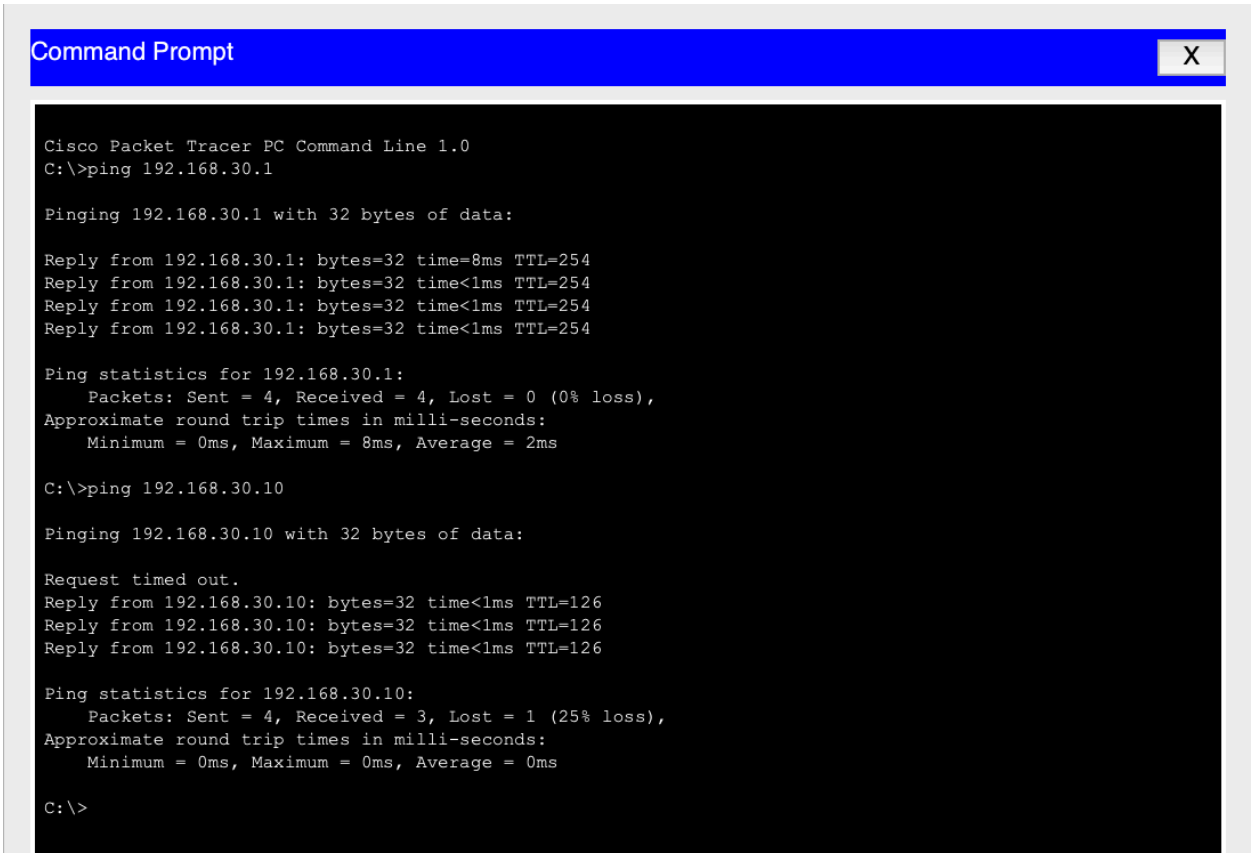
```
Gateway of last resort is not set

R    192.168.10.0/24 [120/1] via 192.168.20.1, 00:00:24, GigabitEthernet0/0
     192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.20.0/24 is directly connected, GigabitEthernet0/0
L       192.168.20.2/32 is directly connected, GigabitEthernet0/0
     192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.30.0/24 is directly connected, GigabitEthernet0/1
L       192.168.30.1/32 is directly connected, GigabitEthernet0/1

Edmonton(config)#
```

Observation:

- Routes learned via RIP appear in the routing table, indicated by R.
- This confirms successful route exchange between Calgary and Edmonton.

End-to-End Connectivity Test

- From **PC1**, ping **PC2**:
    - ping 192.168.30.1 (router_Edmonton)
    - Ping 192.168.30.10 (PC2)
- Successful replies confirm that RIPv2 dynamic routing is functioning correctly.



