Practical No. 1

Aim: OSPF Implementation

a) Implement Single-Area OSPFv2

b) Implement Multi-Area OSPFv2

Introduction:

OSPF (Open Shortest Path First) is a routing protocol that uses a link-state algorithm, while Single-Area OSPFv2 is a simple implementation where all routers are in one area, and Multi-Area OSPFv2 is a more scalable hierarchical design where the network is split into areas, with Area 0 as the backbone

Single-Area OSPFv2

- **Description:** All routers in the network are configured within a single OSPF area, typically Area 0.
- **Configuration:** This is the simplest OSPF setup, involving enabling the OSPF process, configuring a router ID, and enabling OSPF on the interfaces.

Multi-Area OSPFv2

- **Description:** The network is divided into multiple areas, with all areas connected to the backbone area (Area 0). Routers connecting different areas are called Area Border Routers (ABRs).
- **Configuration:** More complex than single-area OSPF, as it requires a hierarchical design and the configuration of multiple areas, with specific roles for routers like ABRs.

STEPS FOR SINGLE-AREA OSPFv2:

Step 1: Open Cisco Packet Tracer, go to Network devices > Routers > add 3 routers of 1841.

Step 2: Now click on Router0 > Switch off the button > add WIC-2T > Switch On. Do the same for remaining Routers.

Step 3: Go to Connections > select Serial DCE and connect the routers with serial 0/0/0 to serial 0/0/1.

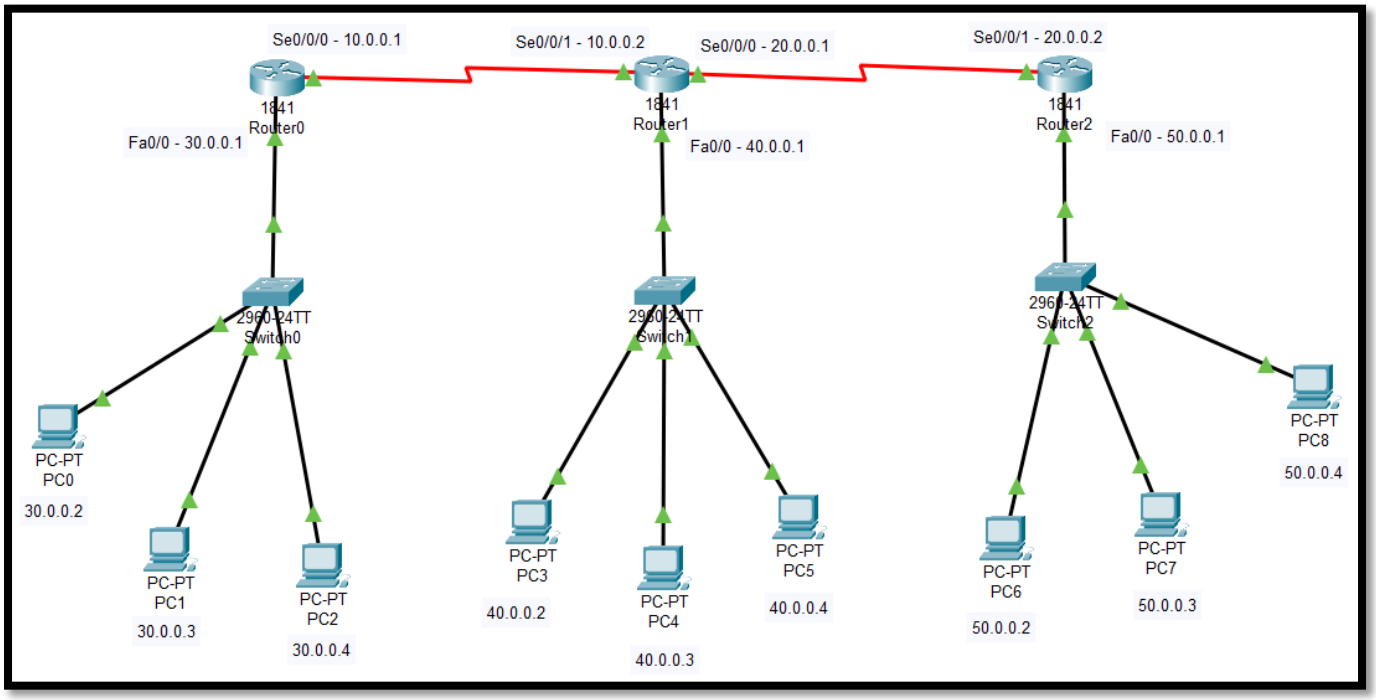
Step 4: Go to Network devices > Switches > add 3 switches of 2960. One Switch for one Router.

Step 5: Go to End Devices > add 3 PCs to each switch.

