Lab 6 : Dynamic Routing Configurations : RIP, EIGRP, OSPF, BGP

Objectives :

- To understand how routers automatically discover remote networks and maintain routing tables without manually configuring each route.
- To configure and analyze the working of RIP, EIGRP, OSPF, and BGP, focusing on different routing algorithms such as Distance Vector, Link-State, and Path Vector.

Theory :

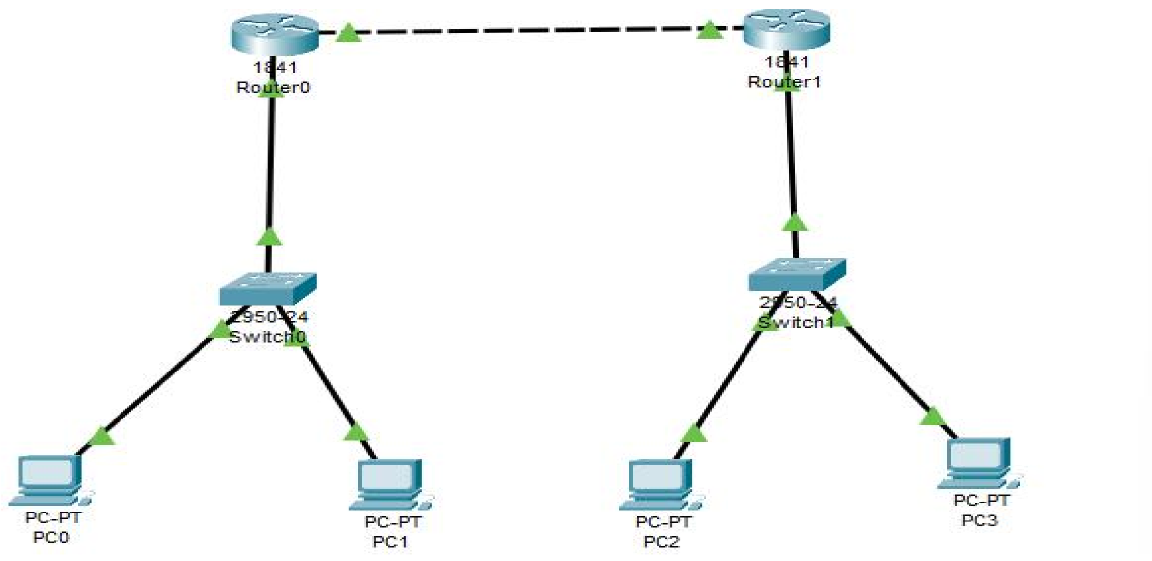
Dynamic routing protocols allow routers to automatically learn and update routing information by exchanging messages with neighboring routers. Unlike static routing, dynamic routing adapts automatically to network topology changes, making it suitable for large and complex networks.

1. **Routing Information Protocol (RIP) :**

   RIP is one of the oldest distance vector protocols. It is characterized by its simplicity but has limitations in larger networks.

   - Algorithm: Uses the Distance Vector algorithm.
   - Metric: Uses Hop Count to determine the best path, with a maximum limit of 15 hops.
   - Operation: Routers send their entire routing table to their neighbours every 30 seconds.
   - Versions: RIP v1 is classful (no subnetting support), while RIP v2 is classless and supports CIDR.

Network Topology :



Configuration :

For PCs :

Device	IPv4 address	Subnet Mask	Default Gateway
PC0	192.168.1.2	255.255.255.0	192.168.1.1
PC1	192.168.1.3	255.255.255.0	192.168.1.1
PC2	192.168.2.2	255.255.255.0	192.168.2.1
PC3	192.168.2.3	255.255.255.0	192.168.2.1

For Routers :

Device	IPv4 address	Subnet Mask	Next Hop	Ethernet Cable	Default Gateway
Router 1	192.168.2.0	255.255.255.0	10.0.0.2	gig 0/0	10.0.0.1
				gig 0/1	192.168.1.1
Router 2	192.168.1.0	255.255.255.0	10.0.0.1	gig 0/0	10.0.0.2
				gig 0/1	192.168.2.1

Commands :

Router 0 :

router rip

version 2

network 192.168.1.0

network 10.0.0.0

no auto-summary

Router 1 :

router rip

version 2

network 192.168.2.0

network 10.0.0.0

no auto-summary

Observation :