Conclusion

RIPv2 successfully enables dynamic routing between the Calgary and Edmonton networks. Routers automatically learn and update routes without manual configuration, demonstrating improved scalability compared to static routing. While suitable for small networks, RIPv2's hop-count limitation makes it less efficient for larger environments.

Step 5.3: Configure OSPF Routing Between Calgary and Edmonton

OSPF (**Open Shortest Path First**) is a **link-state routing protocol** that builds a complete map of the network topology and calculates the shortest path to each network using the **Dijkstra algorithm**. OSPF converges faster than distance-vector protocols and scales efficiently in medium to large networks. This step demonstrates how OSPF enables dynamic routing between the Calgary and Edmonton sites.

Configure OSPF on Calgary Router

```
Calgary>
Calgary>enable
Calgary#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Calgary(config)#router ospf 1
Calgary(config-router)#router ospf 1
Calgary(config-router)#network 192.168.10.0 0.0.0.255 area 1
Calgary(config-router)#network 192.168.20.0 0.0.0.255 area 1
Calgary(config-router)#exit
Calgary(config)#
```

Configure OSPF on Edmonton Router

```
Edmonton>
Edmonton>en
Edmonton#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Edmonton(config)#router ospf 1
Edmonton(config-router)#network 192.168.20.0 0.0.0.255 area 1
Edmonton(config-router)#network 192.168.30.0 0.0.0.255 area 1
00:19:38: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.20.1 on GigabitEthernet0/0 from LOADING to FULL, Loading
Done
```

Verify OSPF Routing

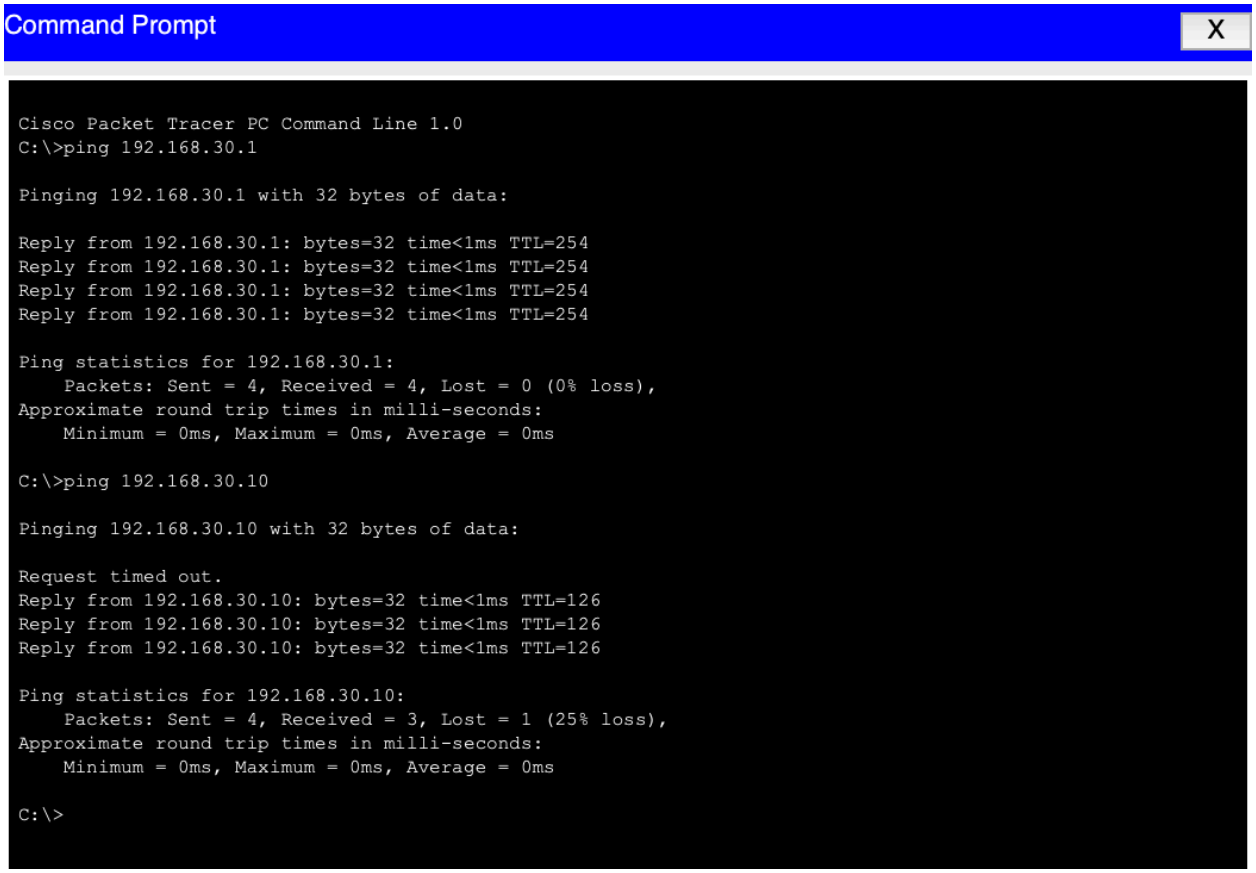
```
Gateway of last resort is not set

O    192.168.10.0/24 [110/2] via 192.168.20.1, 00:00:49, GigabitEthernet0/0
     192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.20.0/24 is directly connected, GigabitEthernet0/0
L       192.168.20.2/32 is directly connected, GigabitEthernet0/0
     192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.30.0/24 is directly connected, GigabitEthernet0/1
L       192.168.30.1/32 is directly connected, GigabitEthernet0/1

Edmonton(config-router)#
```