Step 6: Go to Connections > choose first wire > connect Router to Switch and Switch to PC.

Step 7: Assigning IP address to serial, click on router > config > serial port > checkbox on > clock rate to 64000 then assign IP address and for fastEathernet, click on router > config > fastEathernet port > checkbox on then assign IP address.

Step 8: Assigning IP address to PCs, click on PC > Desktop > IP Configuration > assign IP address and Default Gateway (i.e. the fastEathernet IP connected to the switch), then the final topology with IP addresses will look like:



Step 9: To implement Single-Area OSPFv2, click on Respective Routers then go to CLI tab then execute commands run commands with their respective routers:

Router0: Router>enable

```
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 2
Router(config-router)#network 10.0.0.0 0.255.255.255 area 0
Router(config-router)#network 30.0.0.0 0.255.255.255 area 0
Router(config-router)#exit
Router(config)#
```

Router1: Router>enable

```
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
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 40.0.0.0 0.255.255.255 area 0
Router(config-router)#exit
Router(config)#
04:53:11: %OSPF-5-ADJCHG: Process 2, Nbr 50.0.0.1 on Serial0/0/0 from LOADING to FULL, Loading Done
```

Router2: Router>enable

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 2
Router(config-router)#network 20.0.0.0 0.255.255.255 area 0
Router(config-router)#network 50.0.0.0 0.255.255.255 area 0
Router(config-router)#
04:53:11: %OSPF-5-ADJCHG: Process 2, Nbr 40.0.0.1 on Serial0/0/1 from LOADING to FULL, Loading Done
exit
Router(config)#
```

PC1:

```
C:\>ping 50.0.0.3

Pinging 50.0.0.3 with 32 bytes of data:

Reply from 50.0.0.3: bytes=32 time=22ms TTL=125
Reply from 50.0.0.3: bytes=32 time=19ms TTL=125
Reply from 50.0.0.3: bytes=32 time=2ms TTL=125
Reply from 50.0.0.3: bytes=32 time=16ms TTL=125

Ping statistics for 50.0.0.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 22ms, Average = 14ms

C:\>
```

PC8:

```
C:\>ping 30.0.0.2

Pinging 30.0.0.2 with 32 bytes of data:

Reply from 30.0.0.2: bytes=32 time=23ms TTL=125
Reply from 30.0.0.2: bytes=32 time=2ms TTL=125
Reply from 30.0.0.2: bytes=32 time=2ms TTL=125
Reply from 30.0.0.2: bytes=32 time=22ms TTL=125

Ping statistics for 30.0.0.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 23ms, Average = 12ms

C:\>
```

STEPS FOR MULTI-AREA OSPFv2:

Step 1: Open Cisco Packet Tracer, go to Network devices > Routers > add 3 routers of 1841.

Step 2: Now click on Router0 > Switch off the button > add WIC-2T > Switch On. Do the same for remaining Routers.

Step 3: Go to Connections > select Serial DCE and connect the routers with serial 0/0/0 to serial 0/0/1.

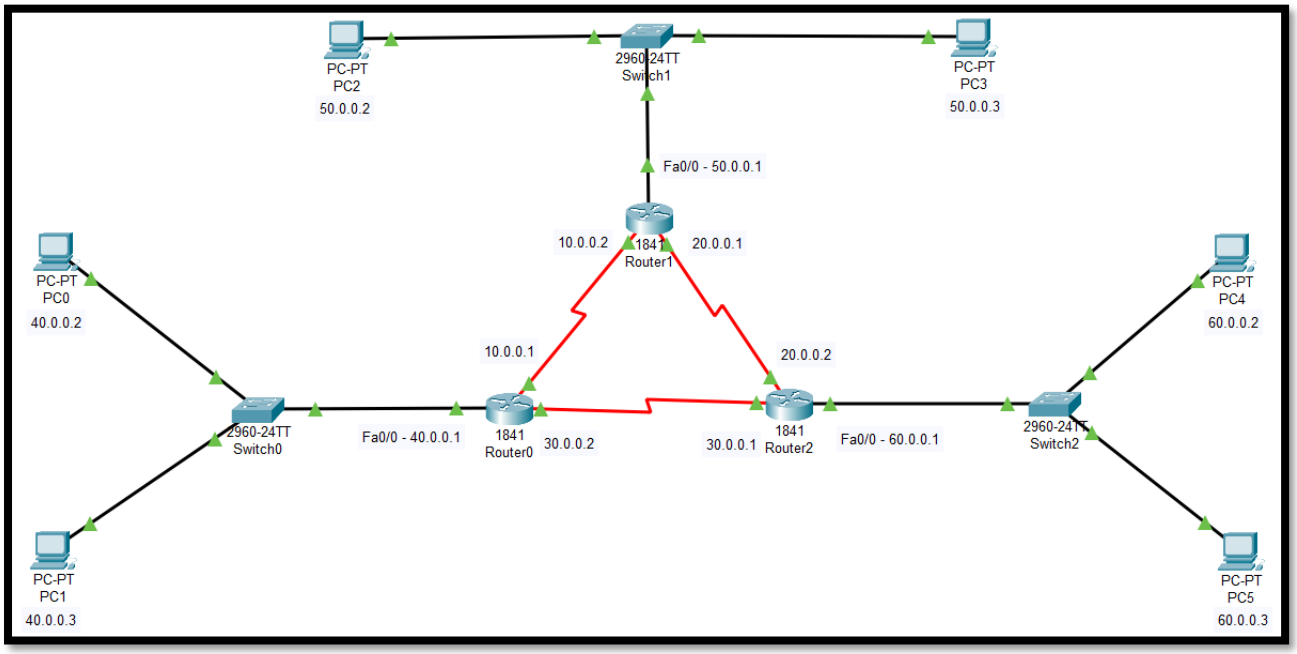
Step 4: Go to Network devices > Switches > add 3 switches of 2960. One Switch for one Router.

Step 5: Go to End Devices > add 2 PCs to each switch.

Step 6: Go to Connections > choose first wire > connect Router to Switch and Switch to PC.

Step 7: Assigning IP address to serial, click on router > config > serial port > checkbox on > clock rate to 64000 then assign IP address and for fastEathernet, click on router > config > fastEathernet port > checkbox on then assign IP address.

Step 8: Assigning IP address to PCs, click on PC > Desktop > IP Configuration > assign IP address and Default Gateway (i.e. the fastEathernet IP connected to the switch), then the final topology with IP addresses will look like:



Step 9: To implement Multi-Area OSPFv2, click on Respective Routers then go to CLI tab then execute commands run commands with their respective routers:

Router 0:

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
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 50.0.0.0 0.255.255.255 area 0
Router(config-router)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
00:42:14: %OSPF-5-ADJCHG: Process 2, Nbr 50.0.0.1 on Serial0/1/0 from LOADING to FULL, Loading Done
```

