IP Routing Protocols Labs

Course Focus: CCNA – IP Routing (Labs)

Abstract

This report presents a series of IP routing labs using Cisco Packet Tracer. Topics include DHCP via servers and routers, Default Routing, Static Routing, RIP (v1 & v2), EIGRP, OSPF (Single & Multi-Area), and BGP. These labs align with CCNA objectives, offering hands-on practice in configuring and troubleshooting routing protocols

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geraldosembiring@gmail.com

Included Lab Configurations:

1. DHCP (Dynamic Host Configuration Protocol) Using Server
2. DHCP (Dynamic Host Configuration Protocol) Using Router
3. Default Routing
4. Static Routing
5. RIP v1 & RIP v2
6. EIGRP (Different Autonomus Systems)
7. OSPF – Single Area
8. OSPF – Multi Area
9. BGP – Path Vector Routing

Tools Used:

- Cisco Packet Tracer
- Cisco 1941 Routers
- Cisco 2960-24TT Switches
- PC-PT and Server-PT End Devices
- CLI Configuration on Routers and PCs

1. Introduction

This report covers the fundamentals and practical implementation of IP routing in CCNA, including DHCP using both routers and external servers, Default Routing, Static Routing, Dynamic Routing (RIP, EIGRP, OSPF, BGP).

2. Theoretical Overview

DHCP (Dynamic Host Configuration Protocol)

DHCP is a service that automatically gives IP addresses to computers and devices. Instead of setting IPs manually on each device, the DHCP server does it for you — it gives the IP address, subnet mask, default gateway, and DNS. This makes it easier to manage big networks. You can use a router as the DHCP server in small networks, or a separate DHCP server in bigger ones. If the server is not in the same network, the router can forward the request using the ip helper-address command.

- Assigns IP, subnet, gateway, and DNS to hosts.
- Can be provided by router or dedicated server.
- Router must use ip helper-address if DHCP server is in another network.

IP Routing

Routing is the process of moving packets from one network to another. Routers use routing tables to decide the path a packet should take to reach its destination.

Routing involves two main tasks:

1. Determining the best path for data to travel across networks.
2. Forwarding packets to their destination via the chosen path.

Types of Routing:

1. Default Routing
2. Static Routing
3. Dynamic Routing

1. Default Routing

Default routing is used to send packets to a default path when no specific route is found in the routing table. Default routing is like a backup route. If a router doesn't know where to send a packet, it sends it to the default route. It's useful in networks with only one way out.

Key Features:

- Acts like a "catch-all" route for unknown destinations.
- Often used in stub networks (networks with only one exit path).
- Usually configured with the IP address of a next-hop router.

  Example: ip route 0.0.0.0 0.0.0.0 192.168.1.1

2. Static Routing

Static routing means the network admin sets the path manually. It's secure, fast, and works well in small networks where routes don't change often. You must know the destination to set it up.

- Routes are manually configured by a network administrator.
- It is more secure and faster than dynamic routing in small networks.
- The destination network address must be known to configure the route.
- Best suited for small and simple networks where paths don't change frequently.

  Example: ip route 192.168.2.0 255.255.255.0 192.168.1.2

3. Dynamic Routing

Dynamic routing is a method where routers automatically learn and update routes using routing protocols. Dynamic routing means routers talk to each other and share

route information. If something changes in the network, they update the paths automatically. It's good for big networks but uses more resources.

Key Features:

- Routers exchange information with each other using routing protocols.
- Routes are automatically adjusted if the network topology changes.
- Suitable for large or complex networks.
- Requires more CPU, memory, and bandwidth compared to static routing.

Common Dynamic Routing Protocols:

- RIP (Routing Information Protocol)
- EIGRP (Enhanced Interior Gateway Routing Protocol)
- OSPF (Open Shortest Path First)
- BGP (Border Gateway Protocol)

RIP (Distance Vector)

- Uses hop count.
- Simple but slow and limited.

EIGRP (Advanced Distance Vector)

- Cisco proprietary.
- Uses DUAL algorithm.

OSPF (Link-State)

- Open standard.
- Fast convergence and area-based.

BGP (Path Vector)

- Open standard used between different autonomous systems.
- Uses attributes like AS-path for route selection.

3. **Practical Lab Summary**

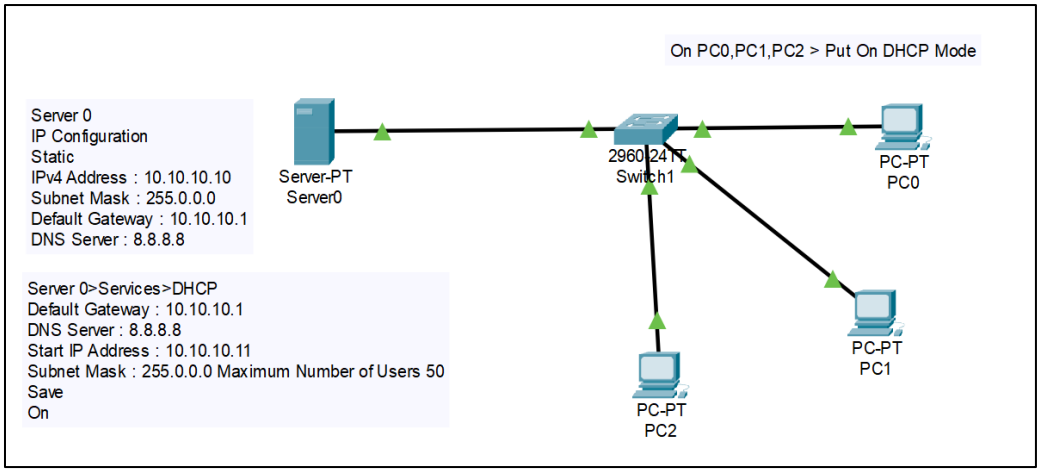
Lab 1: DHCP (Dynamic Host Configuration Protocol) Using Server

DHCP automatically assigns IP addresses and network settings to devices, making network management easier and faster.

Objective: To configure a DHCP Server in a local network environment using Packet Tracer, allowing a PC to automatically obtain an IP address without using a router.

Topology :

- PC0, PC1, PC2 : End Device to receive IP via DHCP
- Switch0 : Provides Layer 2 Connectivity
- Server0 : Acts as the DHCP Server



IP Addressing Table

Device	Interface	IP Address	Subnet mask	Default Gateway
Server0	Fast Ethernet	10.10.10.10	255.0.0.0	10.10.10.1
PC0	DHCP	Assigned dynamically (e.g. 10.10.10.11+)	255.0.0.0	10.10.10.1
PC1	DHCP	Assigned dynamically (e.g. 10.10.10.11+)	255.0.0.0	10.10.10.1
PC2	DHCP	Assigned dynamically (e.g. 10.10.10.11+)	255.0.0.0	10.10.10.1

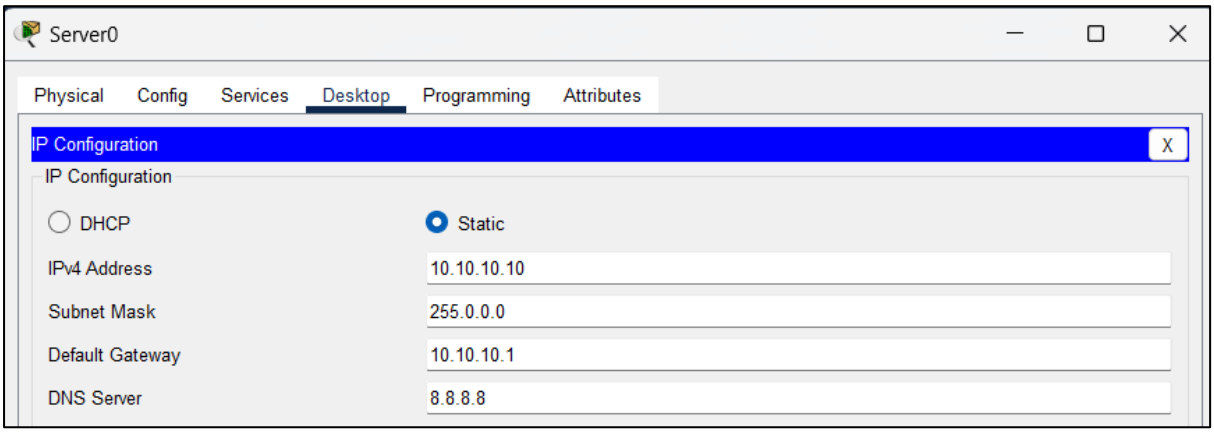
Note: Default gateway 10.0.0.1 is assigned for future scalability, but no router is present in this lab.

Configuration Steps :

1. Configure Server 0 (DHCP Server)

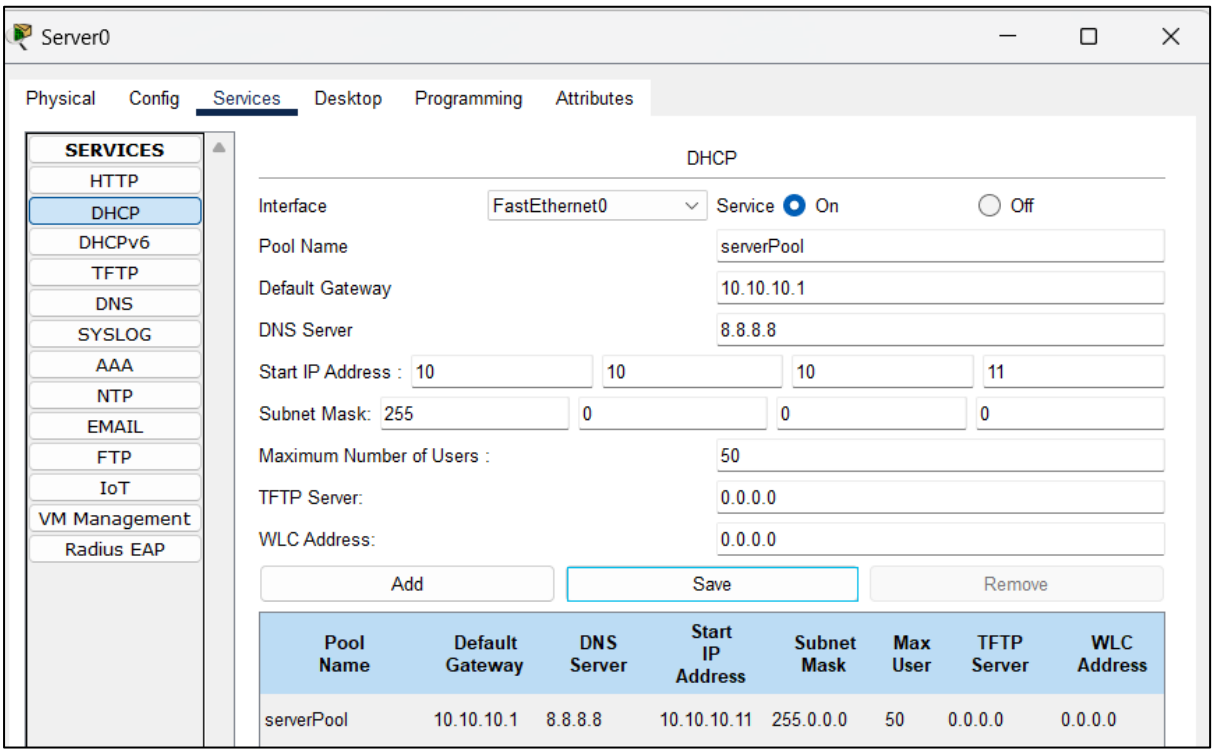
- Go to Server0 > Desktop > IP Configuration

  Set:



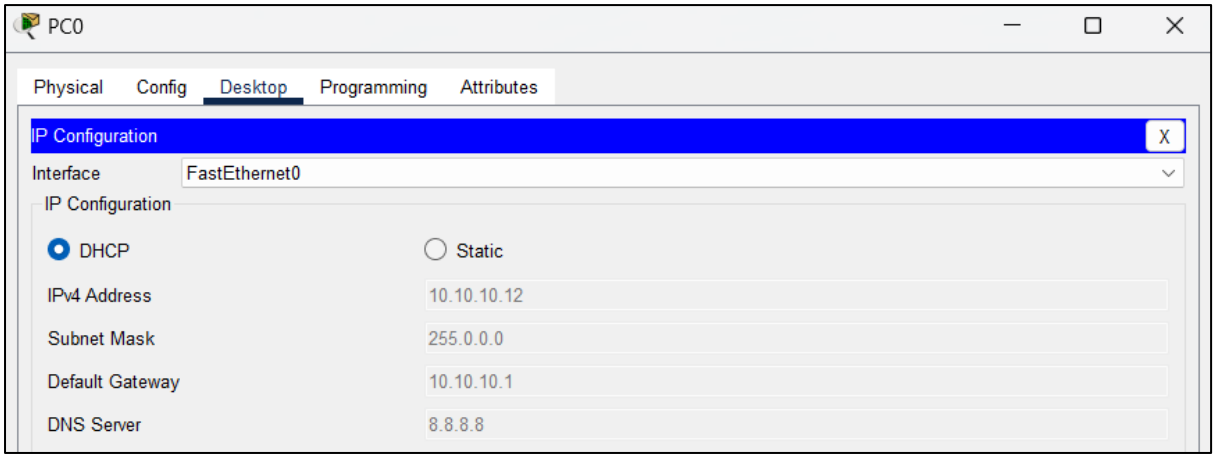
- Go to Service > DHCP

  Enable DHCP and Configure



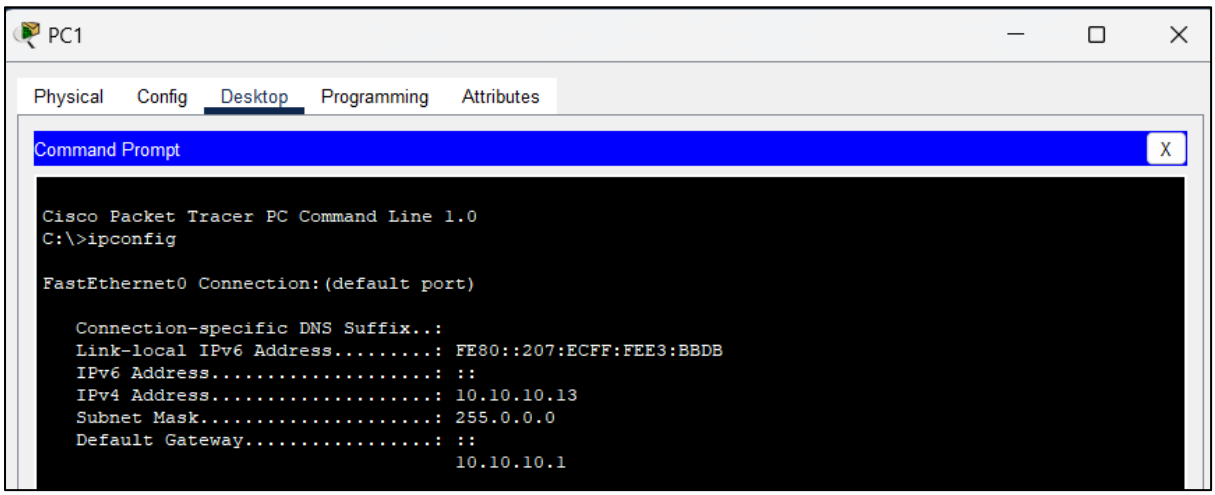
2. Configure to PC0, PC1, PC2 to Use DHCP

- Go to PC0, PC1, PC2 > Desktop > IP Configuration
- Select DHCP
- Wait a few seconds for the IP to be assigned automatically

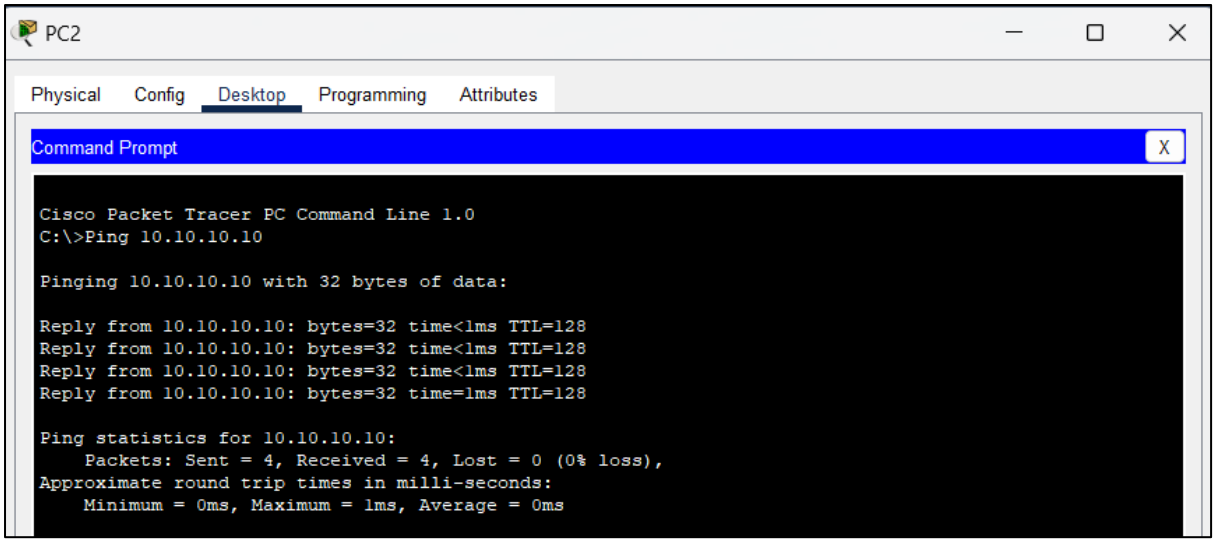


Verification :

- From PC0, PC1, PC2 > Command Prompt, use : ipconfig



- Ping the DHCP Server : ping 10.10.10.10

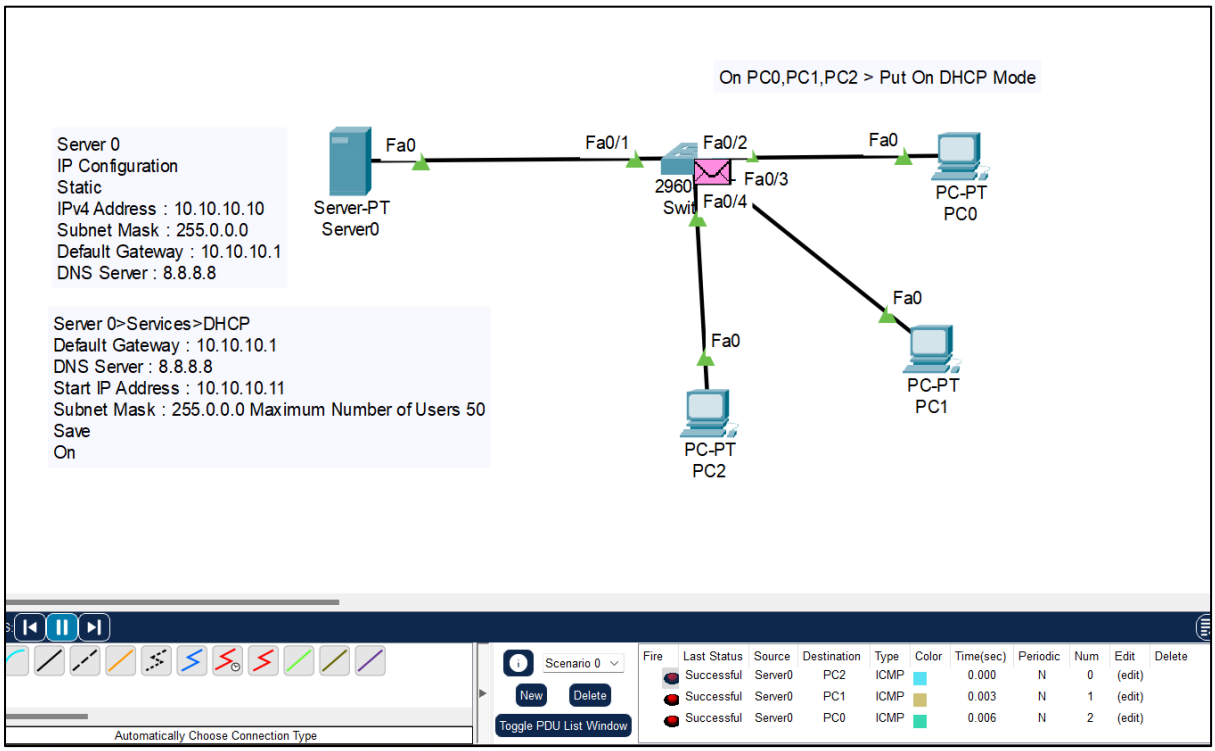


Output :

- IP Configuration Result from PC0, PC1 and PC2 (ipconfig)
- Successful ping to Server0

Conclusion :