Observation:

- Routes learned via OSPF appear in the routing table, indicated by O.
- The OSPF neighbor relationship between Calgary and Edmonton routers is established.

End-to-End Connectivity Test

- From **PC1**, ping **PC2**:
    - ping 192.168.30.1 (router_Edmonton)
    - Ping 192.168.30.10 (PC2)
- Successful replies confirm that OSPF dynamic routing is functioning correctly.



Conclusion

OSPF successfully enables dynamic routing between Calgary and Edmonton. Routers automatically learn all network routes, calculate the shortest path, and adapt to topology changes. Compared to RIPv2, OSPF provides **faster convergence, better scalability, and more efficient routing**, making it suitable for medium to large networks.

Step 5.4: Configure EIGRP Routing Between Calgary and Edmonton

EIGRP (**Enhanced Interior Gateway Routing Protocol**) is an **advanced distance-vector routing protocol** that incorporates some link-state features. EIGRP uses the **DUAL algorithm** to calculate loop-free paths and supports fast convergence and efficient route updates. This step demonstrates how EIGRP enables dynamic routing between the Calgary and Edmonton sites.

Configure EIGRP on Calgary Router

```
Calgary>
Calgary>en
Calgary#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Calgary(config)#router eigrp 1
Calgary(config-router)#network 192.168.10.0
Calgary(config-router)#network 192.168.20.0
Calgary(config-router)#exit
Calgary(config)#
```

Configure EIGRP on Edmonton Router

```
Edmonton>
Edmonton>en
Edmonton#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Edmonton(config)#router eigrp 1
Edmonton(config-router)#network 192.168.30.0
Edmonton(config-router)#network 192.168.20.0
Edmonton(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 192.168.20.1 (GigabitEthernet0/0) is up: new adjacency
```