Router 1:

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 2
Router(config-router)#network 10.0.0.0 0.255.255.255 area 0
Router(config-router)#network 10.0.0.0 0.255.255.255 area 0
00:42:02: %OSPF-5-ADJCHG: Process 2, Nbr 40.0.0.1 on Serial0/1/network 30.0.0.0 0.255.255.255 area
0
Router(config-router)#network 40.0.0.0 0.255.255.255 area 0
Router(config-router)#exit
Router(config)#
```

Router 2:

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 2
Router(config-router)#network 20.0.0.0 0.255.255.255 area 0
Router(config-router)#network 30.0.0.0 0.255.255.255 area 0
Router(config-router)#network 60.0.0.0 0.255.255.255 area 0
Router(config-router)#exit
Router(config)#
```

PC0:

```
C:\>ping 60.0.0.2

Pinging 60.0.0.2 with 32 bytes of data:

Reply from 60.0.0.2: bytes=32 time=22ms TTL=126
Reply from 60.0.0.2: bytes=32 time=11ms TTL=126
Reply from 60.0.0.2: bytes=32 time=1ms TTL=126
Reply from 60.0.0.2: bytes=32 time=1ms TTL=126

Ping statistics for 60.0.0.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 22ms, Average = 8ms

C:\>
```

PC4:

```
C:\>ping 50.0.0.3

Pinging 50.0.0.3 with 32 bytes of data:

Reply from 50.0.0.3: bytes=32 time=11ms TTL=126
Reply from 50.0.0.3: bytes=32 time=1ms TTL=126
Reply from 50.0.0.3: bytes=32 time=9ms TTL=126
Reply from 50.0.0.3: bytes=32 time=14ms TTL=126

Ping statistics for 50.0.0.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 14ms, Average = 8ms

C:\>
```

Practical No. 2

Aim: Implement BGP communities.

Introduction:

Border Gateway Protocol (BGP) refers to a gateway protocol that enables the internet to exchange routing information between autonomous systems (AS). As networks interact with each other, they need a way to communicate. This is accomplished through peering. BGP makes peering possible. Without it, networks would not be able to send and receive information with each other. When you have a network router that connects to other networks, it does not know which network is the best one to send its data to. BGP takes into consideration all the different peering options a router has and chooses the one that is closest to where the router is.

- **Function:** BGP's main purpose is to exchange routing information to find the best path for data traveling across different networks on the internet.
- **Autonomous Systems (AS):** The internet is made up of many ASs, and BGP is the protocol used to manage routing between them.
- **Route selection:** Unlike some other protocols that simply find the shortest path, BGP is designed for the scale of the internet and can be configured to use more complex policies to choose the best route.
- **Connection:** BGP routers establish TCP connections over port 179 to communicate with each other and exchange routing data.
- **Internal vs. External:** BGP can be used for routing within an AS (iBGP) or between different ASs (eBGP).