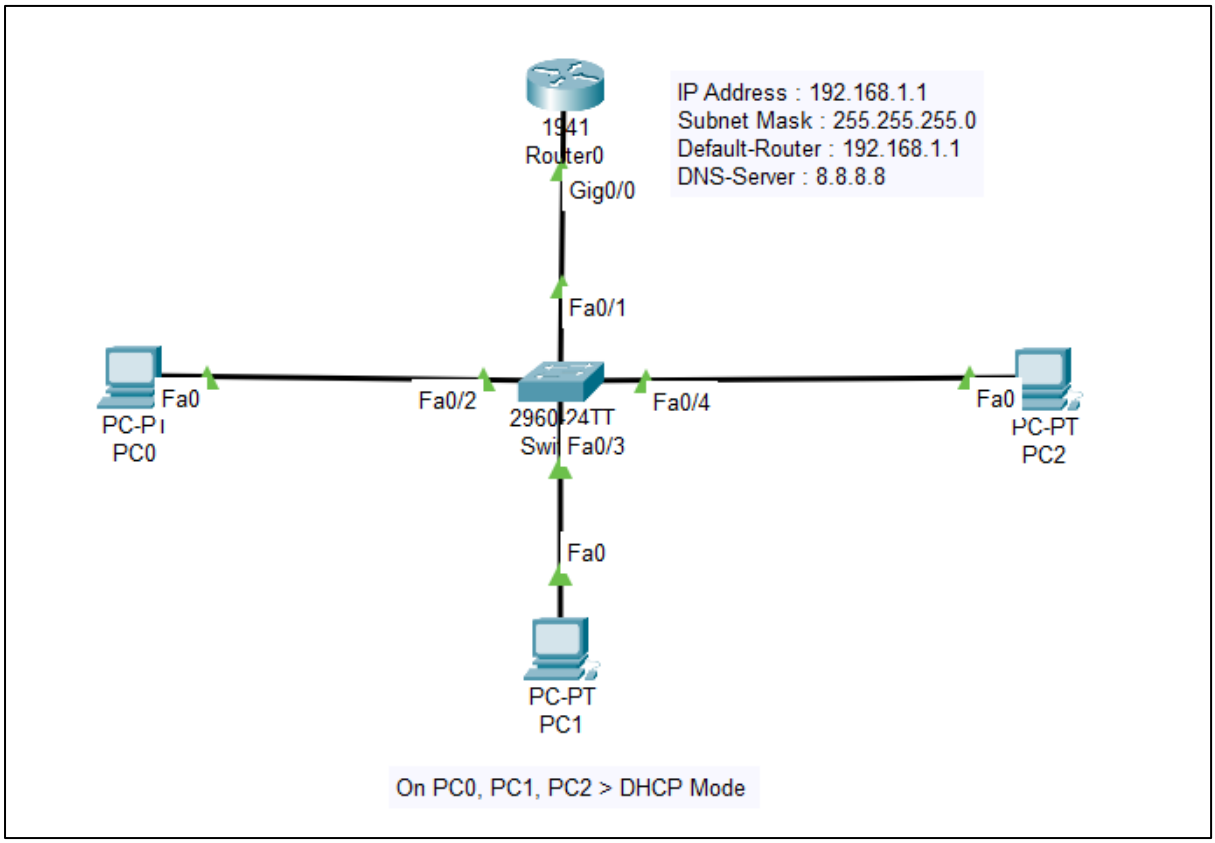
This lab demonstrated how to configure a DHCP Server without a router in a basic LAN. PC0, PC1 and PC2 was able to successfully receive an IP address, subnet mask, gateway, and DNS server from the DHCP service running on Server0. This setup is ideal for internal networks or small labs where a router is not required.



Lab 2 : DHCP (Dynamic Host Configuration Protocol) Using Router

To configure a Cisco router to act as a DHCP server and dynamically assign IP addresses to PCs in a LAN.

Network Topology :



Router Configuration :

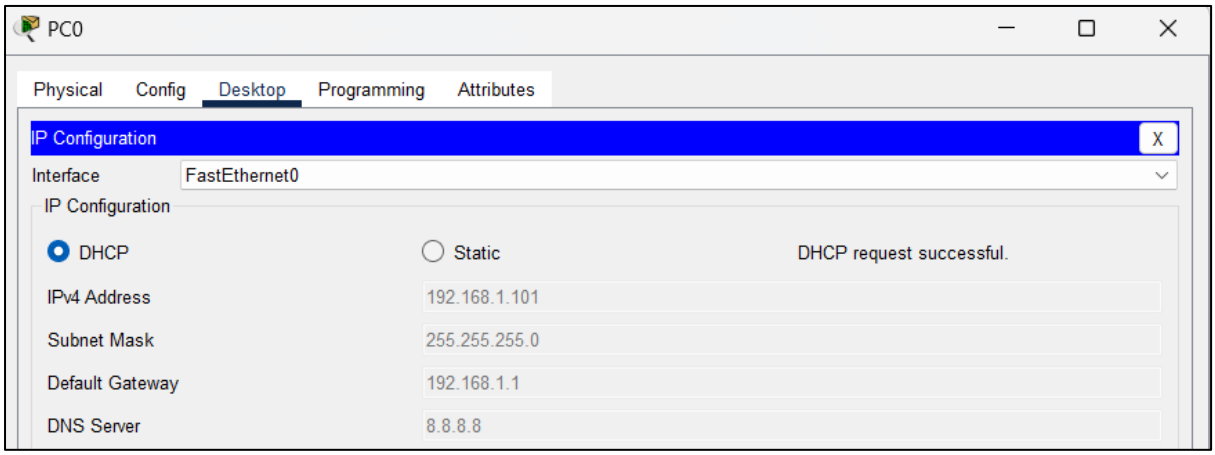
```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface gigabitEthernet 0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown

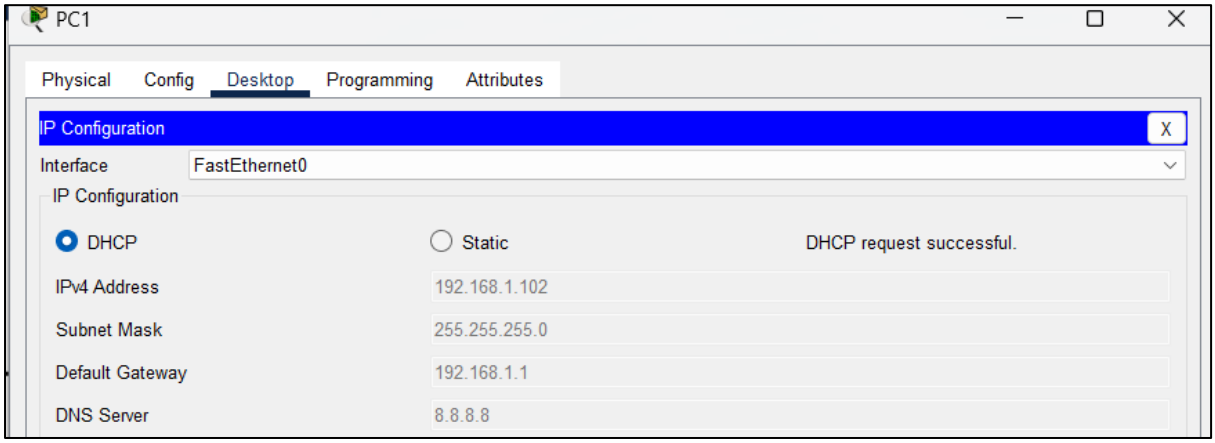
Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

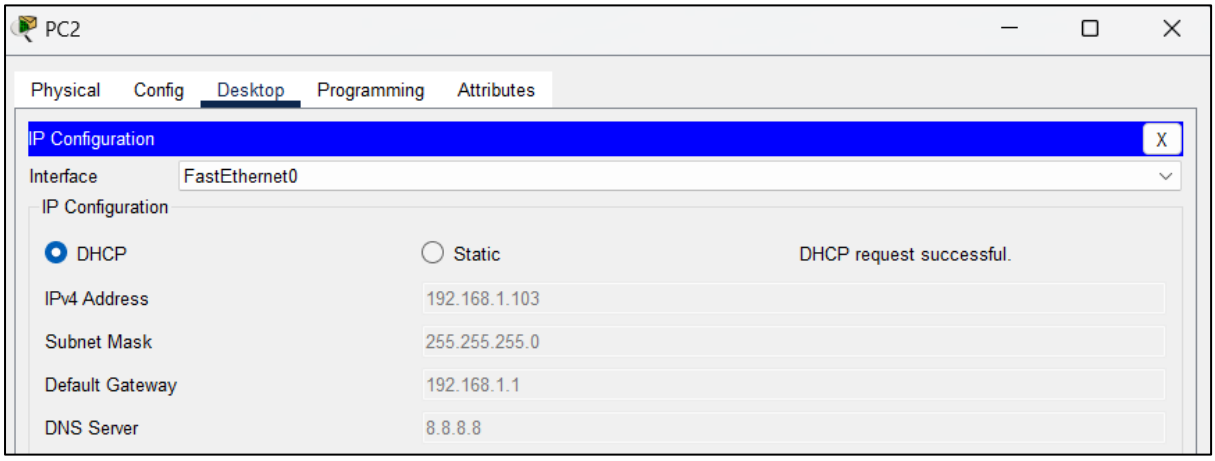
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

Router(config-if)#exit
Router(config)#ip dhcp excluded-address 192.168.1.1 192.168.1.100
Router(config)#ip dhcp pool Lab2
Router(dhcp-config)#default-router 192.168.1.1
Router(dhcp-config)#dns-server 8.8.8.8
Router(dhcp-config)#network 192.168.1.0 255.255.255.0
Router(dhcp-config)#exit
```

PC0, PC1, PC2 : Set to DHCP mode under Desktop > IP Configuration



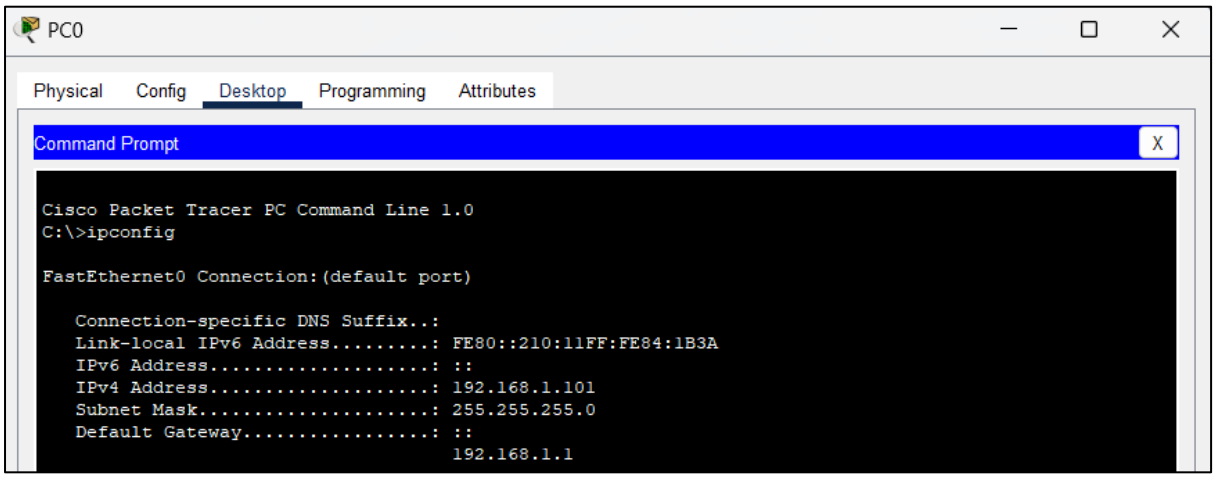


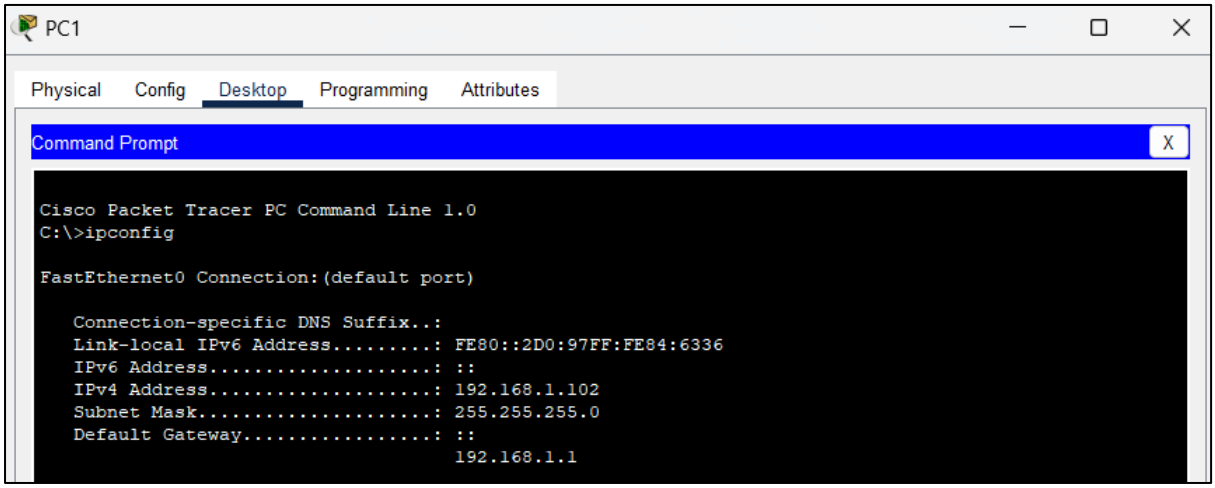


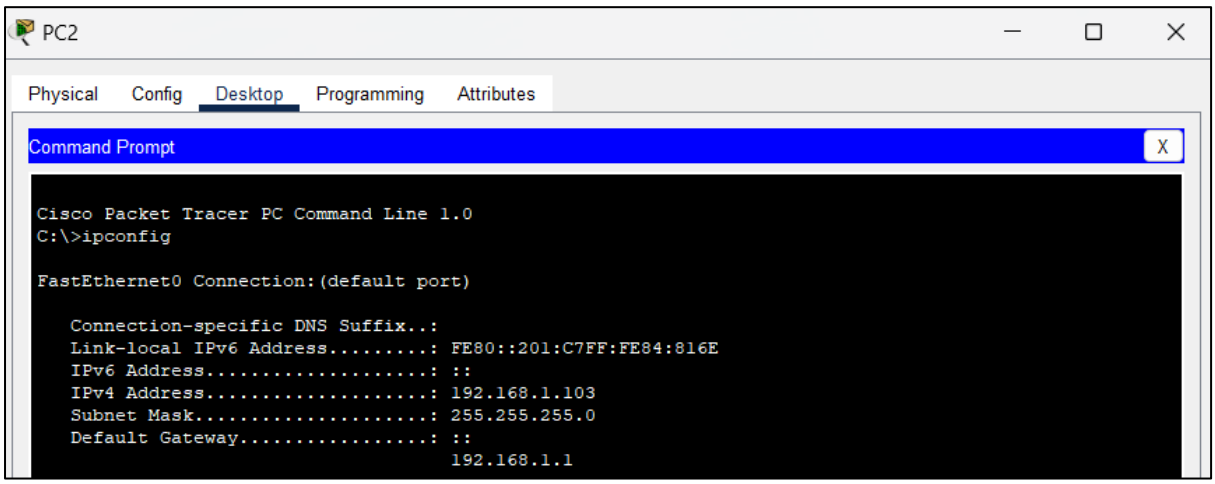
Verification :

Command Used on PCs :

Ipconfig





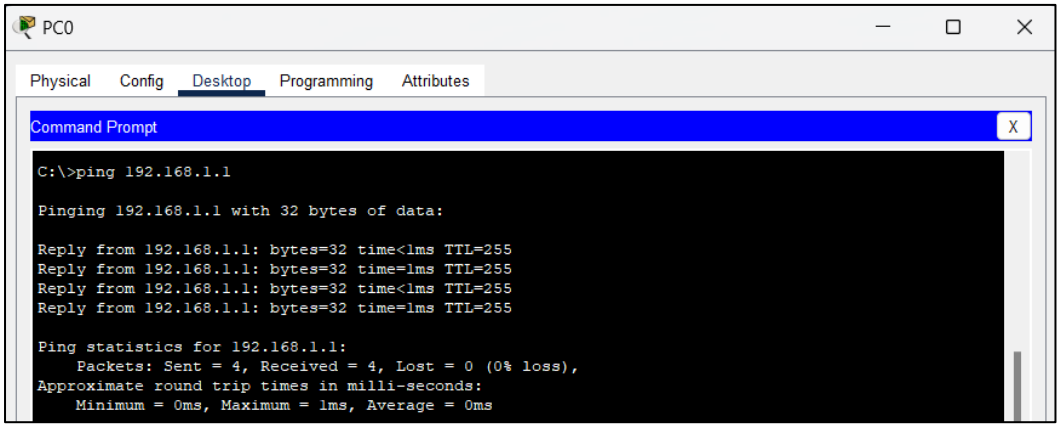


Output :

Device	IP Address	Subnet Mask	Default Gateway
PC0	192.168.1.101	255.255.255.0	192.168.1.1
PC1	192.168.1.102	255.255.255.0	192.168.1.1
PC2	192.168.1.103	255.255.255.0	192.168.1.1

Connectivity Test :

Ping 192.168.1.1



Ping between PC0, PC1, PC2

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.101

Pinging 192.168.1.101 with 32 bytes of data:

Reply from 192.168.1.101: bytes=32 time<1ms TTL=128
Reply from 192.168.1.101: bytes=32 time<1ms TTL=128
Reply from 192.168.1.101: bytes=32 time<1ms TTL=128
Reply from 192.168.1.101: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.1.101:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
C:\>ping 192.168.1.102

Pinging 192.168.1.102 with 32 bytes of data:

Reply from 192.168.1.102: bytes=32 time=14ms TTL=128
Reply from 192.168.1.102: bytes=32 time=14ms TTL=128
Reply from 192.168.1.102: bytes=32 time=7ms TTL=128
Reply from 192.168.1.102: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.1.102:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 14ms, Average = 8ms

C:\>ping 192.168.1.103

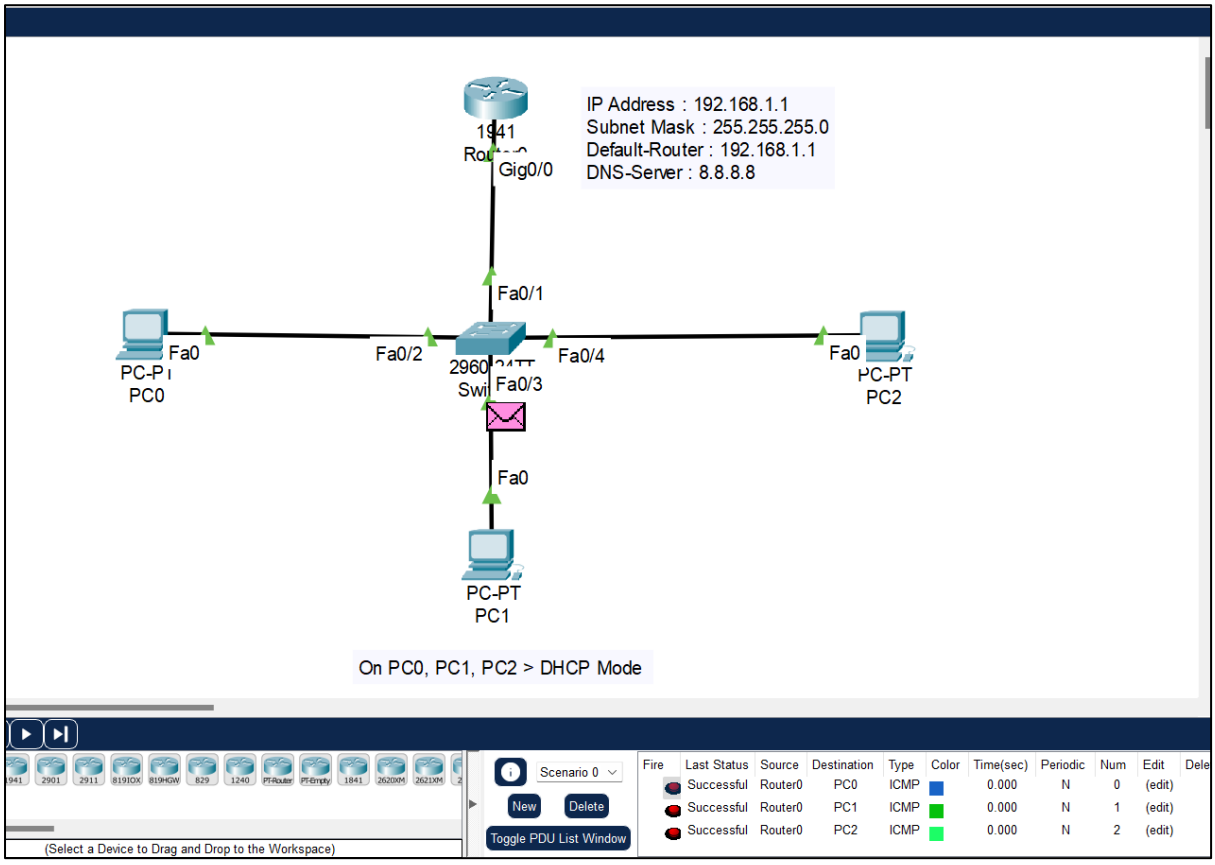
Pinging 192.168.1.103 with 32 bytes of data:

Reply from 192.168.1.103: bytes=32 time<1ms TTL=128
Reply from 192.168.1.103: bytes=32 time=1ms TTL=128
Reply from 192.168.1.103: bytes=32 time<1ms TTL=128
Reply from 192.168.1.103: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.1.103:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

Conclusion :

In this lab, a Cisco router was successfully configured to function as a DHCP server. Clients connected to the router through a switch received IP addresses dynamically from a specified pool. This method reduces manual IP assignment and ensures centralized IP management.