Verify EIGRP Routing

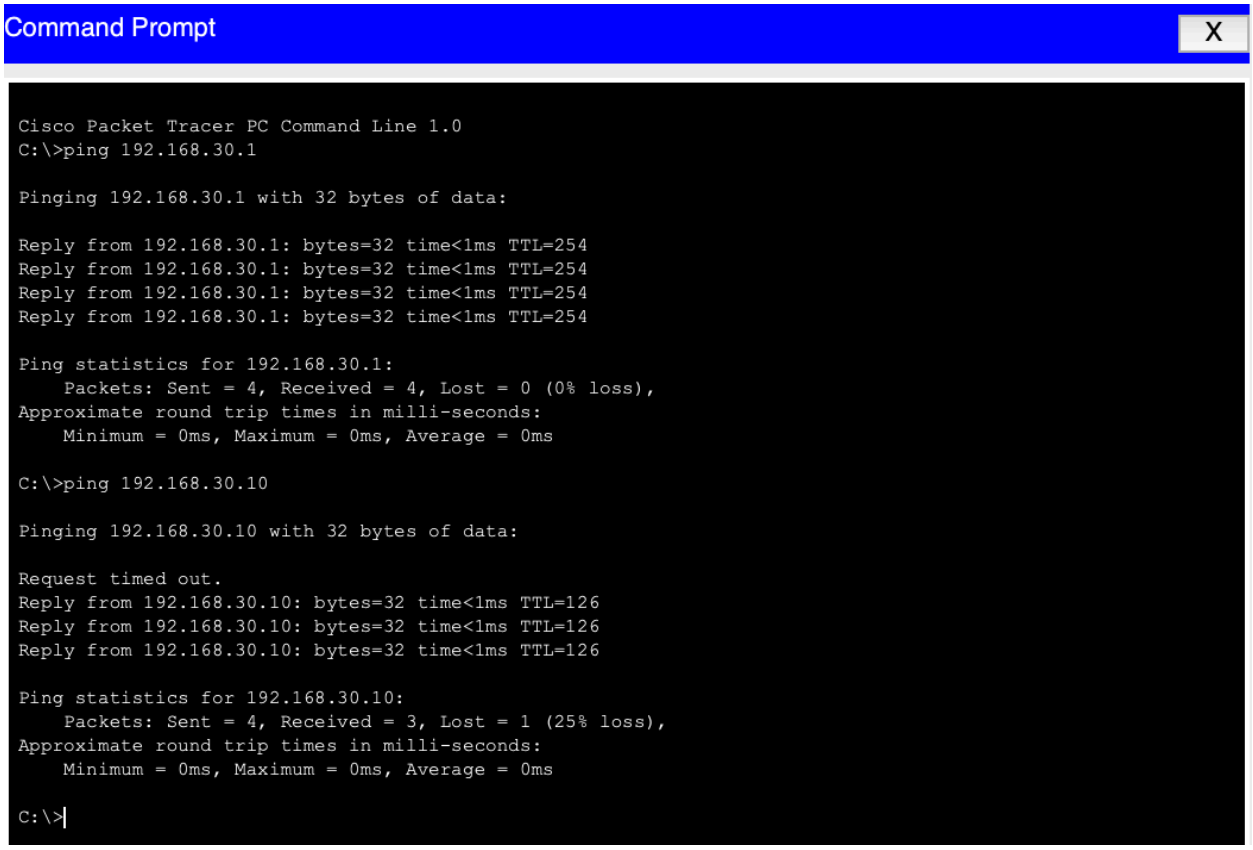
```
Gateway of last resort is not set

D    192.168.10.0/24 [90/28416] via 192.168.20.1, 00:00:43, GigabitEthernet0/0
     192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.20.0/24 is directly connected, GigabitEthernet0/0
L       192.168.20.2/32 is directly connected, GigabitEthernet0/0
     192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.30.0/24 is directly connected, GigabitEthernet0/1
L       192.168.30.1/32 is directly connected, GigabitEthernet0/1

Edmonton(config-router)#
```

Observation:

- Routes learned via EIGRP appear in the routing table, indicated by D.
- The EIGRP neighbour relationship between Calgary and Edmonton routers is established.

End-to-End Connectivity Test

- From **PC1**, ping **PC2**:
    - ping 192.168.30.1 (router_Edmonton)
    - Ping 192.168.30.10 (PC2)
- Successful replies confirm that EIGRP dynamic routing is functioning correctly.



Conclusion

EIGRP successfully enables dynamic routing between Calgary and Edmonton. Routers automatically learn all network routes, calculate optimal paths using the DUAL algorithm, and quickly adapt to topology changes. Compared to RIPv2, EIGRP provides **faster convergence and better scalability**, while retaining some simplicity for small to medium-sized networks.

Final Lab Conclusion

This lab demonstrated the design and configuration of a two-site network between Calgary and Edmonton. Key tasks included:

- Configuring PCs, switches, and routers
- Implementing **static routing** to establish initial connectivity
- Deploying dynamic routing protocols: **RIPv2, OSPF, and EIGRP**

Through this lab, the following networking concepts were reinforced: **IP addressing, Layer 2 switching, Layer 3 routing, static and dynamic routing, distance-vector and link-state protocols, and end-to-end connectivity verification**.

The lab illustrates how routing evolves from **manual static routing** to **dynamic routing protocols**, highlighting the benefits of faster convergence, adaptability, and efficient route calculation for scalable network designs.