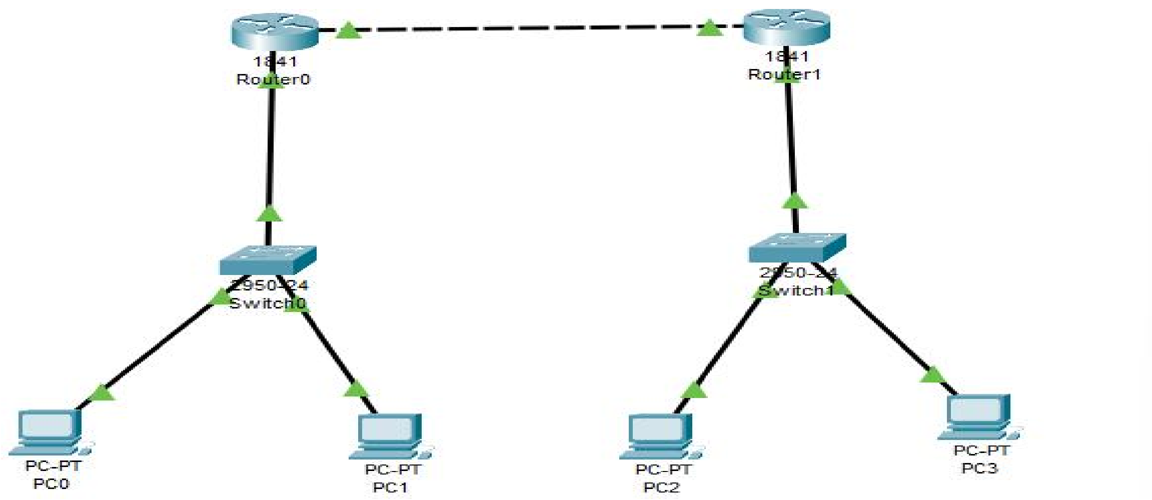
```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.2.3

Pinging 192.168.2.3 with 32 bytes of data:

Request timed out.
Reply from 192.168.2.3: bytes=32 time<1ms TTL=126
Reply from 192.168.2.3: bytes=32 time=14ms TTL=126
Reply from 192.168.2.3: bytes=32 time=15ms TTL=126

Ping statistics for 192.168.2.3:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 15ms, Average = 9ms

C:\>ping 192.168.2.3

Pinging 192.168.2.3 with 32 bytes of data:

Reply from 192.168.2.3: bytes=32 time<1ms TTL=126
Reply from 192.168.2.3: bytes=32 time=20ms TTL=126
Reply from 192.168.2.3: bytes=32 time=11ms TTL=126
Reply from 192.168.2.3: bytes=32 time=12ms TTL=126

Ping statistics for 192.168.2.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 20ms, Average = 10ms

C:\>
```

2. Enhanced Interior Gateway Routing Protocol (EIGRP) :

EIGRP is a hybrid protocol that combines the best features of both distance vector and link-state protocols.

- Algorithm: Uses the Diffusing Update Algorithm (DUAL) to ensure loop-free paths.
- Metric: Uses a composite metric based on Bandwidth and Delay (optionally Reliability and Load).
- Operation: Routers only send updates when a topology change occurs, which saves bandwidth.
- Feature: Supports unequal cost load balancing, which is unique among these protocols.

Network Topology :



Configuration :

For PCs :

Device	IPv4 address	Subnet Mask	Default Gateway
PC0	192.168.1.2	255.255.255.0	192.168.1.1
PC1	192.168.1.3	255.255.255.0	192.168.1.1
PC2	192.168.2.2	255.255.255.0	192.168.2.1
PC3	192.168.2.3	255.255.255.0	192.168.2.1

For Routers :

Device	IPv4 address	Subnet Mask	Next Hop	Ethernet Cable	Default Gateway
Router 1	192.168.2.0	255.255.255.0	10.0.0.2	gig 0/0	10.0.0.1
				gig 0/1	192.168.1.1
Router 2	192.168.1.0	255.255.255.0	10.0.0.1	gig 0/0	10.0.0.2
				gig 0/1	192.168.2.1

Commands :

Router 0 :

router eigrp 100

network 192.168.1.0 0.0.0.255

network 10.0.0.0 0.0.0.255

no auto-summary

Router 1 :

router eigrp 100

network 192.168.2.0 0.0.0.255

network 10.0.0.0 0.0.0.255

no auto-summary

Observation :