LAB 3 : Default Routing

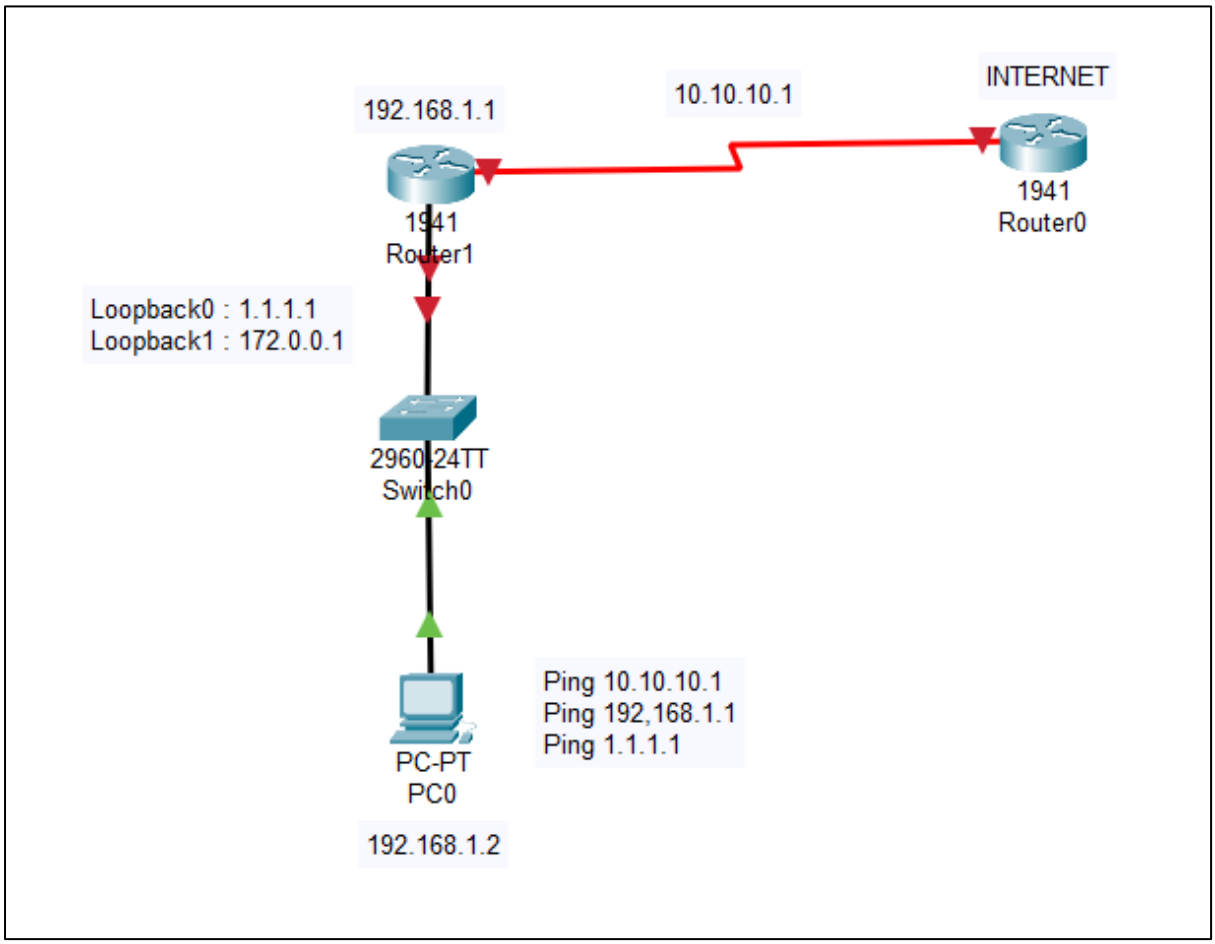
Default Routing is used when a router doesn't know where to send a packet, it sends it to a default route, often called the gateway of last resort.

It's like saying: "If you don't know where to go, just go this way."

It's most useful for edge routers (routers at the end of a network) that only need one path to reach all other networks.

Objective: To configure default routing between two routers so that a host (PC0) can communicate with unknown networks through a default gateway (Router0 → Router1). The lab will demonstrate how a router can forward packets to another router when the destination is not found in its routing table.

Network Topology :



IP Addressing Table :

Device	Interface	IP Address	Subnet Mask
Router0	S0/0/0	10.10.10.1	255.0.0.0
Router1	S0/0/0	10.10.10.2	255.0.0.0
Router1	Gi0/0	192.168.1.1	255.255.255.0
Router1	Loopback0	1.1.1.1	255.255.255.255
Router1	Loopback1	172.0.0.1	255.255.255.255
PC0	NIC	192.168.1.2	255.255.255.0

Configuration :

Router0

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface serial0/0/0
Router(config-if)#ip address 10.10.10.1 255.0.0.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0/0, changed state to down
Router(config-if)#ip route 192.168.1.0 255.255.255.0 10.10.10.2
Router(config)#exit
```

Router1

```
Router>enable
Router#configure terminal
Router(config)#interface Gigabitethernet0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface serial0/0/0
Router(config-if)#ip address 10.10.10.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface loopback0
Router(config-if)#ip address 1.1.1.1 255.255.255.255
Router(config-if)#exit
Router(config)#interface loopback1
Router(config-if)#ip address 172.0.0.1 255.255.255.255
Router(config-if)#exit
Router(config)#ip route 0.0.0.0 0.0.0.0 10.10.10.1
Router(config)#exit
```

Verification :

Router0#show ip route

Router0#show interface

```
Router#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.10.10.1/32 is directly connected, Serial0/0/0
S 192.168.1.0/24 [1/0] via 10.10.10.2

Router#show interface
GigabitEthernet0/0 is administratively down, line protocol is down
(disabled)
Hardware is CN Gigabit Ethernet, address is 0001.c78e.dd01 (bia
0001.c78e.dd01)
MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
Full-duplex, 100Mb/s, media type is RJ45
output flow-control is unsupported, input flow-control is unsupported
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
Input queue: 0/75/0 (size/max/drops); Total output drops: 0
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 watchdog, 1017 multicast, 0 pause input
0 input packets with dribble condition detected
0 packets output, 0 bytes, 0 underruns
0 output errors, 0 collisions, 1 interface resets
0 unknown protocol drops
0 babbles, 0 late collision, 0 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out
GigabitEthernet0/1 is administratively down, line protocol is down
(disabled)
Hardware is CN Gigabit Ethernet, address is 0001.c78e.dd02 (bia
0001.c78e.dd02)
MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
Full-duplex, 100Mb/s, media type is RJ45
output flow-control is unsupported, input flow-control is unsupported
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
Input queue: 0/75/0 (size/max/drops); Total output drops: 0
Queueing strategy: fifo
```

Router1#show ip route

Router1#show interface

```
Router#show ip route
Codes: L - local, 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, 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 10.10.10.1 to network 0.0.0.0

1.0.0.0/32 is subnetted, 1 subnets
C 1.1.1.1/32 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.10.10.2/32 is directly connected, Serial0/0/0
172.0.0.0/32 is subnetted, 1 subnets
C 172.0.0.1/32 is directly connected, Loopback1
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.1.0/24 is directly connected, GigabitEthernet0/0
L 192.168.1.1/32 is directly connected, GigabitEthernet0/0
S* 0.0.0.0/0 [1/0] via 10.10.10.1

Router#show interface
GigabitEthernet0/0 is up, line protocol is up (connected)
Hardware is CN Gigabit Ethernet, address is 0001.6457.4a01 (bia
0001.6457.4a01)
Internet address is 192.168.1.1/24
MTU 1500 bytes, BW 1000000 Kbit, DLY 100 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
Full-duplex, 100Mb/s, media type is RJ45
output flow-control is unsupported, input flow-control is unsupported
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
Input queue: 0/75/0 (size/max/drops); Total output drops: 0
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 watchdog, 1017 multicast, 0 pause input
0 input packets with dribble condition detected
0 packets output, 0 bytes, 0 underruns
0 output errors, 0 collisions, 1 interface resets
0 unknown protocol drops
0 babbles, 0 late collision, 0 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out
GigabitEthernet0/1 is administratively down, line protocol is down
(disabled)
Hardware is CN Gigabit Ethernet, address is 0001.6457.4a02 (bia
0001.6457.4a02)
```

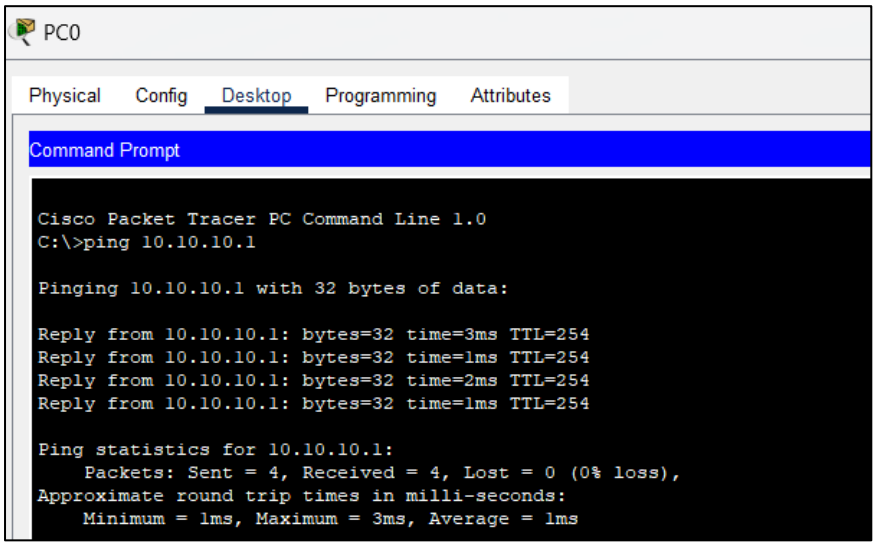
```
MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
Full-duplex, 100Mb/s, media type is RJ45
output flow-control is unsupported, input flow-control is unsupported
ARP type: ARPA, ARP Timeout 04:00:00,
Last input 00:00:08, output 00:00:05, output hang never
Last clearing of "show interface" counters never
Input queue: 0/75/0 (size/max/drops); Total output drops: 0
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
```

Output :

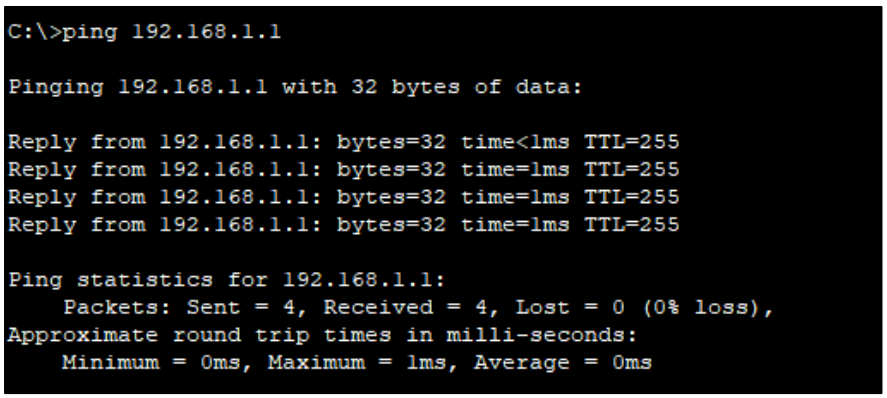
All devices are able to communicate successfully:

PC0 can ping :

Router1 Serial0/0/0 (10.10.10.1)



Router1 GigabitEthernet0/0 (192.168.1.1)



Router0 Loopback0 (1.1.1.1)

```
C:\>ping 1.1.1.1

Pinging 1.1.1.1 with 32 bytes of data:

Reply from 1.1.1.1: bytes=32 time<1ms TTL=255
Reply from 1.1.1.1: bytes=32 time<1ms TTL=255
Reply from 1.1.1.1: bytes=32 time<1ms TTL=255
Reply from 1.1.1.1: bytes=32 time=1ms TTL=255

Ping statistics for 1.1.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

Router0 Loopback (172.0.0.1)

```
C:\>ping 172.0.0.1

Pinging 172.0.0.1 with 32 bytes of data:

Reply from 172.0.0.1: bytes=32 time<1ms TTL=255
Reply from 172.0.0.1: bytes=32 time=1ms TTL=255
Reply from 172.0.0.1: bytes=32 time<1ms TTL=255
Reply from 172.0.0.1: bytes=32 time=1ms TTL=255

Ping statistics for 172.0.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

Router0 can ping:

Router1 Serial0/0/0 (10.10.10.2)

PC0 (192.168.1.2)

```
Router# ping 10.10.10.2

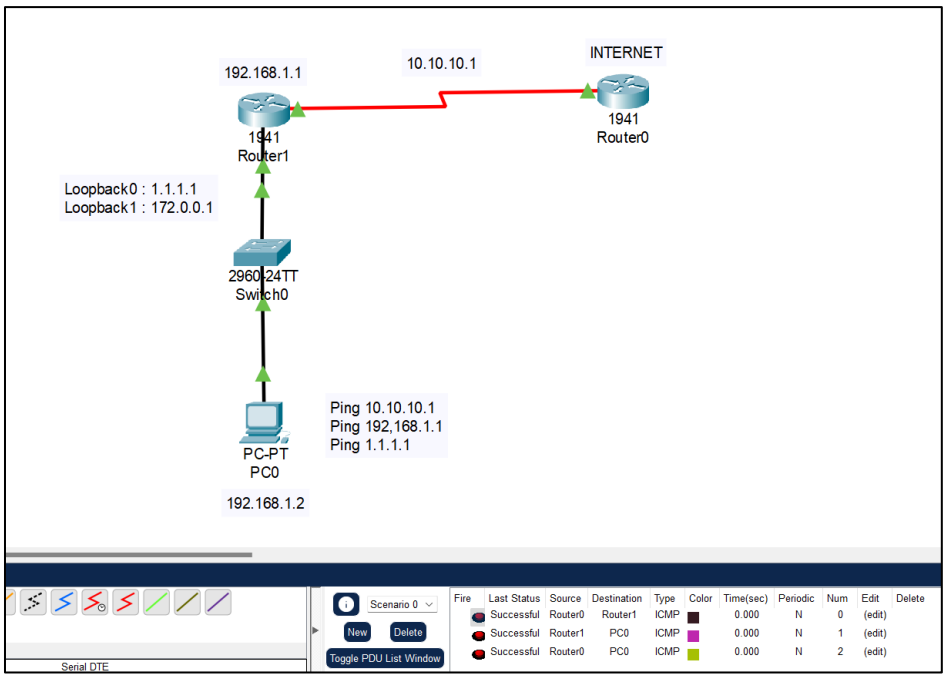
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.10.10.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/42/206 ms

Router#ping 192.168.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/17 ms
```

Conclusion :

This lab successfully demonstrates default routing in a small network. By configuring a single default route on Router1, the router can forward any unknown traffic to Router0, which acts like an internet or backbone router. This simplifies routing in smaller or edge networks.

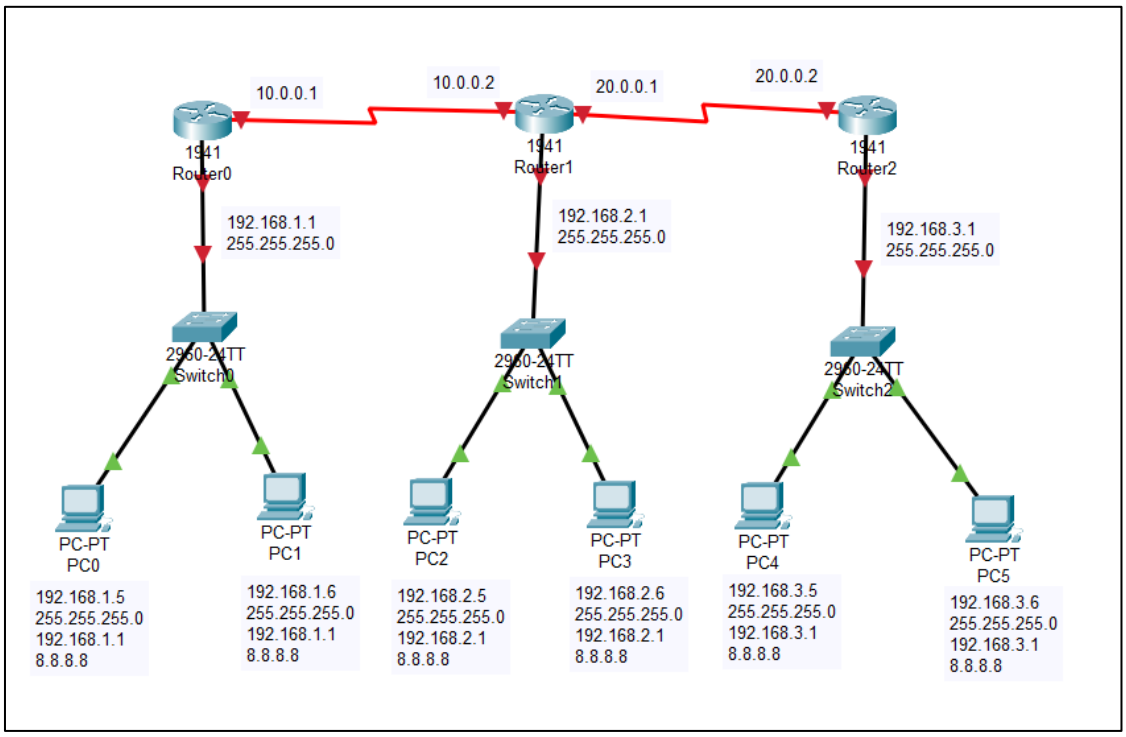


LAB 4 : Static Routing

Static routing is a manual method where routes are set by the administrator, best for small or fixed networks with few changes.

Objective: Configure static routes between routers

Network Topology :



IP Addressing Table :

Device	Interface	IP Address	Subnet Mask	Network
Router0	Serial0/0/0	10.0.0.1	255.0.0.0	10.0.0.0/8
Router0	GigabitEthernet0/0	192.168.1.1	255.255.255.0	192.168.1.0/24
Router1	Serial0/0/0	10.0.0.2	255.0.0.0	10.0.0.0/8
Router1	Serial0/0/1	20.0.0.1	255.0.0.0	20.0.0.0/8
Router1	GigabitEthernet0/0	192.168.2.1	255.255.255.0	192.168.2.0/24
Router2	Serial0/0/0	20.0.0.2	255.0.0.0	20.0.0.0/8
Router2	GigabitEthernet0/0	192.168.3.1	255.255.255.0	192.168.3.0/24

Configuration Step:

#On Router0

```
Router>enable
Router#configure terminal
Router(config)#Interface Serial0/0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
```

```
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#ip route 192.168.2.0 255.255.255.0 10.0.0.2
Router(config)#ip route 192.168.3.0 255.255.255.0 10.0.0.2
```

#On Router1

```
Router>enable
Router#configure terminal
Router(config)#interface serial0/0/0
Router(config-if)#ip address 10.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface serial0/0/1
Router(config-if)#ip address 20.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#ip route 192.168.1.0 255.255.255.0 10.0.0.1
Router(config)#ip route 192.168.3.0 255.255.255.0 20.0.0.2
```

#On Router2

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface serial0/0/0
Router(config-if)#ip address 20.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface gigabitEthernet0/0
Router(config-if)#ip address 192.168.3.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#ip route 192.168.1.0 255.255.255.0 20.0.0.1
Router(config)#ip route 192.168.2.0 255.255.255.0 20.0.0.1
```

Verification Command :

R0#show ip route

```
Router>enable
Router#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.1/32 is directly connected, Serial0/0/0
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.1.0/24 is directly connected, GigabitEthernet0/0
```

```
L 192.168.1.1/32 is directly connected, GigabitEthernet0/0
S 192.168.2.0/24 [1/0] via 10.0.0.2
S 192.168.3.0/24 [1/0] via 10.0.0.2
```

R1#show ip route

```
Router#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.2/32 is directly connected, Serial0/0/0
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/1
L 20.0.0.1/32 is directly connected, Serial0/0/1
S 192.168.1.0/24 [1/0] via 10.0.0.1
192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0
L 192.168.2.1/32 is directly connected, GigabitEthernet0/0
S 192.168.3.0/24 [1/0] via 20.0.0.2
```