Step 1: Open Cisco Packet Tracer, go to Network devices > Routers > add 3 routers of 1841.

Step 2: Now click on Router0 > Switch off the button > add WIC-2T > Switch On. Do the same for remaining Routers.

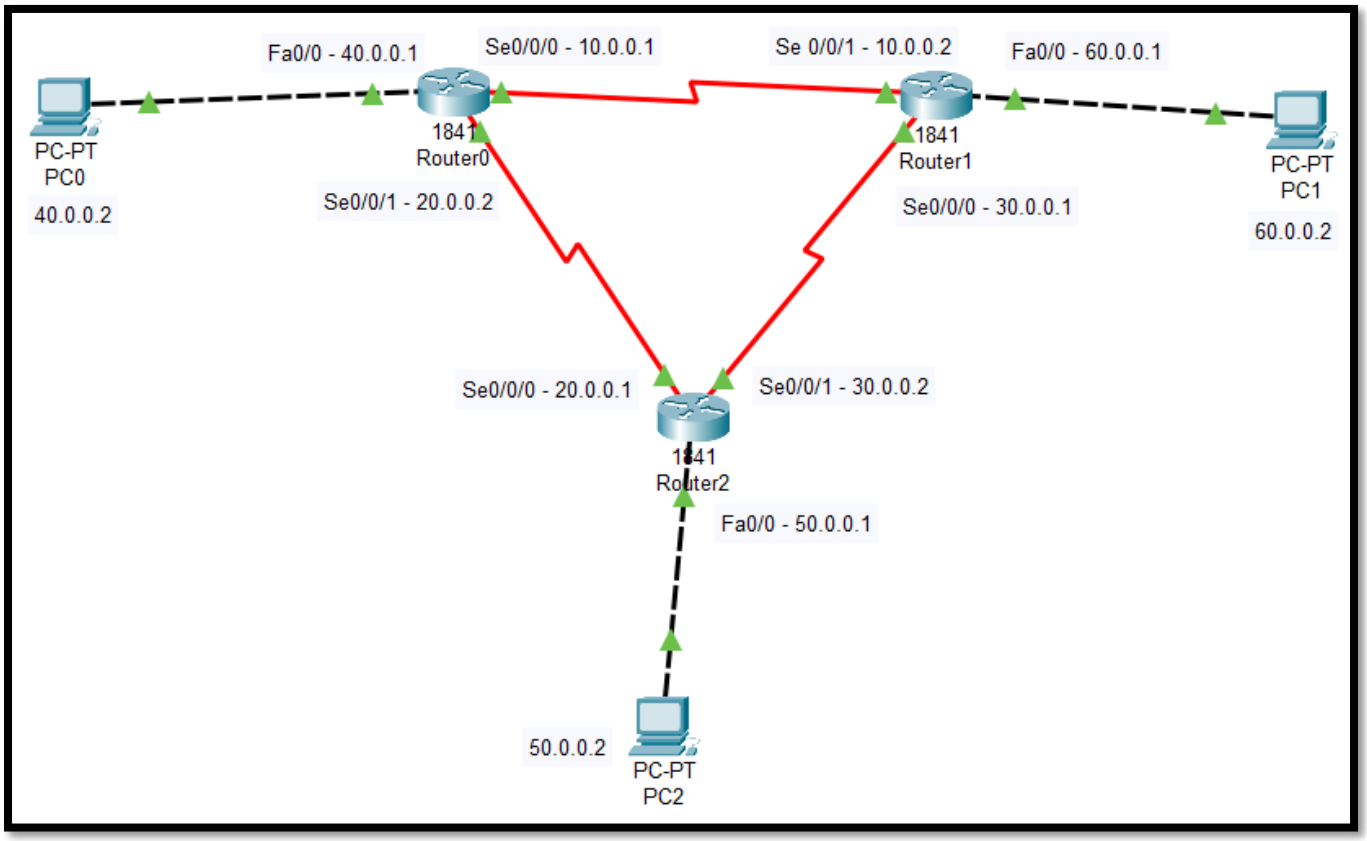
Step 3: Go to Connections > select Serial DCE and connect the routers with serial 0/0/0 to serial 0/0/1.

Step 4: Go to End Devices > add 1 PC to each router.

Step 5: Go to Connections > choose first wire > connect Router to PC.

Step 6: Assigning IP address to serial, click on router > config > serial port > checkbox on > clock rate to 64000 then assign IP address and for fastEathernet, click on router > config > fastEathernet port > checkbox on then assign IP address.