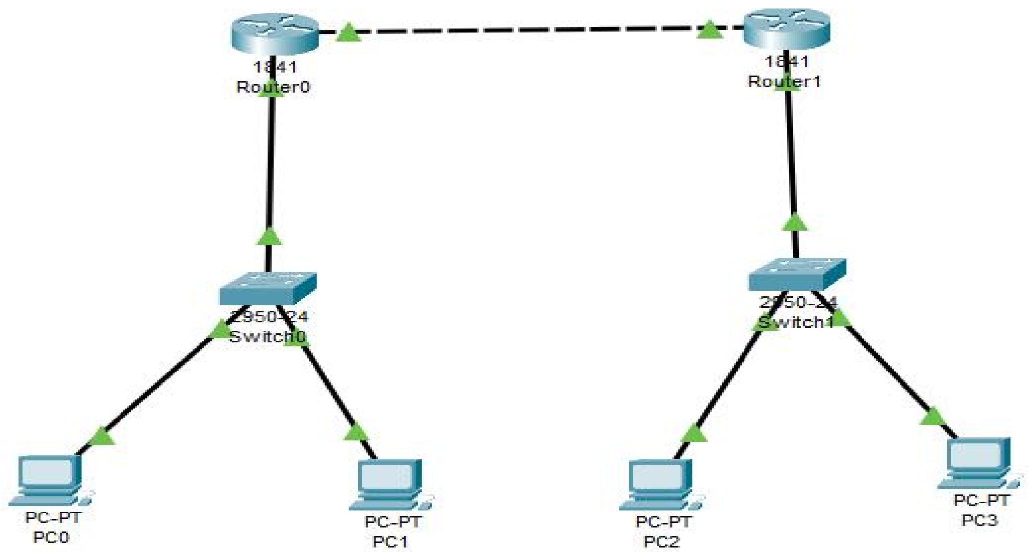
```
Pinging 192.168.2.2 with 32 bytes of data:

Request timed out.
Reply from 192.168.2.2: bytes=32 time=13ms TTL=126
Reply from 192.168.2.2: bytes=32 time<1ms TTL=126
Reply from 192.168.2.2: bytes=32 time=14ms TTL=126

Ping statistics for 192.168.2.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 14ms, Average = 9ms

C:\>ping 192.168.2.2

Pinging 192.168.2.2 with 32 bytes of data:

Reply from 192.168.2.2: bytes=32 time=1ms TTL=126
Reply from 192.168.2.2: bytes=32 time=12ms TTL=126
Reply from 192.168.2.2: bytes=32 time<1ms TTL=126
Reply from 192.168.2.2: bytes=32 time=14ms TTL=126

Ping statistics for 192.168.2.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 14ms, Average = 6ms

C:\>
```

3. Open Shortest Path First (OSPF) :

OSPF is a widely used link-state routing protocol designed for scalability and fast convergence.

- Algorithm: Uses Dijkstra’s Shortest Path First (SPF) algorithm.
- Metric: Uses Cost, which is calculated based on reference bandwidth divided by interface bandwidth.
- Operation: Routers discover neighbors using "Hello" packets and exchange Link State Advertisements (LSAs) to build a synchronized topology database.
- Advantage: Offers very fast convergence compared to RIP.

Network Topology :



Configuration :

For PCs :

Device	IPv4 address	Subnet Mask	Default Gateway
PC0	192.168.1.2	255.255.255.0	192.168.1.1
PC1	192.168.1.3	255.255.255.0	192.168.1.1
PC2	192.168.2.2	255.255.255.0	192.168.2.1
PC3	192.168.2.3	255.255.255.0	192.168.2.1

For Routers :

Device	IPv4 address	Subnet Mask	Next Hop	Ethernet Cable	Default Gateway
Router 1	192.168.2.0	255.255.255.0	10.0.0.2	gig 0/0	10.0.0.1
				gig 0/1	192.168.1.1
Router 2	192.168.1.0	255.255.255.0	10.0.0.1	gig 0/0	10.0.0.2
				gig 0/1	192.168.2.1

Commands :

Router 0 :

router ospf 1

network 192.168.1.0 0.0.0.255 area 0

network 10.0.0.0 0.0.0.255 area 0

Router 1 :

router ospf 1

network 192.168.2.0 0.0.0.255 area 0

network 10.0.0.0 0.0.0.255 area 0

Observation :