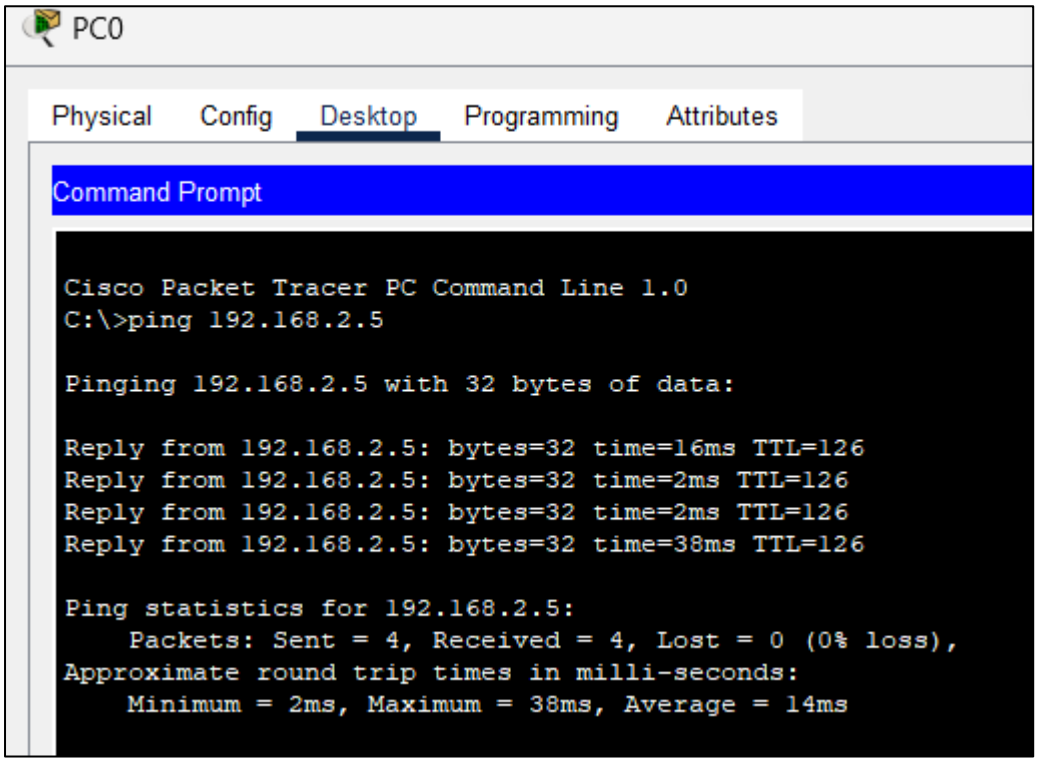
R2#show ip route

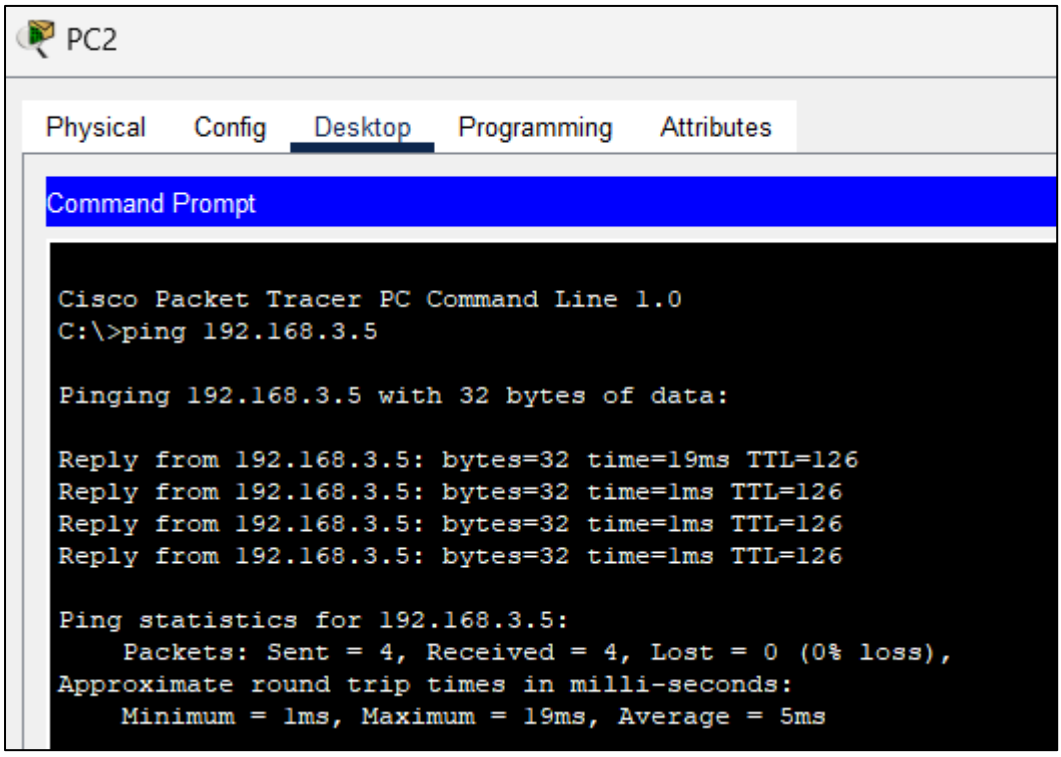
```
Router#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - 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

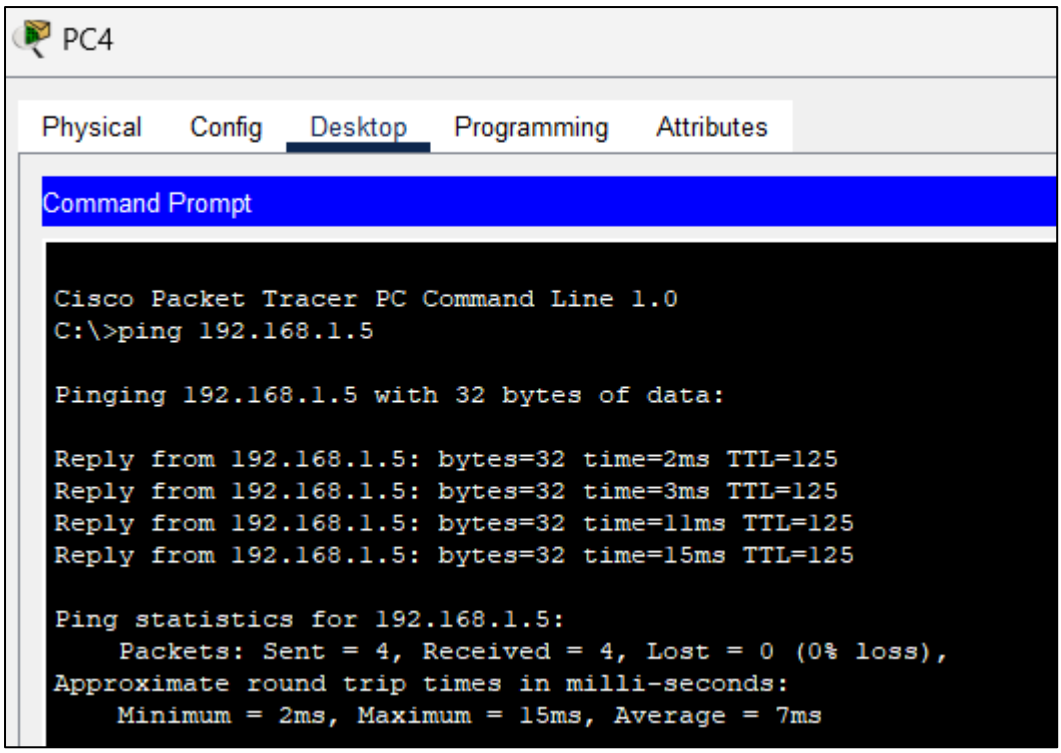
Gateway of last resort is not set

20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/0
L 20.0.0.2/32 is directly connected, Serial0/0/0
S 192.168.1.0/24 [1/0] via 20.0.0.1
S 192.168.2.0/24 [1/0] via 20.0.0.1
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/0
L 192.168.3.1/32 is directly connected, GigabitEthernet0/0
```

Output:

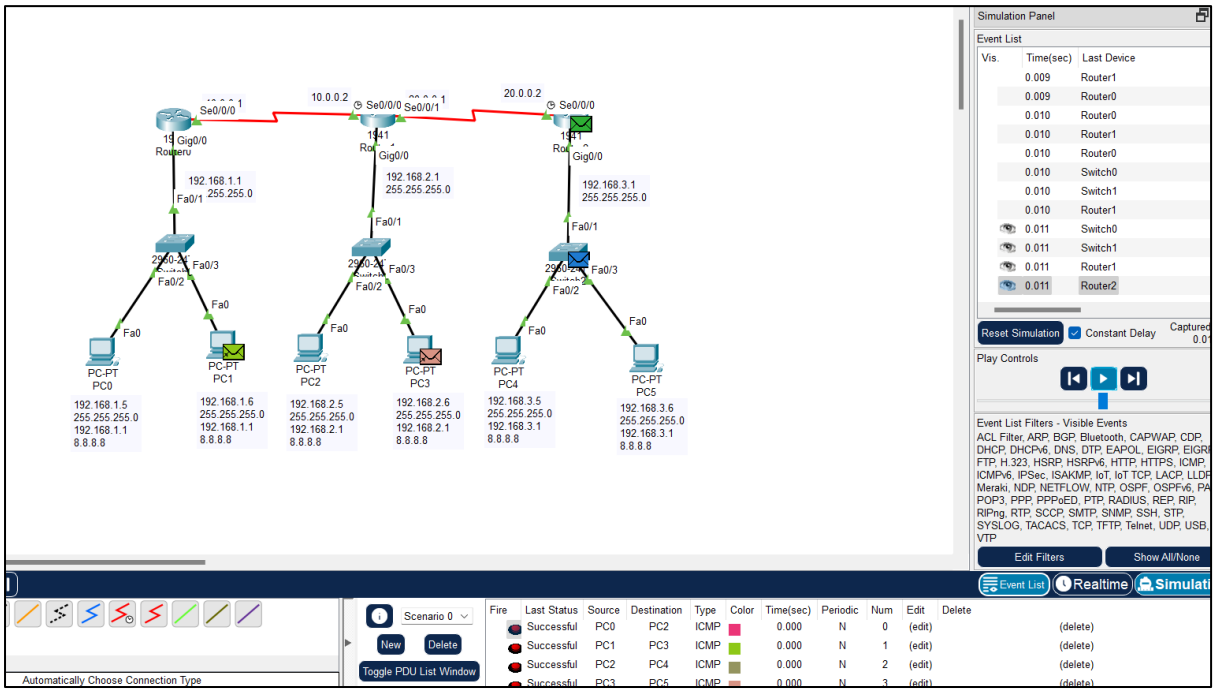

PC0
Physical
Config
Desktop
Programming
Attributes
Command Prompt
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.2.5
Pinging 192.168.2.5 with 32 bytes of data:
Reply from 192.168.2.5: bytes=32 time=16ms TTL=126
Reply from 192.168.2.5: bytes=32 time=2ms TTL=126
Reply from 192.168.2.5: bytes=32 time=2ms TTL=126
Reply from 192.168.2.5: bytes=32 time=38ms TTL=126
Ping statistics for 192.168.2.5:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 2ms, Maximum = 38ms, Average = 14ms


PC2
Physical
Config
Desktop
Programming
Attributes
Command Prompt
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.3.5
Pinging 192.168.3.5 with 32 bytes of data:
Reply from 192.168.3.5: bytes=32 time=19ms TTL=126
Reply from 192.168.3.5: bytes=32 time=1ms TTL=126
Reply from 192.168.3.5: bytes=32 time=1ms TTL=126
Reply from 192.168.3.5: bytes=32 time=1ms TTL=126
Ping statistics for 192.168.3.5:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 19ms, Average = 5ms



Conclusion :

Static routing configured successfully. Routers can reach each other.

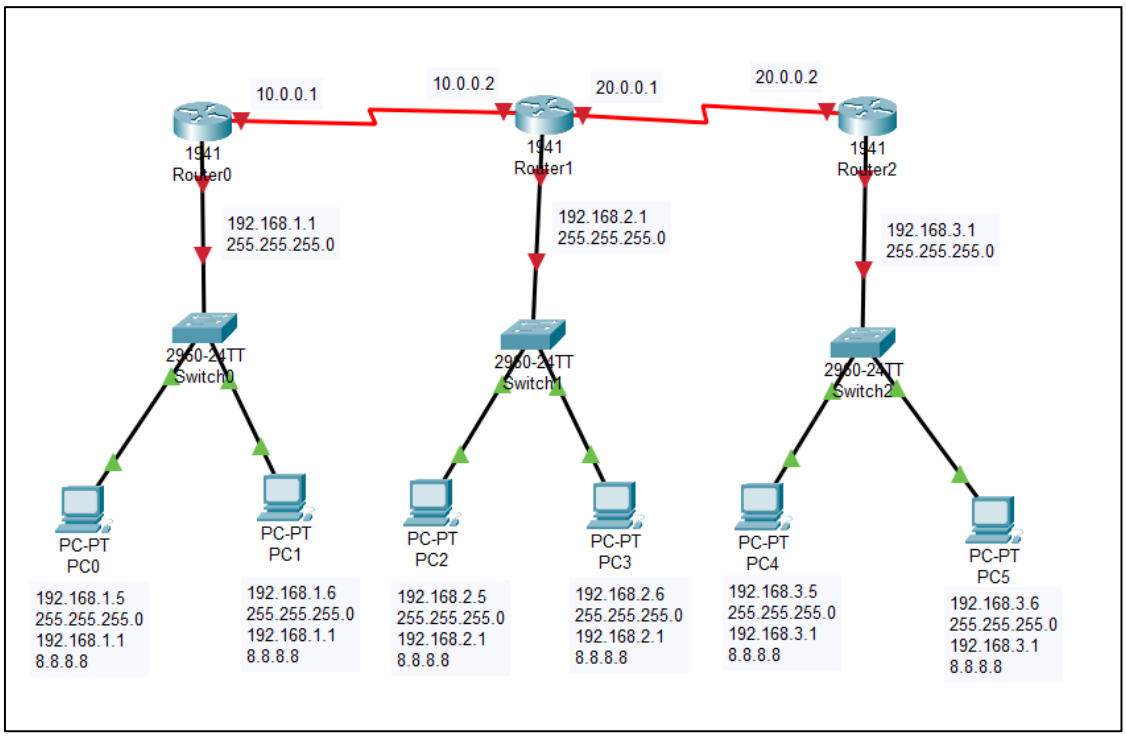


LAB 5 : RIP Configuration

RIP is a simple routing protocol that uses hop count to find routes and is suitable for small networks with limited size and complexity.

Objective: Enable dynamic routing using RIP V1 &V2.

Network Topology :



IP Address Table :

Device	Interface	IP Address	Subnet Mask	Network
Router0	Serial0/0/0	10.0.0.1	255.0.0.0	10.0.0.0/8
Router0	GigabitEthernet0/0	192.168.1.1	255.255.255.0	192.168.1.0/24
Router1	Serial0/0/0	10.0.0.2	255.0.0.0	10.0.0.0/8
Router1	Serial0/0/1	20.0.0.1	255.0.0.0	20.0.0.0/8
Router1	GigabitEthernet0/0	192.168.2.1	255.255.255.0	192.168.2.0/24
Router2	Serial0/0/0	20.0.0.2	255.0.0.0	20.0.0.0/8
Router2	GigabitEthernet0/0	192.168.3.1	255.255.255.0	192.168.3.0/24

Configuration Step :

#On Router0

```
Router>enable
Router#configure terminal
Router(config)#interface serial0/0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
```

```
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#router rip
Router(config-router)#network 192.168.1.0
Router(config-router)#network 10.0.0.0
Router(config-router)#no auto-summary
Router(config-router)#exit
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#exit
```

#On Router1

```
Router>enable
Router#configure terminal
Router(config)#interface serial0/0/0
Router(config-if)#ip address 10.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface serial0/0/1
Router(config-if)#ip address 20.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#router rip
Router(config-router)#network 10.0.0.0
Router(config-router)#network 20.0.0.0
Router(config-router)#network 192.168.2.0
Router(config-router)#no auto-summary
Router(config-router)#exit
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#exit
```

#On Router2

```
Router>enable
Router#configure terminal
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 20.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.3.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#router rip
Router(config-router)#network 20.0.0.0
Router(config-router)#network 192.168.3.0
Router(config-router)#no auto-summary
Router(config-router)#exit
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#exit
```

Verification :

Router0#show ip route

```
Router#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.1/32 is directly connected, Serial0/0/0
R 20.0.0.0/8 [120/1] via 10.0.0.2, 00:00:20, Serial0/0/0
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.1.0/24 is directly connected, GigabitEthernet0/0
L 192.168.1.1/32 is directly connected, GigabitEthernet0/0
R 192.168.2.0/24 [120/1] via 10.0.0.2, 00:00:20, Serial0/0/0
R 192.168.3.0/24 [120/2] via 10.0.0.2, 00:00:20, Serial0/0/0
```

Router1#show ip route

```
Router#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.2/32 is directly connected, Serial0/0/0
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/1
L 20.0.0.1/32 is directly connected, Serial0/0/1
R 192.168.1.0/24 [120/1] via 10.0.0.1, 00:00:02, Serial0/0/0
192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0
L 192.168.2.1/32 is directly connected, GigabitEthernet0/0
R 192.168.3.0/24 [120/1] via 20.0.0.2, 00:00:10, Serial0/0/1
```

Router2#show ip route

```
Router#show ip route
Codes: L - local, 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, 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 20.0.0.1, 00:00:11, Serial0/0/0
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/0
L 20.0.0.2/32 is directly connected, Serial0/0/0
R 192.168.1.0/24 [120/2] via 20.0.0.1, 00:00:11, Serial0/0/0
R 192.168.2.0/24 [120/1] via 20.0.0.1, 00:00:11, Serial0/0/0
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/0
L 192.168.3.1/32 is directly connected, GigabitEthernet0/0
```

Output :

Router0#show ip protocols

Router0/show ip rip database

```
Router#show ip protocols
Routing Protocol is "rip"
Sending updates every 30 seconds, next due in 9 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
GigabitEthernet0/0 22
Serial0/0/0 22
Automatic network summarization is not in effect
Maximum path: 4
Routing for Networks:
10.0.0.0
192.168.1.0
Passive Interface(s):
Routing Information Sources:
Gateway Distance Last Update
10.0.0.2 120 00:00:21
Distance: (default is 120)
Router#show ip rip database
10.0.0.0/8 auto-summary
10.0.0.0/8 directly connected, Serial0/0/0
20.0.0.0/8 auto-summary
20.0.0.0/8
[1] via 10.0.0.2, 00:00:08, Serial0/0/0
192.168.1.0/24 auto-summary
192.168.1.0/24 directly connected, GigabitEthernet0/0
192.168.2.0/24 auto-summary
192.168.2.0/24
[1] via 10.0.0.2, 00:00:08, Serial0/0/0
192.168.3.0/24 auto-summary
192.168.3.0/24
[2] via 10.0.0.2, 00:00:08, Serial0/0/0
```

Router1#show ip protocols

Router1#show ip rip database

```
Router#show ip protocols
Routing Protocol is "rip"
Sending updates every 30 seconds, next due in 12 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
GigabitEthernet0/0 22
Serial0/0/0 22
Serial0/0/1 22
Automatic network summarization is not in effect
Maximum path: 4
Routing for Networks:
10.0.0.0
20.0.0.0
192.168.2.0
Passive Interface(s):
Routing Information Sources:
Gateway Distance Last Update
10.0.0.1 120 00:00:21
20.0.0.2 120 00:00:26
Distance: (default is 120)
Router#show ip rip database
10.0.0.0/8 auto-summary
10.0.0.0/8 directly connected, Serial0/0/0
20.0.0.0/8 auto-summary
20.0.0.0/8 directly connected, Serial0/0/1
192.168.1.0/24 auto-summary
192.168.1.0/24
[1] via 10.0.0.1, 00:00:07, Serial0/0/0
192.168.2.0/24 auto-summary
192.168.2.0/24 directly connected, GigabitEthernet0/0
192.168.3.0/24 auto-summary
192.168.3.0/24
[1] via 20.0.0.2, 00:00:11, Serial0/0/1
```

Router2#show ip protocols

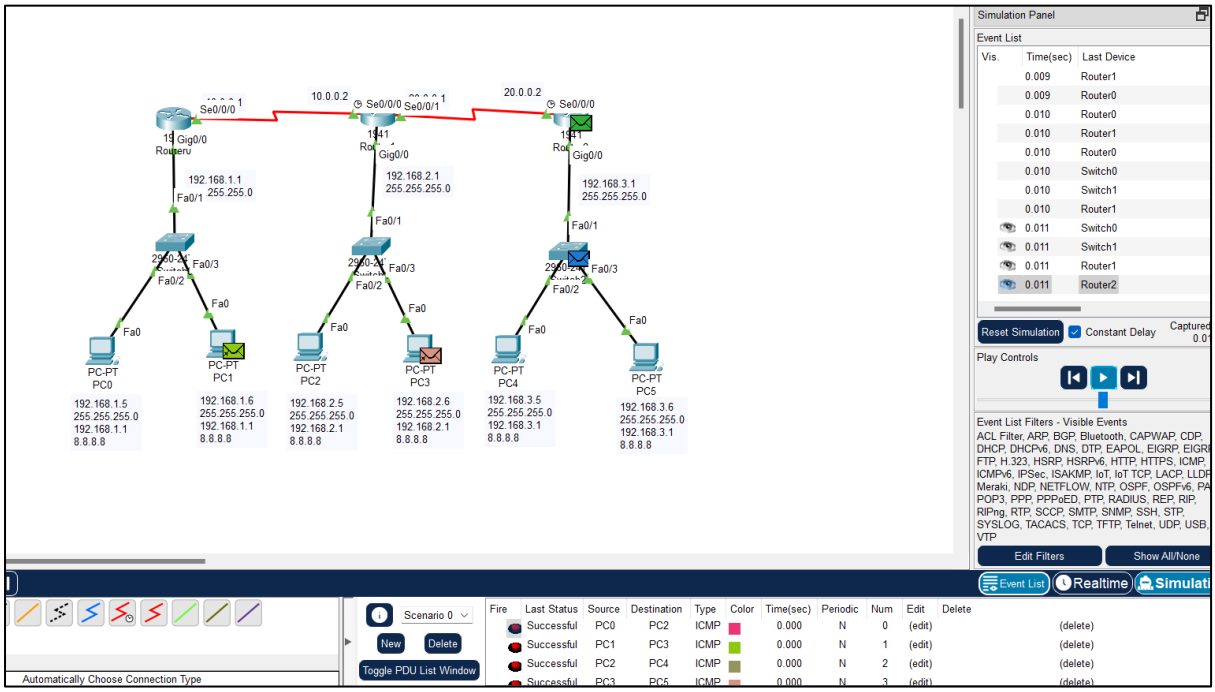
Router2#show ip rip database

```
Router#show ip protocols
Routing Protocol is "rip"
Sending updates every 30 seconds, next due in 10 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
GigabitEthernet0/0 22
Serial0/0/0 22
Automatic network summarization is not in effect
Maximum path: 4
Routing for Networks:
20.0.0.0
192.168.3.0
Passive Interface(s):
Routing Information Sources:
Gateway Distance Last Update
20.0.0.1 120 00:00:13
Distance: (default is 120)
Router#show ip rip database
10.0.0.0/8 auto-summary
10.0.0.0/8
[1] via 20.0.0.1, 00:00:23, Serial0/0/0
```

```
20.0.0.0/8 auto-summary
20.0.0.0/8 directly connected, Serial0/0/0
192.168.1.0/24 auto-summary
192.168.1.0/24
[2] via 20.0.0.1, 00:00:23, Serial0/0/0
192.168.2.0/24 auto-summary
192.168.2.0/24
[1] via 20.0.0.1, 00:00:23, Serial0/0/0
192.168.3.0/24 auto-summary
192.168.3.0/24 directly connected, GigabitEthernet0/0
```

Conclusion :

RIP routing configured successfully. Routers can dynamically exchange routes and reach each other.