Step 7: Assigning IP address to PCs, click on PC > Desktop > IP Configuration > assign IP address and Default Gateway (i.e. the fastEathernet IP connected to the switch), then the final topology with IP addresses will look like:



Step 8: To implement BGP, click on Respective Routers then go to CLI tab then execute commands run commands with their respective routers:

Router0:

```
en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router bgp 100
Router(config-router)#neighbor 10.0.0.2 remote-as 200
Router(config-router)#neighbor 20.0.0.1 remote-as 300
Router(config-router)#network 40.0.0.0 mask 255.0.0.0
Router(config-router)#exit
Router(config)#
```

Router1:

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router bgp 200
Router(config-router)#neighbor 10.0.0.1 remote-as 100
Router(config-router)#%BGP-5-ADJCHANGE: neighbor 10.0.0.1 Up
neighbor 30.0.0.2 remote-as 300
Router(config-router)#network 60.0.0.0 mask 255.0.0.0
Router(config-router)#exit
Router(config)#
```

Router2:

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router bgp 300
Router(config-router)#neighbor 20.0.0.2 remote-as 100
Router(config-router)#%BGP-5-ADJCHANGE: neighbor 20.0.0.2 Up
neighbor 30.0.0.1 remote-as 200
Router(config-router)#%BGP-5-ADJCHANGE: neighbor 30.0.0.1 Up
network 50.0.0.0 mask 255.0.0.0
Router(config-router)#exit
Router(config)#
```

PC1:

```
C:\>ping 50.0.0.2

Pinging 50.0.0.2 with 32 bytes of data:

Reply from 50.0.0.2: bytes=32 time=19ms TTL=126
Reply from 50.0.0.2: bytes=32 time=32ms TTL=126
Reply from 50.0.0.2: bytes=32 time=19ms TTL=126
Reply from 50.0.0.2: bytes=32 time=22ms TTL=126

Ping statistics for 50.0.0.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 19ms, Maximum = 32ms, Average = 23ms

C:\>
```

Practical No. 3

Aim: Access Control List (ACL):

1. Standard ACL
2. Extended ACL

Introduction:

Access Control List (ACL) refers to a specific set of rules used for filtering network traffic, especially in computer security settings. ACLs also allow specific system objects such as directories or file access to authorized users and denies access to unauthorized users. ACLs are mainly found in network devices with packet filtering capabilities including routers and switches.

Standard ACL:

This type allows you to only evaluate packet source IP addresses. They are not as powerful as extended ACLs but use less computing power. They also use numbers 1300-1999 or 1-99 so that the router can identify the specific address as the source IP address.

Extended ACL:

These types of ACL allow you to block source and destination for specific hosts or thewhole network. With Extended ACLs it's possible to filter traffic based on protocols (IP, TCP, ICMP, and UDP).

Step 1: Open Cisco Packet Tracer, go to Network devices > Routers > add 3 routers of 1841.

Step 2: Now click on Router0 > Switch off the button > add WIC-2T > Switch On. Do the same for remaining Routers.

