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

Objectives :

- To grasp how routers automatically discover remote networks and maintain routing tables without manual entry of every path.
- To configure and analyze the operation of RIP, EIGRP, OSPF, and BGP, focusing on how different algorithms (Distance Vector, Link-State, and Path Vector) automatically discover network topologies and populate routing tables.

Theory :

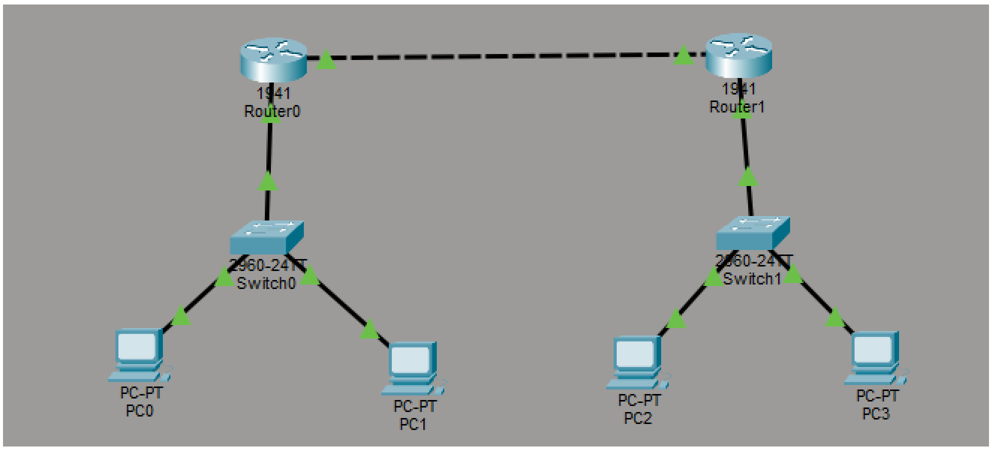
Dynamic routing protocols enable routers to exchange routing information with neighboring routers automatically. Using this shared information, routers can build and update their routing tables without human intervention. Unlike static routing, dynamic routing protocols can adapt to network changes such as link failures, topology modifications, or the addition of new networks, making them suitable for medium to large-scale networks.

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

   RIP is one of the earliest dynamic routing protocols and follows the distance vector approach. Due to its simplicity, it is easy to configure and understand; however, it is not well-suited for large or complex networks.

   - **Routing Algorithm:** Distance Vector algorithm.
   - **Metric Used:** Hop count, with a maximum allowable limit of 15 hops.
   - **Operation:** Routers broadcast their entire routing table to neighboring routers every 30 seconds.
   - **Versions:** RIP version 1 is classful and does not support subnetting, whereas RIP version 2 is classless and supports CIDR and VLSM.

Network Topology :



Configuration :

For PCs : All host devices were configured with appropriate IPv4 addresses, subnet masks, and default gateways to ensure correct communication within their local networks.

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 :