LAB 6 : EIGRP Configuration different Autonomous Systems

EIGRP is more intelligent and efficient than RIP because it uses multiple factors to choose the best path, converges faster, and works better in larger networks.

EIGRP routers must use the same Autonomous System (AS) number to form neighbor relationships and share routes. When different AS numbers are used, they behave like separate networks. To allow communication between them, we configure redistribution on the router that connects both AS domains.

Objective: To configure EIGRP using different AS numbers on different routers and connect them using redistribution.

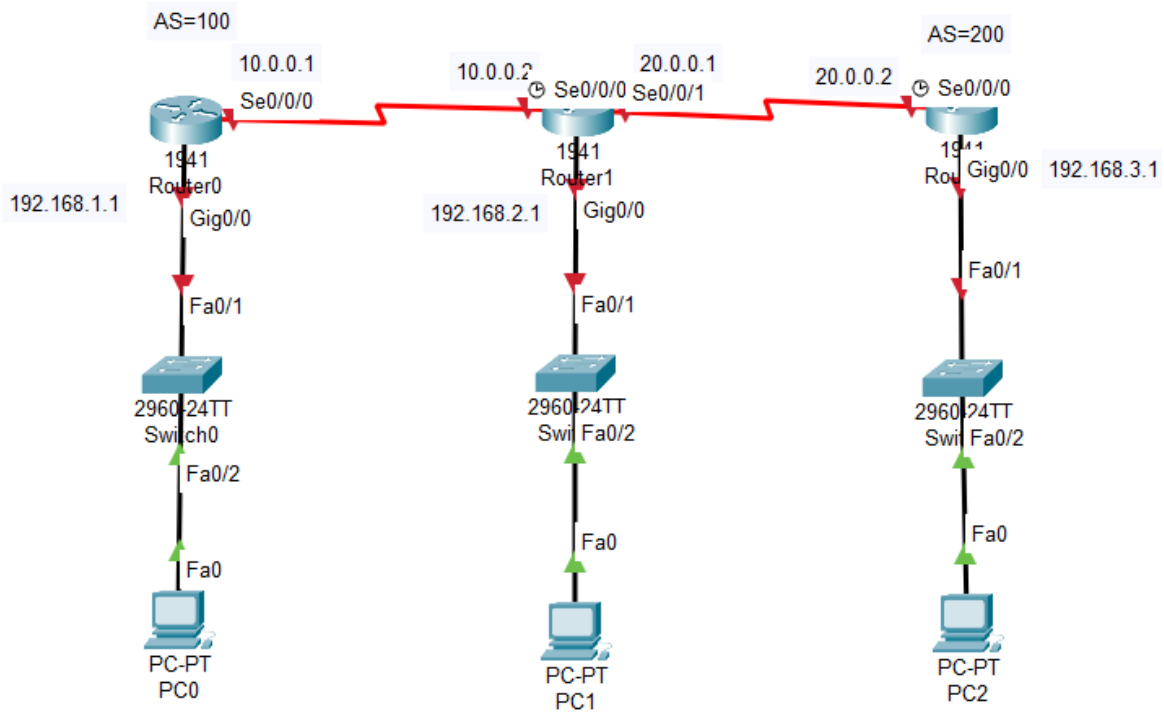
Topology: A triangle connection of three routers with city-based hostnames:

- R1 – Medan (AS 100)
- R2 – Lampung (Middle router in both AS 100 and AS 200)
- R3 – Jakarta (AS 200)

Serial connections are set up in clockwise direction:

- R1 ↔ R2 via S0/0
- R2 ↔ R3 via S0/1

Network Topology :



IP Addressing Table :

Router (Location)	Interface	IP Address	Subnet Mask	Network
Router0 (Medan)	Serial0/0/0	10.0.0.1	255.0.0.0	10.0.0.0
	GigabitEthernet0/0	192.168.1.1	255.255.255.0	192.168.1.0
Router1 (Lampung)	Serial0/0/0	10.0.0.2	255.0.0.0	10.0.0.0
	Serial0/0/1	20.0.0.1	255.0.0.0	20.0.0.0
	GigabitEthernet0/0	192.168.2.1	255.255.255.0	192.168.2.0
Router2 (Jakarta)	Serial0/0/0	20.0.0.2	255.0.0.0	20.0.0.0
	GigabitEthernet0/0	192.168.3.1	255.255.255.0	192.168.3.0

Configuration :

Router0 (Medan – AS 100)

```
Router>enable
Router#configure terminal
Router(config)#hostname Medan
Medan(config)#interface Serial0/0/0
Medan(config-if)#ip address 10.0.0.1 255.0.0.0
Medan(config-if)#no shutdown
Medan(config-if)#exit
Medan(config)#interface GigabitEthernet0/0
Medan(config-if)#ip address 192.168.1.1 255.255.255.0
Medan(config-if)#no shutdown
Medan(config-if)#exit
Medan(config)#router eigrp 100
Medan(config-router)#network 10.0.0.0
Medan(config-router)#network 192.168.1.0
Medan(config-router)#no auto-summary
Medan(config-router)#exit
```

Router1 (Lampung – AS 100& AS 200 with Redistribution)

```
Router>enable
Router#configure terminal
Router(config)#Hostname Lampung
Lampung(config)#interface Serial0/0/0
Lampung(config-if)#ip address 10.0.0.2 255.0.0.0
Lampung(config-if)#no shutdown
Lampung(config-if)#exit
Lampung(config)#interface Serial0/0/1
Lampung(config-if)#ip address 20.0.0.1 255.0.0.0
Lampung(config-if)#no shutdown
Lampung(config-if)#exit
Lampung(config)#interface GigabitEthernet0/0
Lampung(config-if)#ip address 192.168.2.1 255.255.255.0
Lampung(config-if)#no shutdown
Lampung(config-if)#exit
Lampung(config)#router eigrp 100
Lampung(config-router)#network 10.0.0.0
Lampung(config-router)#
Lampung(config-router)#network 192.168.2.0
Lampung(config-router)#no auto-summary
```

```
Lampung(config-router)#redistribute eigrp 200
Lampung(config-router)#exit
Lampung(config)#router eigrp 200
Lampung(config-router)#network 20.0.0.0
Lampung(config-router)#no auto-summary
Lampung(config-router)#redistribute eigrp 100
Lampung(config-router)#exit
```

Router2 (Jakarta – AS 200)

```
Router>enable
Router#configure terminal
Router(config)#Hostname Jakarta
Jakarta(config)#interface Serial0/0/0
Jakarta(config-if)#ip address 20.0.0.2 255.0.0.0
Jakarta(config-if)#no shutdown
Jakarta(config-if)#exit
Jakarta#configure terminal
Jakarta(config)#interface GigabitEthernet0/0
Jakarta(config-if)#ip address 192.168.3.1 255.255.255.0
Jakarta(config-if)#no shutdown
Jakarta(config-if)#exit
Jakarta(config)#router eigrp 200
Jakarta(config-router)#network 20.0.0.0
Jakarta(config-router)#
Jakarta(config-router)#network 192.168.3.0
Jakarta(config-router)#no auto-summary
Jakarta(config-router)#exit
```

Verification :

Medan#show ip route

```
Medan#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.1/32 is directly connected, Serial0/0/0
D EX 20.0.0.0/8 [170/7289856] via 10.0.0.2, 00:03:53, Serial0/0/0
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.1.0/24 is directly connected, GigabitEthernet0/0
L 192.168.1.1/32 is directly connected, GigabitEthernet0/0
D 192.168.2.0/24 [90/2172416] via 10.0.0.2, 00:08:35, Serial0/0/0
D EX 192.168.3.0/24 [170/7315456] via 10.0.0.2, 00:02:13, Serial0/0/0
```

Lampung#show ip route

```
Lampung#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.2/32 is directly connected, Serial0/0/0
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/1
L 20.0.0.1/32 is directly connected, Serial0/0/1
D 192.168.1.0/24 [90/2172416] via 10.0.0.1, 00:10:12, Serial0/0/0
192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0
L 192.168.2.1/32 is directly connected, GigabitEthernet0/0
D 192.168.3.0/24 [90/2172416] via 20.0.0.2, 00:03:39, Serial0/0/1
```

Jakarta#show ip route

```
Jakarta#show ip route
Codes: L - local, 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, 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

D EX 10.0.0.0/8 [170/7289856] via 20.0.0.1, 00:05:06, Serial0/0/0
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/0
L 20.0.0.2/32 is directly connected, Serial0/0/0
D EX 192.168.1.0/24 [170/7315456] via 20.0.0.1, 00:05:06, Serial0/0/0
D EX 192.168.2.0/24 [170/2195456] via 20.0.0.1, 00:05:06, Serial0/0/0
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/0
L 192.168.3.1/32 is directly connected, GigabitEthernet0/0
```

Output :

Medan Router0

#show ip protocols

#show ip eigrp neighbor

#show ip eigrp topology

```
Medan#show ip protocols

Routing Protocol is "eigrp 100 "
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
Redistributing: eigrp 100
EIGRP-IPv4 Protocol for AS(100)
Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
NSF-aware route hold timer is 240
Router-ID: 10.0.0.1
Topology : 0 (base)
Active Timer: 3 min
Distance: internal 90 external 170
```

```
Maximum path: 4
Maximum hopcount 100
Maximum metric variance 1

Automatic Summarization: disabled
Automatic address summarization:
Maximum path: 4
Routing for Networks:
10.0.0.0
192.168.1.0
Routing Information Sources:
Gateway Distance Last Update
10.0.0.2 90 529645
Distance: internal 90 external 170

Medan#show ip eigrp neighbor
IP-EIGRP neighbors for process 100
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 10.0.0.2 Se0/0/0 13 00:17:31 40 1000 0 8

Medan#show ip eigrp topology
IP-EIGRP Topology Table for AS 100/ID(192.168.1.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
r - Reply status

P 10.0.0.0/8, 1 successors, FD is 2169856
via Connected, Serial0/0/0
P 20.0.0.0/8, 1 successors, FD is 7289856
via Rstatic (7289856/6777856)
P 192.168.1.0/24, 1 successors, FD is 5120
via Connected, GigabitEthernet0/0
P 192.168.2.0/24, 1 successors, FD is 2172416
via 10.0.0.2 (2172416/5120), Serial0/0/0
P 192.168.3.0/24, 1 successors, FD is 7315456
via Rstatic (7315456/6803456)
```

Lampung Router1

#show ip protocols

#show ip eigrp neighbor

#show ip eigrp topology

```
Lampung#show ip protocols

Routing Protocol is "eigrp 100 "
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
Redistributing: eigrp 100,
EIGRP-IPv4 Protocol for AS(100)
Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
NSF-aware route hold timer is 240
Router-ID: 10.0.0.2
Topology : 0 (base)
Active Timer: 3 min
Distance: internal 90 external 170
Maximum path: 4
```

```
Maximum hopcount 100
Maximum metric variance 1

Automatic Summarization: disabled
Automatic address summarization:
Maximum path: 4
Routing for Networks:
10.0.0.0
192.168.2.0
Routing Information Sources:
Gateway Distance Last Update
10.0.0.1 90 2091365
Distance: internal 90 external 170

Routing Protocol is "eigrp 200 "
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
Redistributing: eigrp 200,
EIGRP-IPv4 Protocol for AS(200)
Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
NSF-aware route hold timer is 240
Router-ID: 10.0.0.2
Topology : 0 (base)
Active Timer: 3 min
Distance: internal 90 external 170
Maximum path: 4
Maximum hopcount 100
Maximum metric variance 1

Automatic Summarization: disabled
Automatic address summarization:
Maximum path: 4
Routing for Networks:
20.0.0.0
Routing Information Sources:
Gateway Distance Last Update
20.0.0.2 90 2467107
Distance: internal 90 external 170

Lampung#show ip eigrp neighbor
IP-EIGRP neighbors for process 100
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 10.0.0.1 Se0/0/0 14 00:15:48 40 1000 0 7

IP-EIGRP neighbors for process 200
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 20.0.0.2 Se0/0/1 14 00:09:32 40 1000 0 8

Lampung#show ip eigrp topology
IP-EIGRP Topology Table for AS 100/ID(192.168.2.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
r - Reply status

P 10.0.0.0/8, 1 successors, FD is 2169856
via Connected, Serial0/0/0
P 20.0.0.0/8, 1 successors, FD is 2169856
```

```
via Redistributed (2169856/0)
P 192.168.1.0/24, 1 successors, FD is 2172416
via 10.0.0.1 (2172416/5120), Serial0/0/0
P 192.168.2.0/24, 1 successors, FD is 5120
via Connected, GigabitEthernet0/0
P 192.168.3.0/24, 1 successors, FD is 2172416
via Redistributed (2172416/0)
IP-EIGRP Topology Table for AS 200/ID(192.168.2.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
r - Reply status

P 10.0.0.0/8, 1 successors, FD is 2169856
via Redistributed (2169856/0)
P 20.0.0.0/8, 1 successors, FD is 2169856
via Connected, Serial0/0/1
P 192.168.1.0/24, 1 successors, FD is 2172416
via Redistributed (2172416/0)
P 192.168.2.0/24, 1 successors, FD is 5120
via Redistributed (5120/0)
P 192.168.3.0/24, 1 successors, FD is 2172416
via 20.0.0.2 (2172416/5120), Serial0/0/1
```

Jakarta Router2

#show ip protocols

#show ip eigrp neighbor

#show ip eigrp topology

```
Jakarta#show ip protocols

Routing Protocol is "eigrp 200 "
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
Redistributing: eigrp 200
EIGRP-IPv4 Protocol for AS(200)
Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
NSF-aware route hold timer is 240
Router-ID: 20.0.0.2
Topology : 0 (base)
Active Timer: 3 min
Distance: internal 90 external 170
Maximum path: 4
Maximum hopcount 100
Maximum metric variance 1

Automatic Summarization: disabled
Automatic address summarization:
Maximum path: 4
Routing for Networks:
20.0.0.0
192.168.3.0
Routing Information Sources:
Gateway Distance Last Update
20.0.0.1 90 2447991
Distance: internal 90 external 170

Jakarta#show ip eigrp neighbor
```

```
IP-EIGRP neighbors for process 200
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 20.0.0.1 Se0/0/0 13 00:07:59 40 1000 0 9

Jakarta#show ip eigrp topology
IP-EIGRP Topology Table for AS 200/ID(192.168.3.1)

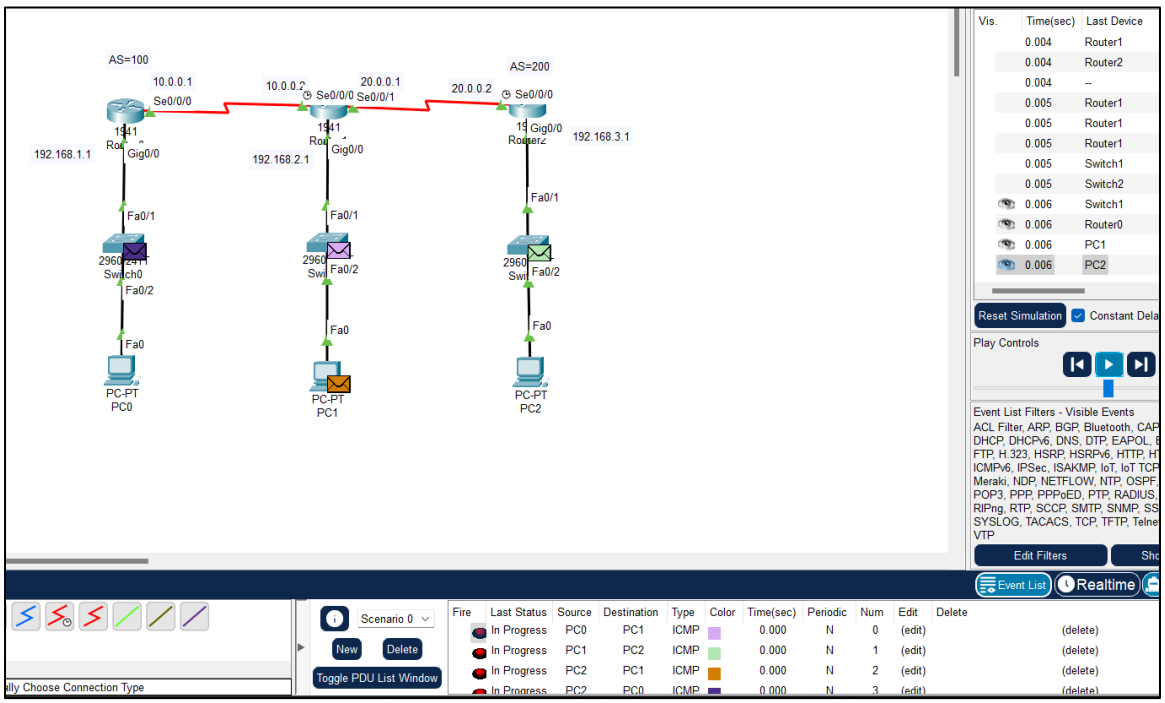
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
r - Reply status

P 10.0.0.0/8, 1 successors, FD is 7289856
via Rstatic (7289856/6777856)
P 20.0.0.0/8, 1 successors, FD is 2169856
via Connected, Serial0/0/0
P 192.168.1.0/24, 1 successors, FD is 7315456
via Rstatic (7315456/6803456)
P 192.168.2.0/24, 1 successors, FD is 2195456
via Rstatic (2195456/28160)
P 192.168.3.0/24, 1 successors, FD is 5120
via Connected, GigabitEthernet0/0
```

- Medan and Lampung form EIGRP neighbors in AS 100
- Lampung and Jakarta form EIGRP neighbors in AS 200
- Routing tables show dynamically learned routes between all networks via redistribution
- Full connectivity is achieved

Conclusion :

EIGRP was configured using different AS numbers with a clockwise serial topology. Redistribution on the intermediate router allowed dynamic route exchange across both AS domains, ensuring full communication between all routers.