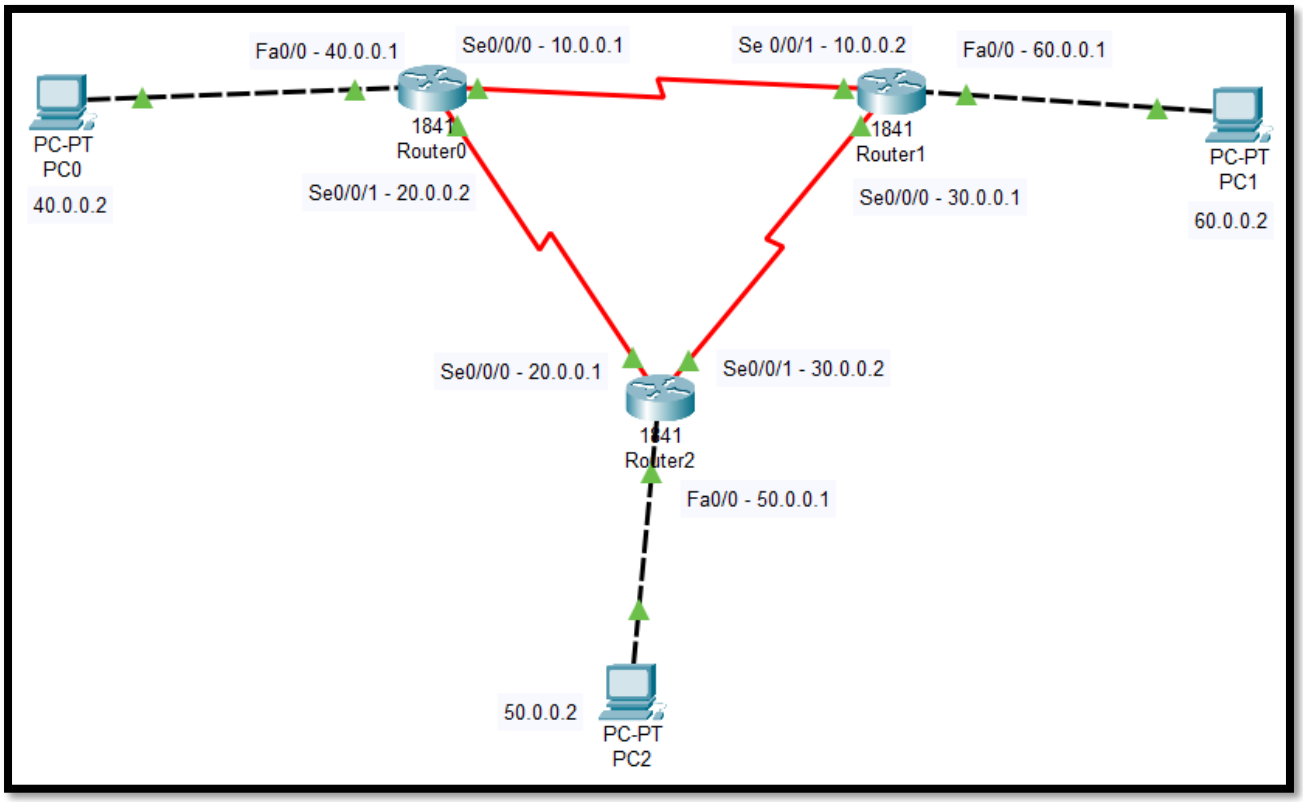
Step 3: Go to Connections > select Serial DCE and connect the routers with serial 0/0/0 to serial 0/0/1.

Step 4: Go to End Devices > add 1 PC to each router.

Step 5: Go to Connections > choose first wire > connect Router to PC.

Step 6: Assigning IP address to serial, click on router > config > serial port > checkbox on > clock rate to 64000 then assign IP address and for fastEathernet, click on router > config > fastEathernet port > checkbox on then assign IP address.

Step 7: Assigning IP address to PCs, click on PC > Desktop > IP Configuration > assign IP address and Default Gateway (i.e. the fastEathernet IP connected to the switch), then the final topology with IP addresses will look like:



Step 8: Commands for **Standard ACL**: go to second (Router1) router and run

```
Router>en
Router#conf t
Router(config)#access-list 1 deny 40.0.0.2 0.0.0.0
Router(config)#access-list 1 permit any
Router(config)#interface Fa0/0
Router(config-if)#ip access-group 1 out
Router(config-if)#exit
Router(config)#exit
Router#show access-list
```

Router1:

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#access-list 1 deny 40.0.0.2 0.0.0.0
Router(config)#access-list 1 permit any
Router(config)#interface Fa0/0
Router(config-if)#ip access-group 1 out
Router(config-if)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
show access-list
Standard IP access list 1
    10 deny host 40.0.0.2 (2 match(es))
    20 permit any (1 match(es))

Router#
```

PC1:

```
C:\>ping 40.0.0.2

Pinging 40.0.0.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 40.0.0.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 50.0.0.2

Pinging 50.0.0.2 with 32 bytes of data:

Reply from 50.0.0.2: bytes=32 time=19ms TTL=126
Reply from 50.0.0.2: bytes=32 time=32ms TTL=126
Reply from 50.0.0.2: bytes=32 time=19ms TTL=126
Reply from 50.0.0.2: bytes=32 time=22ms TTL=126

Ping statistics for 50.0.0.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 19ms, Maximum = 32ms, Average = 23ms

C:\>
```

Step 9: Commands for **Extended ACL**: go to second (Router1) router and run

Router>en
Router#conf t
Router(config)#access-list 101 deny tcp 40.0.0.2 0.0.0.0 50.0.0.2 0.0.0.0 eq 80
Router(config)#access-list 101 permit ip any any
Router(config)#interface Fa0/0
Router(config-if)#ip access-group 101 in
Router(config-if)#exit
Router(config)#exit
Router#show access-list

Router1:

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#access-list 101 deny tcp 40.0.0.2 0.0.0.0 50.0.0.2 0.0.0.0 eq 80
Router(config)#access-list 101 permit ip any any
Router(config)#interface Fa0/0
Router(config-if)#ip access-group 101 in
Router(config-if)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
show access-list
Standard IP access list 1
    10 deny host 40.0.0.2 (6 match(es))
    20 permit any (5 match(es))
Extended IP access list 101
    10 deny tcp host 40.0.0.2 host 50.0.0.2 eq www
    20 permit ip any any

Router#
```