After configuring RIP, the routers successfully exchanged routing information. The routing tables were automatically updated, and connectivity between hosts located in different LANs was verified using ping commands. Initial convergence required a short delay due to periodic update intervals.

```
Cisco 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<1ms TTL=126
Reply from 192.168.2.3: bytes=32 time<1ms 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 = 0ms, Average = 0ms

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Reply from 192.168.2.3: bytes=32 time<1ms TTL=126
Reply from 192.168.2.3: bytes=32 time<1ms 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 = 0ms, Average = 0ms

C:\>
```
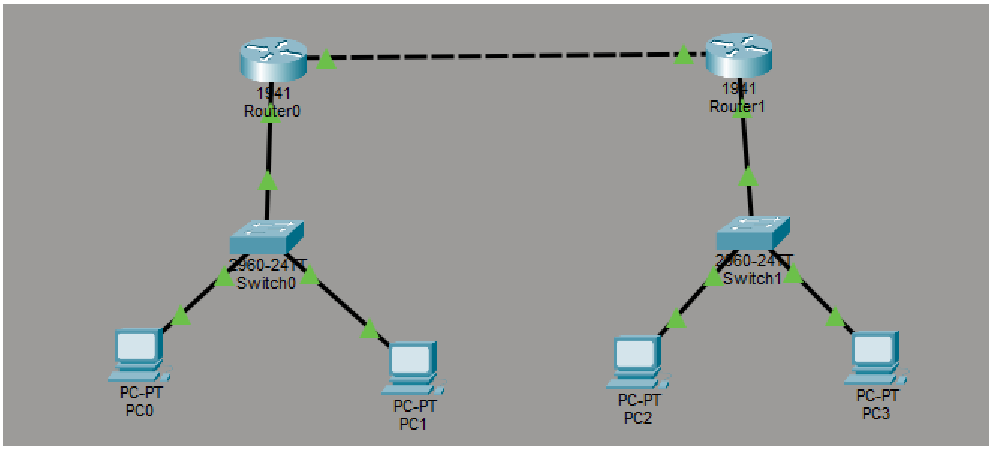

2. **Enhanced Interior Gateway Routing Protocol (EIGRP) :**

   EIGRP is a Cisco proprietary routing protocol that combines characteristics of both distance vector and link-state routing, making it a hybrid protocol. It is designed to provide fast convergence and efficient bandwidth usage.

   - **Routing Algorithm:** Diffusing Update Algorithm (DUAL).
   - **Metric Used:** Composite metric based on bandwidth and delay (with optional reliability and load).
   - **Operation:** Sends incremental updates only when topology changes occur.
   - **Feature**: Supports unequal cost load balancing.

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 :

EIGRP demonstrated faster convergence compared to RIP. Routing tables were updated almost immediately after configuration, and end-to-end connectivity between all devices was confirmed. The protocol efficiently reacted to changes, showcasing its reliability in dynamic environments.

```
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Reply from 192.168.2.2: bytes=32 time<1ms 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 = 1ms, Average = 0ms
```
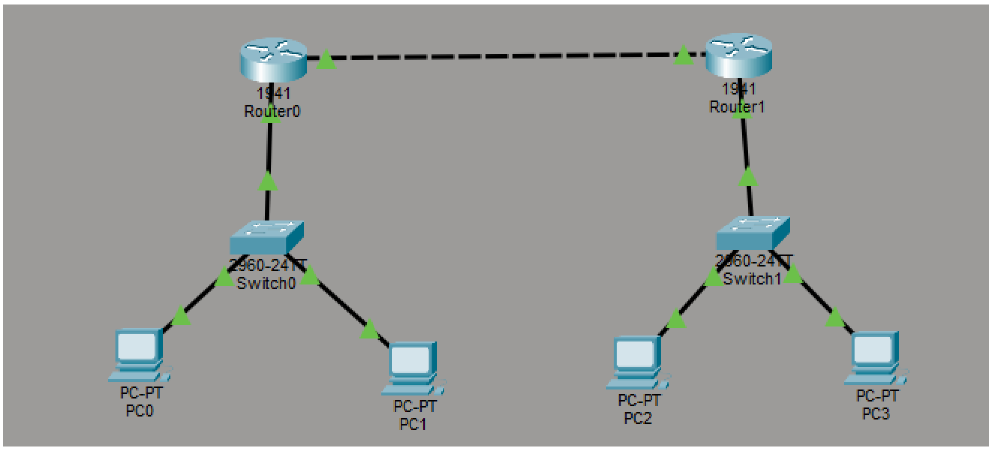

3. **Open Shortest Path First (OSPF) :**

   OSPF is a widely used link-state routing protocol designed for scalability and fast convergence. It is commonly used in enterprise and service provider networks.