LAB 7 : OSPF Configuration

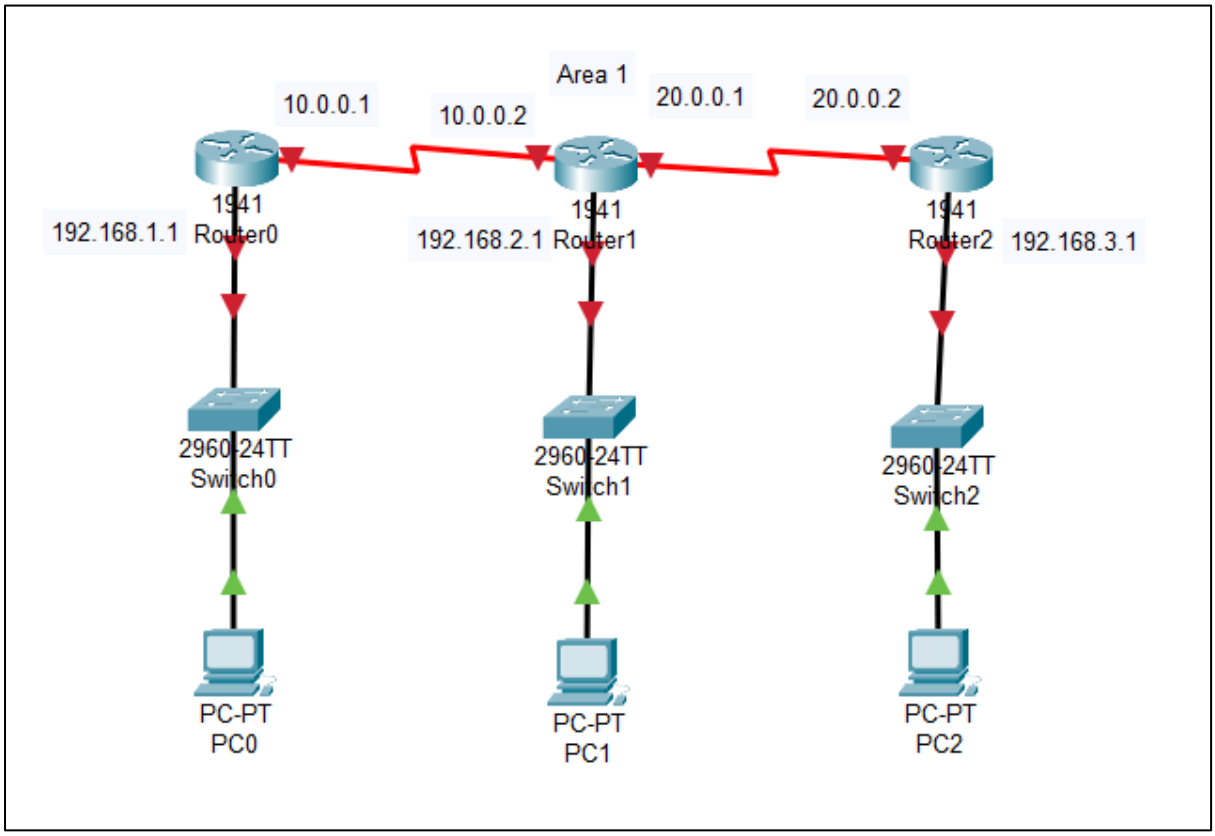
OSPF is a fast and scalable link-state protocol that finds the best path using cost and works well in large and complex networks.

Objective: Use single-area OSPF.

Single-Area OSPF

All routers are in Area 0 (the backbone area). Best for small to medium networks.

Topology :



IP Address :

Router	Interface	IP Address	Subnet Mask	Network
Router0	Serial0/0/0	10.0.0.1	255.0.0.0	10.0.0.0
	GigabitEthernet0/0	192.168.1.1	255.255.255.0	192.168.1.0
Router1	Serial0/0/0	10.0.0.2	255.0.0.0	10.0.0.0
	Serial0/0/1	20.0.0.1	255.0.0.0	20.0.0.0
	GigabitEthernet0/0	192.168.2.1	255.255.255.0	192.168.2.0
Router2	Serial0/0/0	20.0.0.2	255.0.0.0	20.0.0.0
	GigabitEthernet0/0	192.168.3.1	255.255.255.0	192.168.3.0

Configuration :

#Router0

```
Router>enable
Router#configure terminal
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#Router ospf 1
Router(config-router)#Network 10.0.0.0 0.255.255.255 Area 0
Router(config-router)#Network 192.168.1.0 0.0.0.255 Area 0
Router(config-router)#exit
```

#Router1

```
Router>enable
Router#configure terminal
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 10.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/0/1
Router(config-if)#ip address 20.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#Router ospf 2
Router(config-router)#Network 10.0.0.0 0.255.255.255 Area 0
Router(config-router)#Network 20.0.0.0 0.255.255.255 Area 0
Router(config-router)#Network 192.168.2.0 0.0.0.255 Area 0
Router(config-router)#exit
```

#Router2

```
Router>enable
Router#configure terminal
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 20.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.3.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#exit
Router(config)#Router ospf 3
Router(config-router)#Network 20.0.0.0 0.255.255.255 Area 0
Router(config-router)#Network 192.168.3.0 0.0.0.255 Area 0
Router(config-router)#exit
```

Verification :

Router0

#show ip route

#show ip protocols

```
Router#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.1/32 is directly connected, Serial0/0/0
O 20.0.0.0/8 [110/128] via 10.0.0.2, 00:07:38, Serial0/0/0
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.1.0/24 is directly connected, GigabitEthernet0/0
L 192.168.1.1/32 is directly connected, GigabitEthernet0/0
O 192.168.2.0/24 [110/65] via 10.0.0.2, 00:08:49, Serial0/0/0
O 192.168.3.0/24 [110/129] via 10.0.0.2, 00:05:20, Serial0/0/0

Router#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 192.168.1.1
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Maximum path: 4
Routing for Networks:
10.0.0.0 0.255.255.255 area 0
192.168.1.0 0.0.0.255 area 0
Routing Information Sources:
Gateway Distance Last Update
192.168.1.1 110 00:09:38
192.168.2.1 110 00:05:57
192.168.3.1 110 00:05:30
Distance: (default is 110)
```

Router1

#show ip route

#show ip protocols

```
Router#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.2/32 is directly connected, Serial0/0/0
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/1
L 20.0.0.1/32 is directly connected, Serial0/0/1
O 192.168.1.0/24 [110/65] via 10.0.0.1, 00:11:17, Serial0/0/0
192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0
L 192.168.2.1/32 is directly connected, GigabitEthernet0/0
O 192.168.3.0/24 [110/65] via 20.0.0.2, 00:07:08, Serial0/0/1

Router#show ip protocols

Routing Protocol is "ospf 2"
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Router ID 192.168.2.1
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Maximum path: 4
Routing for Networks:
10.0.0.0 0.255.255.255 area 0
20.0.0.0 0.255.255.255 area 0
192.168.2.0 0.0.0.255 area 0
Routing Information Sources:
Gateway Distance Last Update
192.168.1.1 110 00:11:22
192.168.2.1 110 00:07:42
192.168.3.1 110 00:07:15
Distance: (default is 110)
```

Router2

#show ip route

#show ip protocols

```
Router#show ip route
Codes: L - local, 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, 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

O 10.0.0.0/8 [110/128] via 20.0.0.1, 00:08:27, Serial0/0/0
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/0
L 20.0.0.2/32 is directly connected, Serial0/0/0
O 192.168.1.0/24 [110/129] via 20.0.0.1, 00:08:27, Serial0/0/0
O 192.168.2.0/24 [110/65] via 20.0.0.1, 00:08:27, Serial0/0/0
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/0
L 192.168.3.1/32 is directly connected, GigabitEthernet0/0

Router#show ip protocols

Routing Protocol is "ospf 3"
```

```
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Router ID 192.168.3.1
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Maximum path: 4
Routing for Networks:
20.0.0.0 0.255.255.255 area 0
192.168.3.0 0.0.0.255 area 0
Routing Information Sources:
Gateway Distance Last Update
192.168.1.1 110 00:12:14
192.168.2.1 110 00:08:34
192.168.3.1 110 00:08:07
Distance: (default is 110)
```

Output :

Router0

#show ip ospf neighbor

#show ip ospf database

```
Router#show ip ospf neighbor


Neighbor ID Pri State Dead Time Address Interface
192.168.2.1 0 FULL/ - 00:00:32 10.0.0.2 Serial0/0/0
Router#show ip ospf database
OSPF Router with ID (192.168.1.1) (Process ID 1)

Router Link States (Area 0)

Link ID ADV Router Age Seq# Checksum Link count
192.168.1.1 192.168.1.1 850 0x80000003 0x007d73 3
192.168.2.1 192.168.2.1 629 0x80000005 0x003086 5
192.168.3.1 192.168.3.1 602 0x80000003 0x00e8ec 3
```

Router1

#show ip ospf neighbor

#show ip ospf database

```
Router#show ip ospf neighbor


Neighbor ID Pri State Dead Time Address Interface
192.168.1.1 0 FULL/ - 00:00:32 10.0.0.1 Serial0/0/0
192.168.3.1 0 FULL/ - 00:00:35 20.0.0.2 Serial0/0/1
Router#show ip ospf database
OSPF Router with ID (192.168.2.1) (Process ID 2)

Router Link States (Area 0)

Link ID ADV Router Age Seq# Checksum Link count
192.168.1.1 192.168.1.1 916 0x80000003 0x007d73 3
192.168.2.1 192.168.2.1 696 0x80000005 0x003086 5
192.168.3.1 192.168.3.1 669 0x80000003 0x00e8ec 3
```

Router2

#show ip ospf neighbor

#show ip ospf database

```
Router#show ip ospf neighbor


Neighbor ID Pri State Dead Time Address Interface
192.168.2.1 0 FULL/ - 00:00:32 20.0.0.1 Serial0/0/0
Router#show ip ospf database
OSPF Router with ID (192.168.3.1) (Process ID 3)

Router Link States (Area 0)

Link ID ADV Router Age Seq# Checksum Link count
192.168.1.1 192.168.1.1 992 0x80000003 0x007d73 3
192.168.2.1 192.168.2.1 772 0x80000005 0x003086 5
192.168.3.1 192.168.3.1 745 0x80000003 0x00e8ec 3
```

PCs on different networks can ping each other

```
C:\>ping 192.168.2.5

Pinging 192.168.2.5 with 32 bytes of data:

Reply from 192.168.2.5: bytes=32 time=9ms TTL=126
Reply from 192.168.2.5: bytes=32 time=10ms TTL=126
Reply from 192.168.2.5: bytes=32 time=10ms TTL=126
Reply from 192.168.2.5: bytes=32 time=10ms TTL=126

Ping statistics for 192.168.2.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 9ms, Maximum = 10ms, Average = 9ms
```

```
Command Prompt


Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.3.5

Pinging 192.168.3.5 with 32 bytes of data:

Reply from 192.168.3.5: bytes=32 time=12ms TTL=126
Reply from 192.168.3.5: bytes=32 time=20ms TTL=126
Reply from 192.168.3.5: bytes=32 time=11ms TTL=126
Reply from 192.168.3.5: bytes=32 time=8ms TTL=126

Ping statistics for 192.168.3.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 8ms, Maximum = 20ms, Average = 12ms
```

```
Command Prompt

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.5

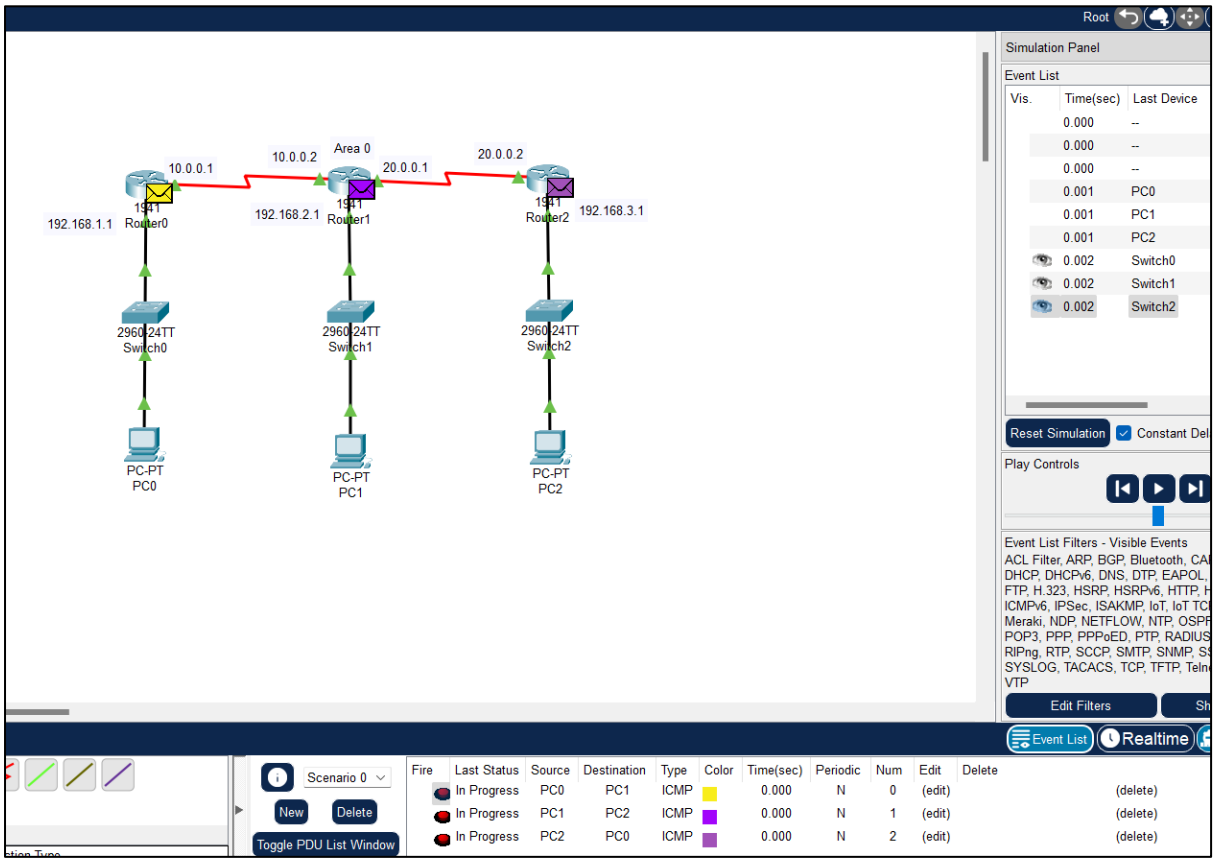
Pinging 192.168.1.5 with 32 bytes of data:

Reply from 192.168.1.5: bytes=32 time=26ms TTL=125
Reply from 192.168.1.5: bytes=32 time=19ms TTL=125
Reply from 192.168.1.5: bytes=32 time=2ms TTL=125
Reply from 192.168.1.5: bytes=32 time=21ms TTL=125

Ping statistics for 192.168.1.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 26ms, Average = 17ms
```

Conclusions :

OSPF was configured successfully in Single Area (Area 0). Routers exchanged routing information dynamically and full connectivity was achieved.

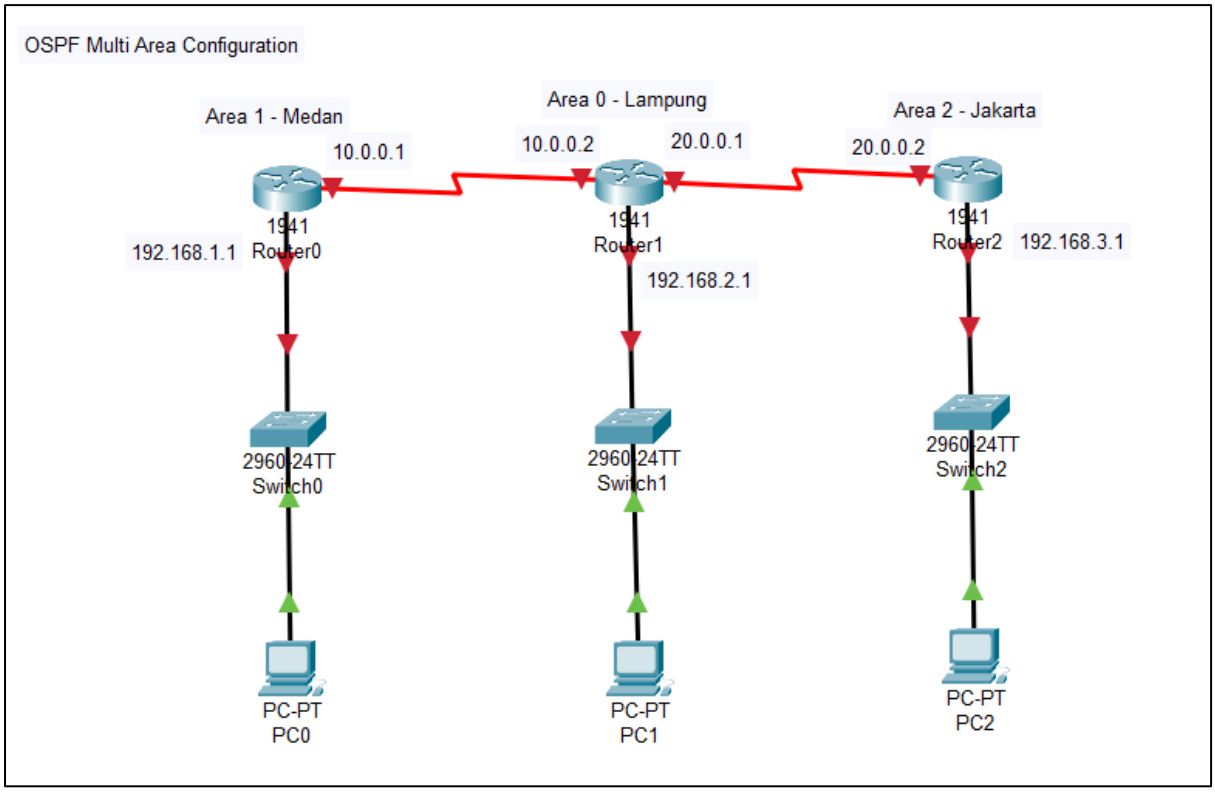


LAB 8 :Multi-Area OSPF Configuration

Objective: To configure OSPF with multiple areas across three routers in different locations:

- Router0 (Medan) – Area 1
- Router1 (Lampung) – Backbone Area 0
- Router2 (Jakarta) – Area 1

Topology :



IP Addressing Table :

Router	Interface	IP Address	Subnet Mask	Location
Router0	Serial0/0/0	10.0.0.1	255.0.0.0	Medan
	GigabitEthernet0/0	192.168.1.1	255.255.255.0	
Router1	Serial0/0/0	10.0.0.2	255.0.0.0	Lampung
	Serial0/0/1	20.0.0.1	255.0.0.0	
	GigabitEthernet0/0	192.168.2.1	255.255.255.0	
Router2	Serial0/0/0	20.0.0.2	255.0.0.0	Jakarta
	GigabitEthernet0/0	192.168.3.1	255.255.255.0	

Configuration :

Router0 (Medan – Area 1)

```
Router>enable
Router#configure terminal
Router(config)#hostname Medan
Medan(config)#Interface Serial0/0/0
Medan(config-if)#ip address 10.0.0.1 255.0.0.0
Medan(config-if)#no shutdown
Medan(config-if)#exit
Medan(config)#interface GigabitEthernet0/0
Medan(config-if)#ip address 192.168.1.1 255.255.255.0
Medan(config-if)#no shutdown
Medan(config-if)#exit
Medan(config)#Router ospf 1
Medan(config-router)#Network 10.0.0.0 0.255.255.255 Area 1
Medan(config-router)#Network 192.168.1.0 0.0.0.255 Area 1
Medan(config-router)#exit
```

Router1 (Lampung – Area 0)

```
Router>enable
Router#configure terminal
Router(config)#hostname Lampung
Lampung(config)#interface Serial0/0/0
Lampung(config-if)#ip address 10.0.0.2 255.0.0.0
Lampung(config-if)#no shutdown
Lampung(config-if)#exit
Lampung(config)#Interface Serial0/0/1
Lampung(config-if)#ip address 20.0.0.1 255.0.0.0
Lampung(config-if)#no shutdown
Lampung(config)#interface GigabitEthernet0/0
Lampung(config-if)#ip address 192.168.2.1 255.255.255.0
Lampung(config-if)#no shutdown
Lampung(config-if)#exit
Lampung(config)#Router ospf 2
Lampung(config-router)#Network 10.0.0.0 0.255.255.255 Area 1
Lampung(config-router)#Network 20.0.0.0 0.255.255.255 Area 2
Lampung(config-router)#Network 192.168.2.0 0.0.0.255 Area 0
Lampung(config-router)#exit
```

Router2 (Jakarta – Area 2)

```
Router>enable
Router#configure terminal
Router(config)#hostname Jakarta
Jakarta(config)#interface Serial0/0/0
Jakarta(config-if)#ip address 20.0.0.2 255.0.0.0
Jakarta(config-if)#no shutdown
Jakarta(config-if)#exit
Jakarta(config)#Interface GigabitEthernet0/0
Jakarta(config-if)#ip address 192.168.3.1 255.255.255.0
Jakarta(config-if)#no shutdown
Jakarta(config-if)#exit
Jakarta(config)#router ospf 3
Jakarta(config-router)#Network 20.0.0.0 0.255.255.255 Area 2
Jakarta(config-router)#Network 192.168.3.0 0.0.0.255 Area 2
Jakarta(config-router)#exit
```

Note: The backbone area (Area 0) is essential in OSPF for inter-area communication. R1 connects Area 1 (R0 & R2) through Area 0 as the ABR (Area Border Router)

Verification :