PC1:

```
C:\>ping 40.0.0.2

Pinging 40.0.0.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 40.0.0.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 50.0.0.2

Pinging 50.0.0.2 with 32 bytes of data:

Reply from 50.0.0.2: bytes=32 time=15ms TTL=126
Reply from 50.0.0.2: bytes=32 time=13ms TTL=126
Reply from 50.0.0.2: bytes=32 time=9ms TTL=126
Reply from 50.0.0.2: bytes=32 time=13ms TTL=126

Ping statistics for 50.0.0.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 9ms, Maximum = 15ms, Average = 12ms

C:\>
```

Practical No. 4

Aim: Implement Inter-VLAN Routing:

Introduction:

Inter-VLAN routing is a method that allows communication between different VLANS (Virtual Local Area Networks) within a network. VLANs are used to segment a network into smaller, isolated broadcast domains to improve performance and security. However, by default, devices in separate VLANs cannot communicate with each other because each VLAN is treated as a separate network. Inter-VLAN routing enables data exchange between these segmented networks.

How it works

- **VLANs and isolation:** VLANs segment a network into logical groups, and devices within a VLAN can communicate freely, but they cannot communicate with devices in other VLANs by default.
- **The need for routing:** To enable communication between VLANs, a device capable of routing is required. This device acts as the default gateway for devices on each VLAN.
- **The routing process:** When a device sends traffic to a different VLAN, it sends the packet to its default gateway (the router or Layer 3 switch). The gateway then uses the destination IP address to route the packet to the correct destination VLAN.

Step 1: Open Cisco Packet Tracer, go to Network devices > Routers > add 3 routers of 1841.

Step 2: Now click on Router0 > Switch off the button > add WIC-2T > Switch On. Do the same for remaining Routers.

Step 3: Go to Connections > select Serial DCE and connect the routers with serial 0/0/0 to serial 0/0/1.

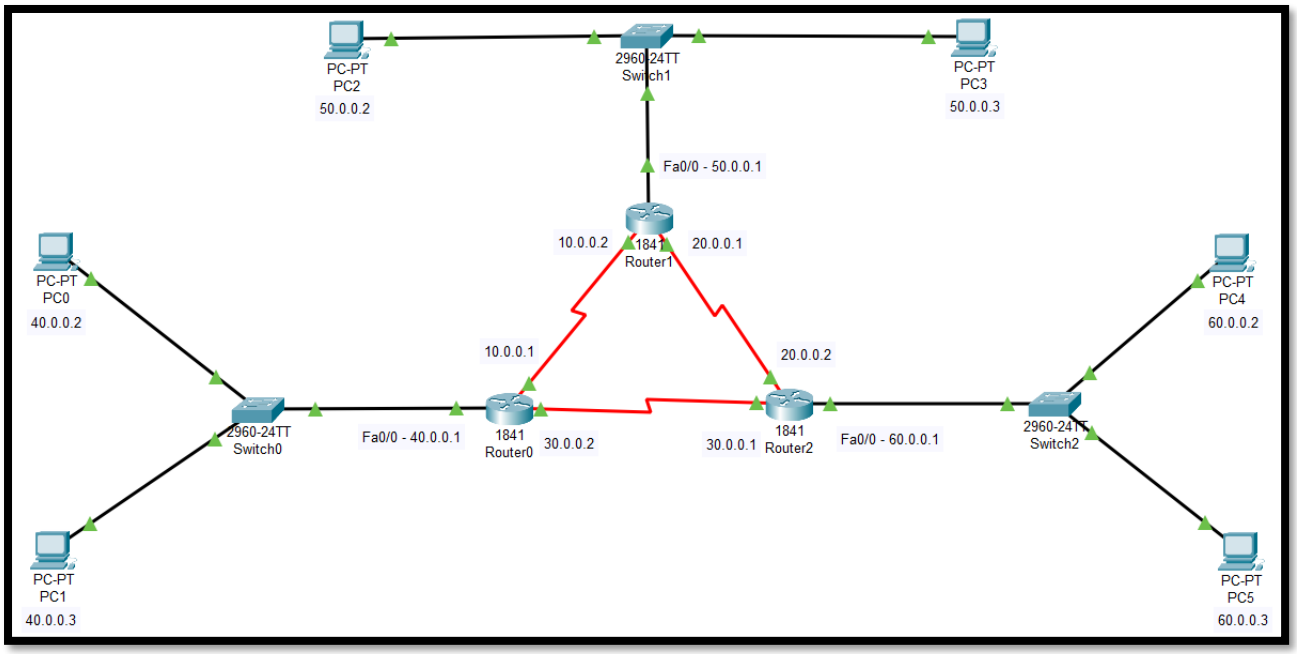
Step 4: Go to Network devices > Switches > add 3 switches of 2960. One Switch for one Router.