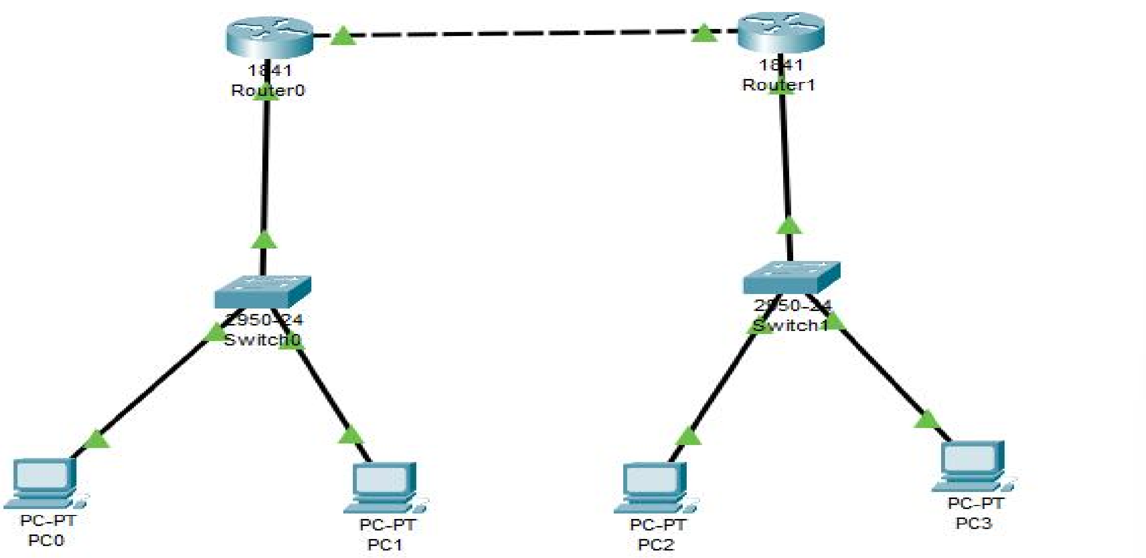
```
Pinging 192.168.1.2 with 32 bytes of data:

Reply from 192.168.1.2: bytes=32 time=3ms TTL=128
Reply from 192.168.1.2: bytes=32 time=3ms TTL=128
Reply from 192.168.1.2: bytes=32 time=3ms TTL=128
Reply from 192.168.1.2: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 3ms, Average = 2ms

C:\>ping 192.168.1.2

Pinging 192.168.1.2 with 32 bytes of data:

Reply from 192.168.1.2: bytes=32 time=2ms TTL=128
Reply from 192.168.1.2: bytes=32 time=1ms TTL=128
Reply from 192.168.1.2: bytes=32 time=2ms TTL=128
Reply from 192.168.1.2: bytes=32 time=1ms TTL=128

Ping statistics for 192.168.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms

C:\>
```

4. Border Gateway Protocol (BGP) :

BGP is a path vector protocol and is considered the "routing protocol of the internet".

- Purpose: It is used to connect different Autonomous Systems (AS), which are groups of networks under a single administration.
- Operation: BGP uses path attributes (like AS-Path) rather than simple metrics to select the best path.
- Reliability: It uses TCP port 179 for reliable communication between routers.
- Scalability: It is highly reliable and scales to manage the entire global internet routing table.

Network Topology :



Configuration :

For PCs :

Device	IPv4 address	Subnet Mask	Default Gateway
PC0	192.168.1.2	255.255.255.0	192.168.1.1
PC1	192.168.1.3	255.255.255.0	192.168.1.1
PC2	192.168.2.2	255.255.255.0	192.168.2.1
PC3	192.168.2.3	255.255.255.0	192.168.2.1

For Routers :

Device	IPv4 address	Subnet Mask	Next Hop	Ethernet Cable	Default Gateway
Router 1	192.168.2.0	255.255.255.0	10.0.0.2	gig 0/0	10.0.0.1
				gig 0/1	192.168.1.1
Router 2	192.168.1.0	255.255.255.0	10.0.0.1	gig 0/0	10.0.0.2
				gig 0/1	192.168.2.1

Commands :

Assumption :

R1 -> AS 65001

R2 -> AS 65002

Router 0 :

router bgp 65001

neighbor 10.0.0.2 remote-as 65002

network 192.168.1.0 mask 255.255.255.0

Router 1 :

router bgp 65001

neighbor 10.0.0.1 remote-as 65001

network 192.168.2.0 mask 255.255.255.0

Observation :

```
Pinging 192.168.1.3 with 32 bytes of data:

Reply from 192.168.1.3: bytes=32 time=1ms TTL=128
Reply from 192.168.1.3: bytes=32 time<1ms TTL=128
Reply from 192.168.1.3: bytes=32 time<1ms TTL=128
Reply from 192.168.1.3: bytes=32 time=3ms TTL=128

Ping statistics for 192.168.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 3ms, Average = 1ms

C:\>ping 192.168.1.3

Pinging 192.168.1.3 with 32 bytes of data:

Reply from 192.168.1.3: bytes=32 time<1ms TTL=128
Reply from 192.168.1.3: bytes=32 time=1ms TTL=128
Reply from 192.168.1.3: bytes=32 time<1ms TTL=128
Reply from 192.168.1.3: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
```

Result :

The lab successfully demonstrated dynamic routing using RIP, EIGRP, OSPF, and BGP. Routers automatically learned and updated routing information without manual configuration. Routing tables were populated correctly, and full network connectivity was confirmed.

Discussion :

Each routing protocol exhibited distinct characteristics. RIP was easy to configure but limited by hop count. EIGRP provided fast convergence and efficient updates. OSPF used bandwidth-based cost and showed professional-grade scalability. BGP demonstrated how large-scale networks such as the Internet manage routing using Autonomous Systems. Connectivity was verified using ping commands.

Conclusion :

This lab successfully implemented multiple dynamic routing protocols and demonstrated their operation and differences. Dynamic routing proved efficient, scalable, and adaptive for modern network environments.