Router0 (Medan - Area 1)

```
Medan#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.1/32 is directly connected, Serial0/0/0
O IA 20.0.0.0/8 [110/128] via 10.0.0.2, 00:04:02, Serial0/0/0
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.1.0/24 is directly connected, GigabitEthernet0/0
L 192.168.1.1/32 is directly connected, GigabitEthernet0/0
O IA 192.168.2.0/24 [110/65] via 10.0.0.2, 00:07:00, Serial0/0/0
O IA 192.168.3.0/24 [110/129] via 10.0.0.2, 00:02:10, Serial0/0/0

Medan#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 192.168.1.1
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Maximum path: 4
Routing for Networks:
10.0.0.0 0.255.255.255 area 1
192.168.1.0 0.0.0.255 area 1
Routing Information Sources:
Gateway Distance Last Update
192.168.1.1 110 00:08:11
192.168.2.1 110 00:07:24
Distance: (default is 110)
```

Router1 (Lampung – Area 0)

#show ip route

#show ip protocols

```
Lampung#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.2/32 is directly connected, Serial0/0/0
```

```
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/1
L 20.0.0.1/32 is directly connected, Serial0/0/1
O 192.168.1.0/24 [110/65] via 10.0.0.1, 00:10:04, Serial0/0/0
192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0
L 192.168.2.1/32 is directly connected, GigabitEthernet0/0
O 192.168.3.0/24 [110/65] via 20.0.0.2, 00:04:17, Serial0/0/1

Lampung#show ip protocols

Routing Protocol is "ospf 2"
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Router ID 192.168.2.1
Number of areas in this router is 3. 3 normal 0 stub 0 nssa
Maximum path: 4
Routing for Networks:
10.0.0.0 0.255.255.255 area 1
20.0.0.0 0.255.255.255 area 2
192.168.2.0 0.0.0.255 area 0
Routing Information Sources:
Gateway Distance Last Update
192.168.1.1 110 00:10:10
192.168.2.1 110 00:09:22
192.168.3.1 110 00:04:26
Distance: (default is 110)
```

Router2 (Jakarta – Area 2)

#show ip route

#show ip protocols

```
Jakarta#show ip route
Codes: L - local, 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, 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

O IA 10.0.0.0/8 [110/128] via 20.0.0.1, 00:06:17, Serial0/0/0
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/0
L 20.0.0.2/32 is directly connected, Serial0/0/0
O IA 192.168.1.0/24 [110/129] via 20.0.0.1, 00:06:17, Serial0/0/0
O IA 192.168.2.0/24 [110/65] via 20.0.0.1, 00:06:17, Serial0/0/0
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/0
L 192.168.3.1/32 is directly connected, GigabitEthernet0/0

Jakarta#show ip protocols

Routing Protocol is "ospf 3"
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Router ID 192.168.3.1
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
```

```
Maximum path: 4
Routing for Networks:
20.0.0.0 0.255.255.255 area 2
192.168.3.0 0.0.0.255 area 2
Routing Information Sources:
Gateway Distance Last Update
192.168.2.1 110 00:06:24
192.168.3.1 110 00:06:03
Distance: (default is 110)
```

Output :

Router0 (Medan – Area 1)

#show ip ospf neighbor

#show ip ospf database

```
Medan#show ip ospf neighbor


Neighbor ID Pri State Dead Time Address Interface
192.168.2.1 0 FULL/ - 00:00:39 10.0.0.2 Serial0/0/0
Medan#show ip ospf database
OSPF Router with ID (192.168.1.1) (Process ID 1)

Router Link States (Area 1)

Link ID ADV Router Age Seq# Checksum Link count
192.168.1.1 192.168.1.1 821 0x80000003 0x007d73 3
192.168.2.1 192.168.2.1 774 0x80000003 0x003a2f 2

Summary Net Link States (Area 1)
Link ID ADV Router Age Seq# Checksum
192.168.2.0 192.168.2.1 759 0x80000001 0x00abda
20.0.0.0 192.168.2.1 581 0x80000002 0x00e4b8
192.168.3.0 192.168.2.1 471 0x80000003 0x001f24
```

Router1 (Lampung -Area 0)

#show ip ospf neighbor

#show ip ospf database

```
Lampung#show ip ospf neighbor


Neighbor ID Pri State Dead Time Address Interface
192.168.1.1 0 FULL/ - 00:00:36 10.0.0.1 Serial0/0/0
192.168.3.1 0 FULL/ - 00:00:30 20.0.0.2 Serial0/0/1
Lampung#show ip ospf database
OSPF Router with ID (192.168.2.1) (Process ID 2)

Router Link States (Area 0)

Link ID ADV Router Age Seq# Checksum Link count
192.168.2.1 192.168.2.1 858 0x80000001 0x00a866 1

Summary Net Link States (Area 0)
Link ID ADV Router Age Seq# Checksum
10.0.0.0 192.168.2.1 854 0x80000001 0x00693f
192.168.1.0 192.168.2.1 854 0x80000002 0x00370f
20.0.0.0 192.168.2.1 666 0x80000003 0x00e2b9
```

```
192.168.3.0 192.168.2.1 556 0x80000004 0x001d25

Router Link States (Area 1)

Link ID ADV Router Age Seq# Checksum Link count
192.168.1.1 192.168.1.1 906 0x80000003 0x007d73 3
192.168.2.1 192.168.2.1 859 0x80000003 0x003a2f 2

Summary Net Link States (Area 1)
Link ID ADV Router Age Seq# Checksum
192.168.2.0 192.168.2.1 844 0x80000001 0x00abda
20.0.0.0 192.168.2.1 667 0x80000002 0x00e4b8
192.168.3.0 192.168.2.1 556 0x80000003 0x001f24

Router Link States (Area 2)

Link ID ADV Router Age Seq# Checksum Link count
192.168.2.1 192.168.2.1 582 0x80000003 0x006be8 2
192.168.3.1 192.168.3.1 561 0x80000003 0x00e8ec 3

Summary Net Link States (Area 2)
Link ID ADV Router Age Seq# Checksum
10.0.0.0 192.168.2.1 854 0x80000001 0x00693f
192.168.1.0 192.168.2.1 854 0x80000002 0x00370f
192.168.2.0 192.168.2.1 844 0x80000003 0x00a7dc
```

Router2 (Jakarta – Area 2)

#show ip ospf neighbor

#show ip ospf database

```
Jakarta#show ip ospf neighbor

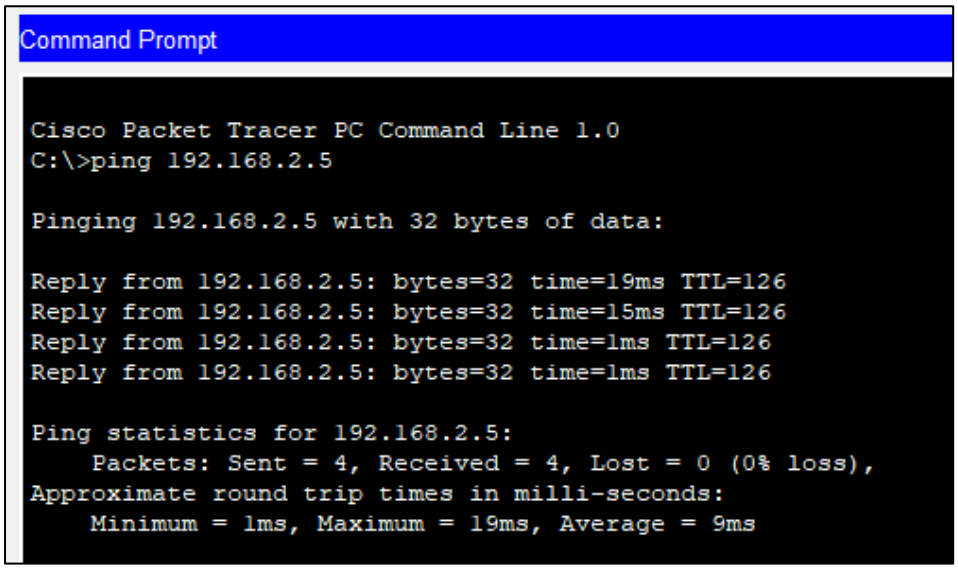

Neighbor ID Pri State Dead Time Address Interface
192.168.2.1 0 FULL/ - 00:00:37 20.0.0.1 Serial0/0/0
Jakarta#show ip ospf database
OSPF Router with ID (192.168.3.1) (Process ID 3)

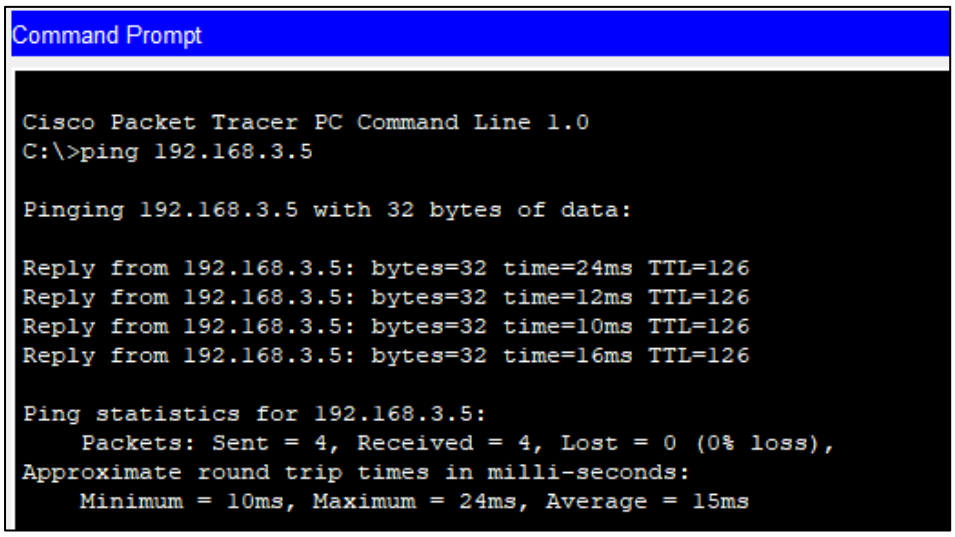
Router Link States (Area 2)

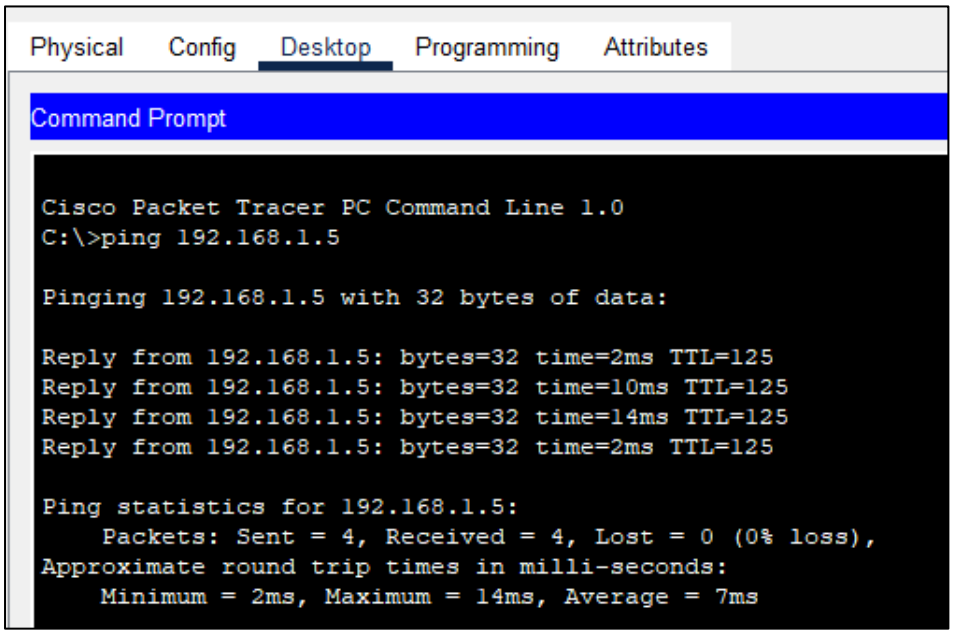
Link ID ADV Router Age Seq# Checksum Link count
192.168.2.1 192.168.2.1 715 0x80000003 0x006be8 2
192.168.3.1 192.168.3.1 694 0x80000003 0x00e8ec 3

Summary Net Link States (Area 2)
Link ID ADV Router Age Seq# Checksum
10.0.0.0 192.168.2.1 987 0x80000001 0x00693f
192.168.1.0 192.168.2.1 987 0x80000002 0x00370f
192.168.2.0 192.168.2.1 977 0x80000003 0x00a7dc
```

PCs on different networks can ping each other

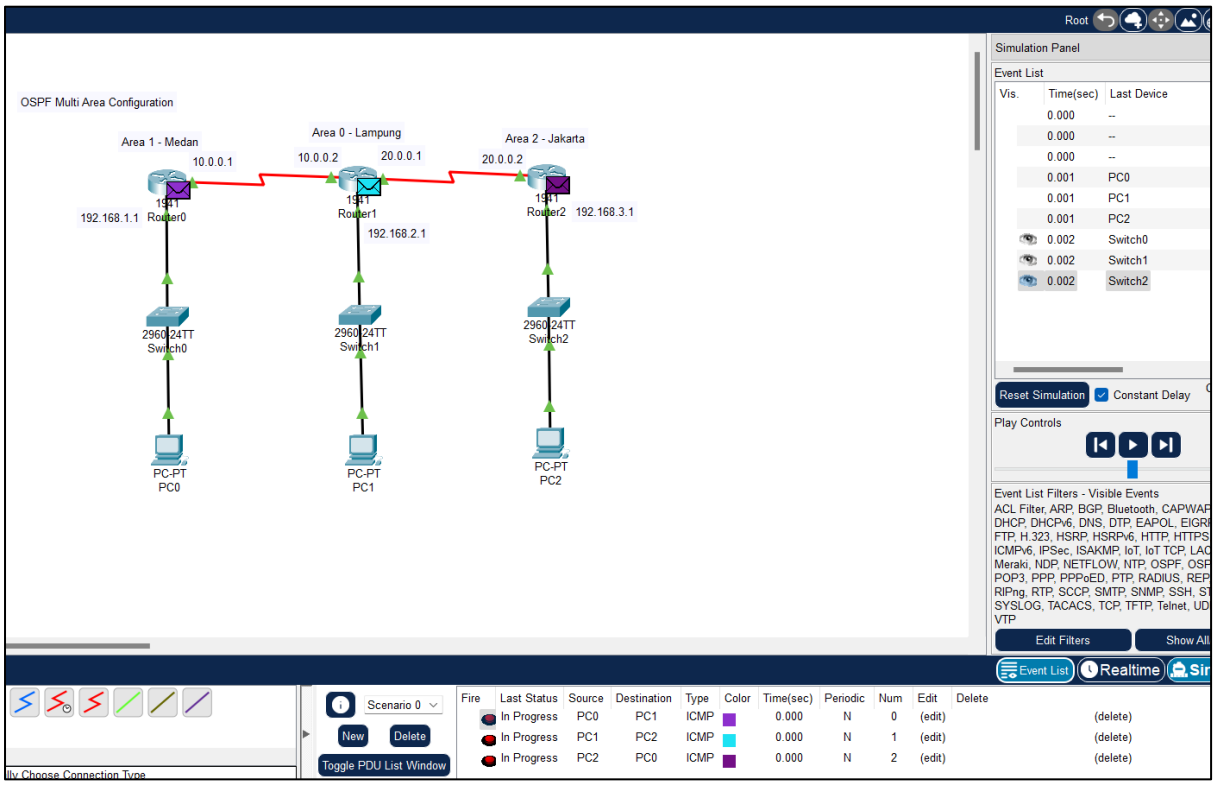






Conclusion :

OSPF Multi-Area was successfully configured. Routers in different areas established neighbor relationships through Area 0, and inter-area routing worked properly.

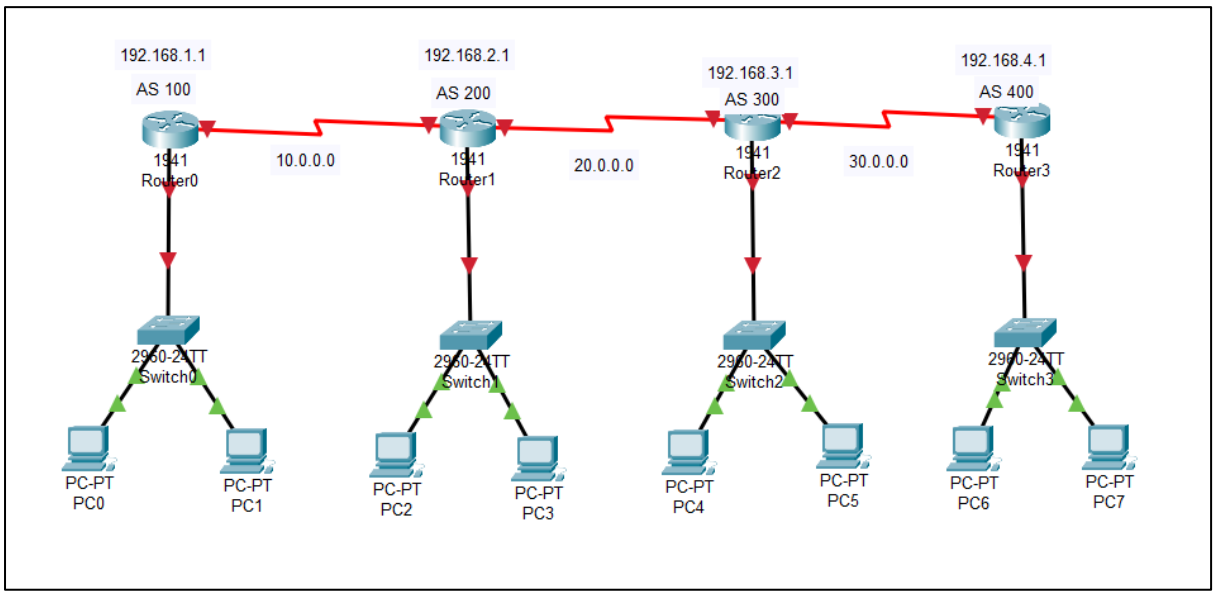


LAB 9 : BGP Configuration

BGP is used to connect different networks (like ISPs), making routing decisions based on policies and paths, ideal for large-scale internet routing.

Objective: Configure BGP between 4 routers, each in its own Autonomous System (AS).