   - **Routing Algorithm:** Dijkstra's Shortest Path First (SPF) algorithm.
   - **Metric Used:** Cost, calculated using reference bandwidth divided by interface bandwidth.
   - **Operation:** Routers exchange Hello packets to discover neighbors and use Link State Advertisements (LSAs) to maintain 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
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For Routers :

Device	IPv4 address	Subnet Mask	Next Hop	Ethernet Cable	Default Gateway
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				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 :

OSPF successfully established neighbor relationships and synchronized routing databases. The routers calculated the shortest path efficiently, and connectivity across the network was verified through ping tests with minimal convergence time.

```
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Ping statistics for 192.168.1.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
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Reply from 192.168.1.2: bytes=32 time<1ms TTL=126

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 = 0ms, Average = 0ms
```
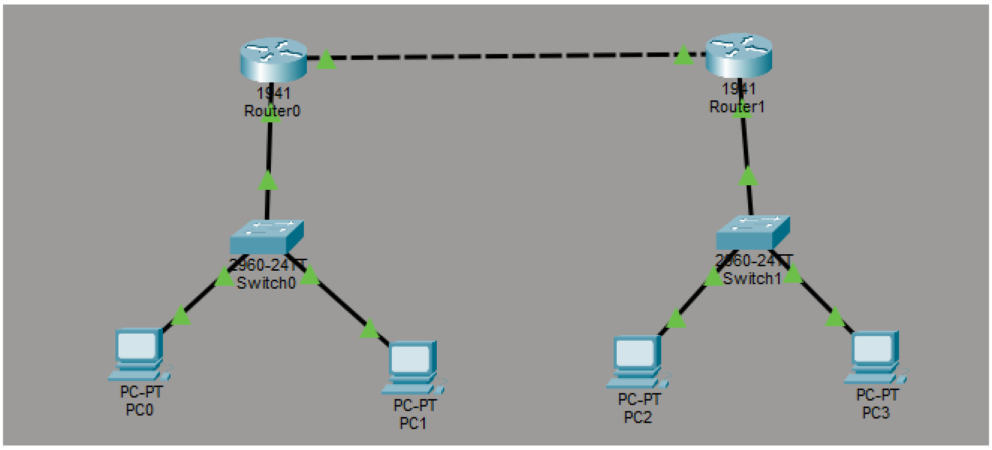

4. **Border Gateway Protocol (BGP) :**

   BGP is a path vector routing protocol primarily used for routing between different Autonomous Systems (AS). It forms the backbone of internet routing.

   - **Purpose:** Facilitates routing between multiple Autonomous Systems.
   - **Path Selection:** Uses path attributes such as AS-Path instead of simple metrics.
   - **Transport Protocol:** Uses TCP on port 179 for reliable communication.
   - **Scalability:** Capable of handling extremely large routing tables, including the global internet.

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
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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 :

After BGP configuration, neighbor relationships were successfully established between the routers. Routes were exchanged based on AS-path information, and inter-network connectivity was verified using ping commands.

```
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C:\>ping 192.168.1.3

Pinging 192.168.1.3 with 32 bytes of data:

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Approximate round trip times in milli-seconds:
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Pinging 192.168.1.3 with 32 bytes of data:

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

Result :

In this lab, four dynamic routing protocols—RIP, EIGRP, OSPF, and BGP—were successfully implemented and tested. In each case, routers automatically exchanged routing information and updated their routing tables without manual route entry. The presence of learned routes in the routing table and successful ping tests across the network confirmed correct operation.

Discussion :

In this lab , we highlighted the differences and use cases of various dynamic routing protocols. RIP was the simplest to configure but offered limited scalability and slower convergence. EIGRP demonstrated rapid convergence and efficient bandwidth usage. OSPF provided a more structured and scalable approach with fast and reliable route calculation. BGP offered insight into how large-scale networks, such as the internet, manage routing between autonomous systems. Connectivity testing using ping commands validated the effectiveness of each protocol.

Conclusion :

In this lab various algorithms of dynamic routing were successfully implemented.