Topology :



IP Addressing Table :

Router	Interface	IP Address	Subnet Mask
Router0	Serial0/0/0	10.0.0.1	255.0.0.0
	GigabitEthernet0/0	192.168.1.1	255.255.255.0
Router1	Serial0/0/0	10.0.0.2	255.0.0.0
	Serial0/0/1	20.0.0.1	255.0.0.0
	GigabitEthernet0/0	192.168.2.1	255.255.255.0
Router2	Serial0/0/0	20.0.0.2	255.0.0.0
	Serial0/0/1	30.0.0.1	255.0.0.0
	GigabitEthernet0/0	192.168.3.1	255.255.255.0
Router3	Serial0/0/0	30.0.0.2	255.0.0.0
	GigabitEthernet0/0	192.168.4.1	255.255.255.0

Configuration :

Each router is in a different AS:

Router0 (AS 100)

```
Router>enable
Router#configure terminal
Router(config)#interface serial0/0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
```

```
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#router bgp 100
Router(config-router)#network 10.0.0.0 mask 255.0.0.0
Router(config-router)#network 192.168.1.0 mask 255.255.255.0
Router(config-router)#neighbor 10.0.0.2 remote-AS 200
Router(config-router)#exit
```

Router1 (AS 200)

```
Router>enable
Router#configure terminal
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 10.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface serial0/0/1
Router(config-if)#ip address 20.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#router bgp 200
Router(config-router)#network 10.0.0.0 mask 255.0.0.0
Router(config-router)#network 20.0.0.0 mask 255.0.0.0
Router(config-router)#network 192.168.2.0 mask 255.255.255.0
Router(config-router)#neighbor 10.0.0.1 remote-AS 100
Router(config-router)#neighbor 20.0.0.2 remote-AS 300
```

Router2 (AS 300)

```
Router>enable
Router#configure terminal
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 20.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/0/1
Router(config-if)#ip address 30.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.3.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#router bgp 300
Router(config-router)#network 20.0.0.0 mask 255.0.0.0
Router(config-router)#network 30.0.0.0 mask 255.0.0.0
Router(config-router)#network 192.168.3.0 mask 255.255.255.0
Router(config-router)#neighbor 20.0.0.1 remote-AS 200
Router(config-router)#neighbor 30.0.0.2 remote-AS 400
Router(config-router)#exit
```

Router3 (AS 400)

```
Router>enable
Router#configure terminal
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 30.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 192.168.4.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#router bgp 400
Router(config-router)#network 30.0.0.0 mask 255.0.0.0
Router(config-router)#network 192.168.4.0 mask 255.255.255.0
Router(config-router)#neighbor 30.0.0.1 remote-AS 300
Router(config-router)#exit
```

Verification :

Router0 (AS 100)

#show ip route

#show ip protocols

```
Router#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.1/32 is directly connected, Serial0/0/0
B 20.0.0.0/8 [20/0] via 10.0.0.2, 00:00:00
B 30.0.0.0/8 [20/0] via 10.0.0.2, 00:00:00
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.1.0/24 is directly connected, GigabitEthernet0/0
L 192.168.1.1/32 is directly connected, GigabitEthernet0/0
B 192.168.2.0/24 [20/0] via 10.0.0.2, 00:00:00
B 192.168.3.0/24 [20/0] via 10.0.0.2, 00:00:00
B 192.168.4.0/24 [20/0] via 10.0.0.2, 00:00:00

Router#show ip protocols
Routing Protocol is "bgp 100"
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
IGP synchronization is disabled
Automatic route summarization is disabled
Neighbor(s):
Address FiltIn FiltOut DistIn DistOut Weight RouteMap
10.0.0.2
Maximum path: 1
Routing Information Sources:
Gateway Distance Last Update
10.0.0.2 20 00:00:00
```

```
Distance: external 20 internal 200 local 200
```

Router1 (AS 200)

#show ip route

#show ip protocols

```
Router#show ip route
Codes: L - local, 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, 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 10.0.0.0/8 is directly connected, Serial0/0/0
L 10.0.0.2/32 is directly connected, Serial0/0/0
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/1
L 20.0.0.1/32 is directly connected, Serial0/0/1
B 30.0.0.0/8 [20/0] via 20.0.0.2, 00:00:00
B 192.168.1.0/24 [20/0] via 10.0.0.1, 00:00:00
192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0
L 192.168.2.1/32 is directly connected, GigabitEthernet0/0
B 192.168.3.0/24 [20/0] via 20.0.0.2, 00:00:00
B 192.168.4.0/24 [20/0] via 20.0.0.2, 00:00:00

Router#show ip protocols
Routing Protocol is "bgp 200"
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
IGP synchronization is disabled
Automatic route summarization is disabled
Neighbor(s):
Address FiltIn FiltOut DistIn DistOut Weight RouteMap
10.0.0.1
20.0.0.2
Maximum path: 1
Routing Information Sources:
Gateway Distance Last Update
10.0.0.1 20 00:00:00
20.0.0.2 20 00:00:00
Distance: external 20 internal 200 local 200
```

Router2 (AS 300)

#show ip route

#show ip protocols

```
Router#show ip route
Codes: L - local, 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, 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

B 10.0.0.0/8 [20/0] via 20.0.0.1, 00:00:00
20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 20.0.0.0/8 is directly connected, Serial0/0/0
L 20.0.0.2/32 is directly connected, Serial0/0/0
30.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 30.0.0.0/8 is directly connected, Serial0/0/1
L 30.0.0.1/32 is directly connected, Serial0/0/1
B 192.168.1.0/24 [20/0] via 20.0.0.1, 00:00:00
B 192.168.2.0/24 [20/0] via 20.0.0.1, 00:00:00
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/0
L 192.168.3.1/32 is directly connected, GigabitEthernet0/0
B 192.168.4.0/24 [20/0] via 30.0.0.2, 00:00:00

Router#show ip protocols
Routing Protocol is "bgp 300"
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
IGP synchronization is disabled
Automatic route summarization is disabled
Neighbor(s):
Address FiltIn FiltOut DistIn DistOut Weight RouteMap
20.0.0.1
30.0.0.2
Maximum path: 1
Routing Information Sources:
Gateway Distance Last Update
20.0.0.1 20 00:00:00
30.0.0.2 20 00:00:00
Distance: external 20 internal 200 local 200
```

Router3 (AS 400)

#show ip route

#show ip protocols

```
Router#show ip route
Codes: L - local, 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, 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

B 10.0.0.0/8 [20/0] via 30.0.0.1, 00:00:00
B 20.0.0.0/8 [20/0] via 30.0.0.1, 00:00:00
30.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 30.0.0.0/8 is directly connected, Serial0/0/0
L 30.0.0.2/32 is directly connected, Serial0/0/0
B 192.168.1.0/24 [20/0] via 30.0.0.1, 00:00:00
B 192.168.2.0/24 [20/0] via 30.0.0.1, 00:00:00
B 192.168.3.0/24 [20/0] via 30.0.0.1, 00:00:00
192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.4.0/24 is directly connected, GigabitEthernet0/0
```

```
L 192.168.4.1/32 is directly connected, GigabitEthernet0/0

Router#show ip protocols
Routing Protocol is "bgp 400"
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
IGP synchronization is disabled
Automatic route summarization is disabled
Neighbor(s):
Address FiltIn FiltOut DistIn DistOut Weight RouteMap
30.0.0.1
Maximum path: 1
Routing Information Sources:
Gateway Distance Last Update
30.0.0.1 20 00:00:00
Distance: external 20 internal 200 local 200
```

Output :

Router0 (AS 100)

#show ip bgp summary

#show ip bgp

#show ip bgp neighbor

```
Router#show ip bgp summary
BGP router identifier 192.168.1.1, local AS number 100
BGP table version is 9, main routing table version 6
8 network entries using 1056 bytes of memory
8 path entries using 416 bytes of memory
6/5 BGP path/bestpath attribute entries using 1012 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
Bitfield cache entries: current 1 (at peak 1) using 32 bytes of memory
BGP using 2612 total bytes of memory
BGP activity 7/0 prefixes, 8/0 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
10.0.0.2 4 200 29 20 9 0 0 00:18:24 4

Router#show ip bgp
BGP table version is 9, local router ID is 192.168.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
*> 10.0.0.0/8 0.0.0.0 0 0 32768 i
* 10.0.0.2 0 0 0 200 i
*> 20.0.0.0/8 10.0.0.2 0 0 0 200 i
*> 30.0.0.0/8 10.0.0.2 0 0 0 200 300 i
*> 192.168.1.0/24 0.0.0.0 0 0 32768 i
*> 192.168.2.0/24 10.0.0.2 0 0 0 200 i
*> 192.168.3.0/24 10.0.0.2 0 0 0 200 300 i
*> 192.168.4.0/24 10.0.0.2 0 0 0 200 300 400 i

Router#show ip bgp neighbor
BGP neighbor is 10.0.0.2, remote AS 200, external link
```

```
BGP version 4, remote router ID 192.168.2.1
BGP state = Established, up for 00:18:45
Last read 00:18:45, last write 00:18:45, hold time is 180, keepalive
interval is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Message statistics:
InQ depth is 0
OutQ depth is 0

Sent Rcvd
Opens: 1 1
Notifications: 0 0
Updates: 3 9
Keepalives: 19 19
Route Refresh: 0 3
Total: 23 32
Default minimum time between advertisements runs is 30 seconds
```

Router1 (AS 200)

#show ip bgp summary

#show ip bgp

#show ip bgp neighbor

```
Router#show ip bgp summary
BGP router identifier 192.168.2.1, local AS number 200
BGP table version is 10, main routing table version 6
9 network entries using 1188 bytes of memory
9 path entries using 468 bytes of memory
6/4 BGP path/bestpath attribute entries using 920 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
Bitfield cache entries: current 1 (at peak 1) using 32 bytes of memory
BGP using 2704 total bytes of memory
BGP activity 7/0 prefixes, 9/0 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
10.0.0.1 4 100 25 22 10 0 0 00:20:27 4
20.0.0.2 4 300 23 16 10 0 0 00:14:35 4

Router#show ip bgp
BGP table version is 10, local router ID is 192.168.2.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
*> 10.0.0.0/8 0.0.0.0 0 0 32768 i
* 10.0.0.1 0 0 0 100 i
*> 20.0.0.0/8 0.0.0.0 0 0 32768 i
* 20.0.0.2 0 0 0 300 i
*> 30.0.0.0/8 20.0.0.2 0 0 0 300 i
*> 192.168.1.0/24 10.0.0.1 0 0 0 100 i
*> 192.168.2.0/24 0.0.0.0 0 0 32768 i
*> 192.168.3.0/24 20.0.0.2 0 0 0 300 i
*> 192.168.4.0/24 20.0.0.2 0 0 0 300 400 i
```

```
Router#show ip bgp neighbor
BGP neighbor is 10.0.0.1, remote AS 100, external link
BGP version 4, remote router ID 192.168.1.1
BGP state = Established, up for 00:20:40
Last read 00:20:40, last write 00:20:40, hold time is 180, keepalive
interval is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Message statistics:
InQ depth is 0
OutQ depth is 0

Sent Rcvd
Opens: 1 1
Notifications: 0 0
Updates: 9 3
Keepalives: 21 21
Route Refresh: 0 1
Total: 31 26
Default minimum time between advertisements runs is 30 seconds
```

Router2 (AS 300)

#show ip bgp summary

#show ip bgp

#show ip bgp neighbor

```
Router#show ip bgp summary
BGP router identifier 192.168.3.1, local AS number 300
BGP table version is 10, main routing table version 6
9 network entries using 1188 bytes of memory
9 path entries using 468 bytes of memory
6/4 BGP path/bestpath attribute entries using 920 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
Bitfield cache entries: current 1 (at peak 1) using 32 bytes of memory
BGP using 2704 total bytes of memory
BGP activity 7/0 prefixes, 9/0 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
20.0.0.1 4 200 23 17 10 0 0 00:15:34 4
30.0.0.2 4 400 15 12 10 0 0 00:10:29 4

Router#show ip bgp
BGP table version is 10, local router ID is 192.168.3.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
*> 10.0.0.0/8 20.0.0.1 0 0 0 200 i
*> 20.0.0.0/8 0.0.0.0 0 0 32768 i
* 20.0.0.1 0 0 0 200 i
*> 30.0.0.0/8 0.0.0.0 0 0 32768 i
* 30.0.0.2 0 0 0 400 i
*> 192.168.1.0/24 20.0.0.1 0 0 0 200 100 i
```

```
*> 192.168.2.0/24 20.0.0.1 0 0 0 200 i
*> 192.168.3.0/24 0.0.0.0 0 0 32768 i
*> 192.168.4.0/24 30.0.0.2 0 0 0 400 i

Router#show ip bgp neighbor
BGP neighbor is 20.0.0.1, remote AS 200, external link
BGP version 4, remote router ID 192.168.2.1
BGP state = Established, up for 00:15:49
Last read 00:15:49, last write 00:15:49, hold time is 180, keepalive
interval is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Message statistics:
InQ depth is 0
OutQ depth is 0

Sent Rcvd
Opens: 1 1
Notifications: 0 0
Updates: 7 6
Keepalives: 16 16
Route Refresh: 0 2
Total: 24 25
Default minimum time between advertisements runs is 30 seconds
```

Router3 (AS 400)

#show ip bgp summary

#show ip bgp

#show ip bgp neighbor

```
Router#show ip bgp summary
BGP router identifier 192.168.4.1, local AS number 400
BGP table version is 9, main routing table version 6
8 network entries using 1056 bytes of memory
8 path entries using 416 bytes of memory
6/5 BGP path/bestpath attribute entries using 1012 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
Bitfield cache entries: current 1 (at peak 1) using 32 bytes of memory
BGP using 2612 total bytes of memory
BGP activity 7/0 prefixes, 8/0 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
30.0.0.1 4 300 21 13 9 0 0 00:11:23 4

Router#show ip bgp
BGP table version is 9, local router ID is 192.168.4.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

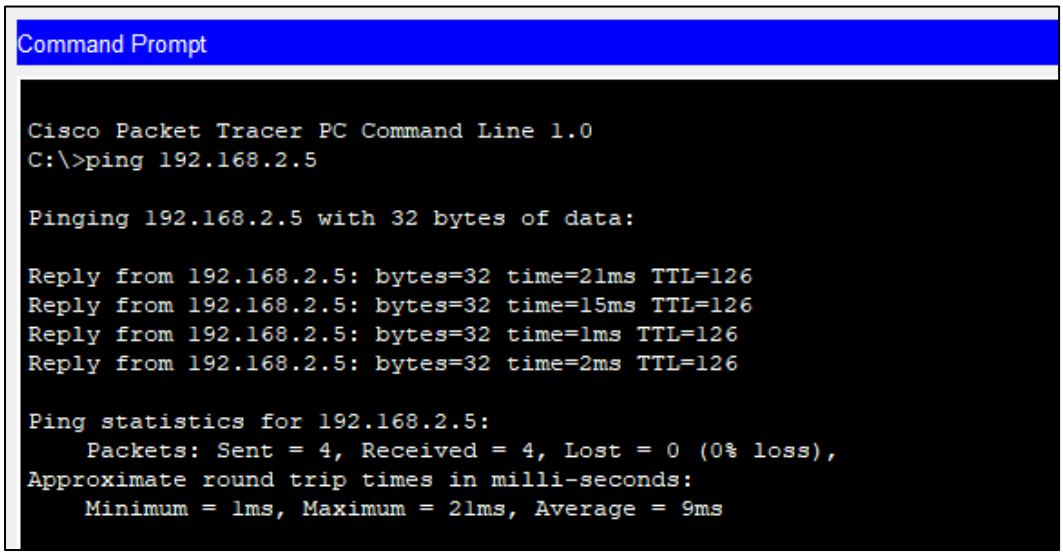
Network Next Hop Metric LocPrf Weight Path
*> 10.0.0.0/8 30.0.0.1 0 0 0 300 200 i
*> 20.0.0.0/8 30.0.0.1 0 0 0 300 i
*> 30.0.0.0/8 0.0.0.0 0 0 32768 i
* 30.0.0.1 0 0 0 300 i
```

```
*> 192.168.1.0/24 30.0.0.1 0 0 0 300 200 100 i
*> 192.168.2.0/24 30.0.0.1 0 0 0 300 200 i
*> 192.168.3.0/24 30.0.0.1 0 0 0 300 i
*> 192.168.4.0/24 0.0.0.0 0 0 32768 i

Router#show ip bgp neighbor
BGP neighbor is 30.0.0.1, remote AS 300, external link
BGP version 4, remote router ID 192.168.3.1
BGP state = Established, up for 00:11:33
Last read 00:11:33, last write 00:11:33, hold time is 180, keepalive
interval is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Message statistics:
InQ depth is 0
OutQ depth is 0

Sent Rcvd
Opens: 1 1
Notifications: 0 0
Updates: 3 8
Keepalives: 12 12
Route Refresh: 0 2
Total: 16 23
Default minimum time between advertisements runs is 30 seconds
```

PCs on different networks can ping each other



Command Prompt

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.3.5

Pinging 192.168.3.5 with 32 bytes of data:

Reply from 192.168.3.5: bytes=32 time=15ms TTL=126
Reply from 192.168.3.5: bytes=32 time=2ms TTL=126
Reply from 192.168.3.5: bytes=32 time=1ms TTL=126
Reply from 192.168.3.5: bytes=32 time=1ms TTL=126

Ping statistics for 192.168.3.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 15ms, Average = 4ms
```

Command Prompt

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.4.5

Pinging 192.168.4.5 with 32 bytes of data:

Reply from 192.168.4.5: bytes=32 time=16ms TTL=126
Reply from 192.168.4.5: bytes=32 time=9ms TTL=126
Reply from 192.168.4.5: bytes=32 time=1ms TTL=126
Reply from 192.168.4.5: bytes=32 time=2ms TTL=126

Ping statistics for 192.168.4.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 16ms, Average = 7ms
```

Command Prompt

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Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.1

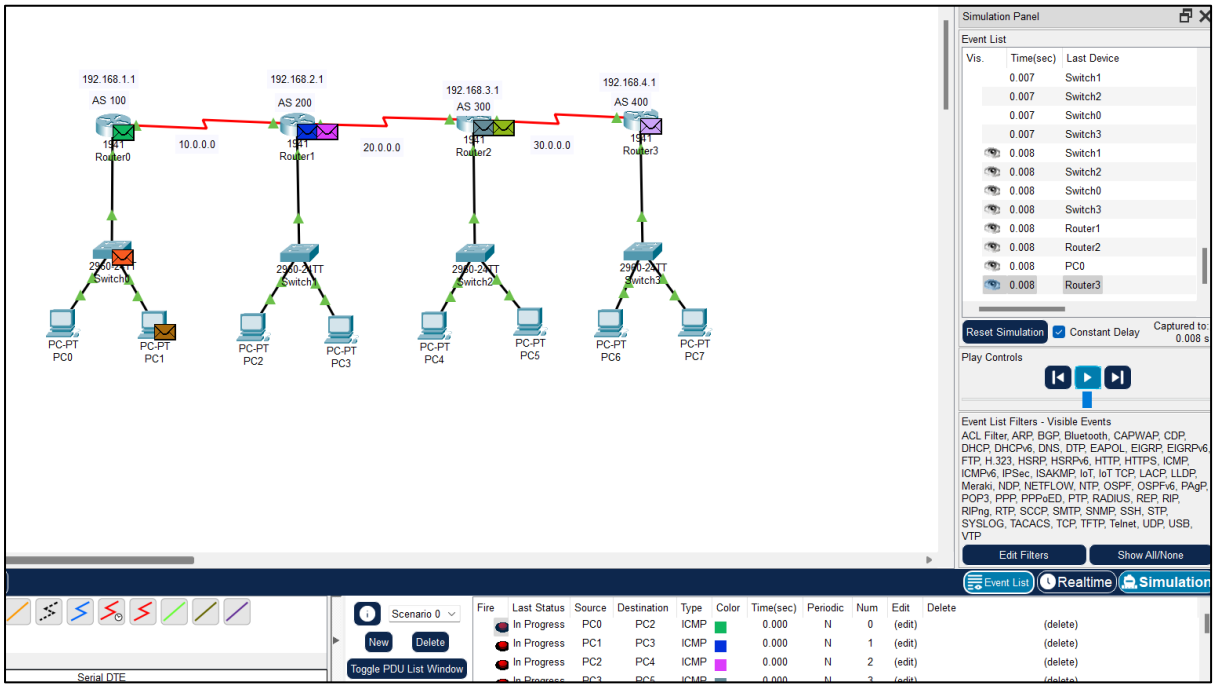
Pinging 192.168.1.1 with 32 bytes of data:

Reply from 192.168.1.1: bytes=32 time=38ms TTL=252
Reply from 192.168.1.1: bytes=32 time=3ms TTL=252
Reply from 192.168.1.1: bytes=32 time=10ms TTL=252
Reply from 192.168.1.1: bytes=32 time=33ms TTL=252

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 38ms, Average = 21ms
```

Conclusion :

BGP was successfully configured between 4 routers, each in a different AS. Each router shared its local LAN with others, enabling PC-to-PC communication across AS boundaries using BGP-learned routes.



Overview Table

Feature	RIP	EIGRP	OSPF (Single-Area)	OSPF (Multi-Area)	BGP
Protocol Type	Distance Vector	Advanced Distance Vector	Link State	Link State	Path Vector
Use Case	Small Networks	Medium to Large Cisco-only	Medium to Large Networks	Large Enterprise Networks	Internet, ISPs, Very Large Nets
Algorithm	Bellman-Ford	Dual	Dijkstra (SPF)	Dijkstra (SPF)	Best Path Selection (AS_PATH)
Metric	Hop Count (Max 15)	Bandwidth + Delay	Cost (Bandwidth)	Cost (Bandwidth)	AS-Path, Policy, Prefix Length
Convergence Speed	Slow	Fast	Fast	Fast	Slow
Routing Update	Periodic (30s)	Triggered	Triggered	Triggered	Triggered (Event-driven)
VLSM Support	v1 : No v2 : Yes	Yes	Yes	Yes	Yes
Vendor Support	All Vendors	Cisco Only	All Vendors	All Vendors	All Vendors
Configuration Ease	Very Easy	Easy	Moderate	Comlex	Complex
Ideal for	Small, Simple LANs	Fast Cisco-only Environments	Enterprise with 1 Area	Structured Enterprise Networks	Internet-scale External Routing

Conclusion

In this networking lab, various essential routing protocols and IP address management techniques were successfully configured and tested in simulated network environments using Cisco Packet Tracer. The objective of the lab exercises was to gain practical experience with the configuration and behavior of different types of routing protocols and services, which are fundamental to modern computer networks.

Through this lab, the following were achieved:

- **DHCP using a Server** illustrated centralized IP address assignment, allowing end devices to dynamically receive network configuration.
- **DHCP using a Cisco Router** showed how routers can also provide DHCP services when dedicated servers are not available.
- **Default Routing** demonstrated how to handle unknown destinations by routing them through a default gateway, ensuring reachability outside local networks.
- **Static Routing** was used to demonstrate manual path configuration between networks, ideal for small-scale topologies.
- **RIP (v1 and v2)** was explored to understand distance-vector routing protocols, their limitations (such as RIP v1's classful nature), and improvements (such as RIP v2's support for subnetting and multicasting).
- **EIGRP** was configured across multiple Autonomous Systems, providing insight into Cisco's advanced distance-vector protocol and its advantages in speed and convergence.
- **OSPF** was implemented in both single and multi-area configurations to show how link-state routing scales well in larger networks with hierarchical design.
- **BGP** introduced the basics of path vector routing between Autonomous Systems, simulating inter domain routing similar to what ISPs use.

All configurations were verified through proper connectivity testing (ping, ipconfig, and routing table inspections), ensuring that networks were fully operational and communicating as intended.

Overall, this lab enhanced my understanding of how different routing protocols and IP addressing mechanisms operate, interconnect, and contribute to scalable, dynamic, and reliable network infrastructures.