Step 5: Go to End Devices > add 2 PCs to each switch.

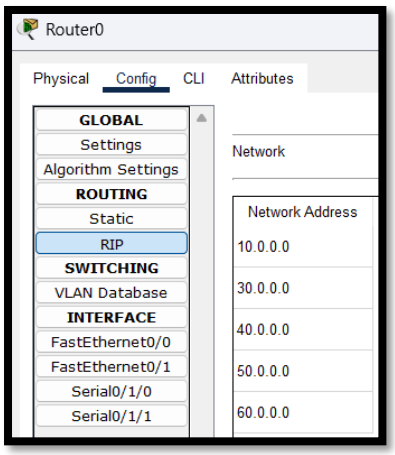
Step 6: Go to Connections > choose first wire > connect Router to Switch and Switch to PC.

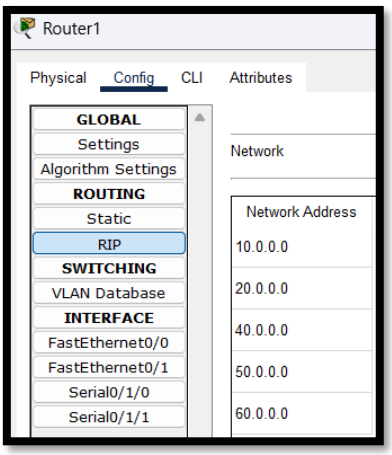
Step 7: Assigning IP address to serial, click on router > config > serial port > checkbox on > clock rate to 64000 then assign IP address and for fastEathernet, click on router > config > fastEathernet port > checkbox on then assign IP address.

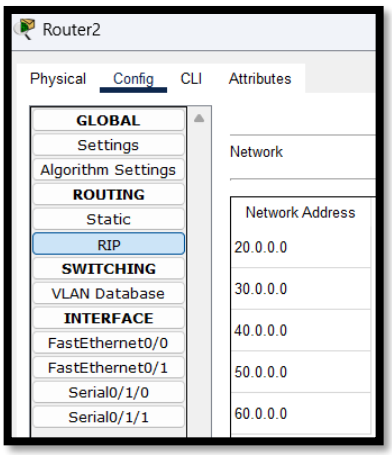
Step 8: Assigning IP address to PCs, click on PC > Desktop > IP Configuration > assign IP address and Default Gateway (i.e. the fastEathernet IP connected to the switch), then the final topology with IP addresses will look like:



Step 9: To implement V-LAN, first go to router 0,1,2 > Config > RIP > add IP addresses:







Step 10: Now click on any one switch > go to CLI and run following commands:

Switch>en
Switch#conf t
Switch(config)#vlan 10
Switch(config-vlan)#name administration-Department
Switch(config-vlan)#exit
Switch(config)#vlan 20
Switch(config-vlan)#name operation-Department
Switch(config-vlan)#exit
Switch(config)#vlan 30
Switch(config-vlan)#name HR-Department
Switch(config-vlan)#exit
Switch(config)#exit
Switch#show vlan brief

```
Switch>en
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#vlan 10
Switch(config-vlan)#name administration-Department
Switch(config-vlan)#exit
Switch(config)#vlan 20
Switch(config-vlan)#name operation-Department
Switch(config-vlan)#exit
Switch(config)#vlan 30
Switch(config-vlan)#name HR-Department
Switch(config-vlan)#exit
Switch(config)#exit
Switch#
%SYS-5-CONFIG_I: Configured from console by console
show vlan brief

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                 Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                 Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                                 Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                                 Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                                 Fa0/21, Fa0/22, Fa0/23, Fa0/24
                                                 Gig0/1, Gig0/2
10   administration-Department         active
20   operation-Department              active
30   HR-Department                     active
1002 fddi-default                      active
1003 token-ring-default                active
1004 fddinet-default                   active
1005 trnet-default                     active
Switch#
```

Practical No. 5

Aim: Observe STP Topology Changes and Implement RSTP

a) Implement Advanced STP Modifications and Mechanisms
b) Implement MST

Introduction:

In a switched network with redundant links, loops can occur causing broadcast storms. The **Spanning Tree Protocol (STP)** is used to prevent loops by placing some ports in a blocking state. It elects a **Root Bridge** based on Bridge ID (priority + MAC address). **Rapid Spanning Tree Protocol (RSTP)** is an enhancement of STP that provides faster convergence when the network topology changes.

Key Terms:

- **Root Bridge:** The central switch chosen to manage the tree topology.
- **Blocking State:** Ports that prevent loops by not forwarding traffic.
- **Forwarding State:** Ports that forward traffic normally.

Requirements:

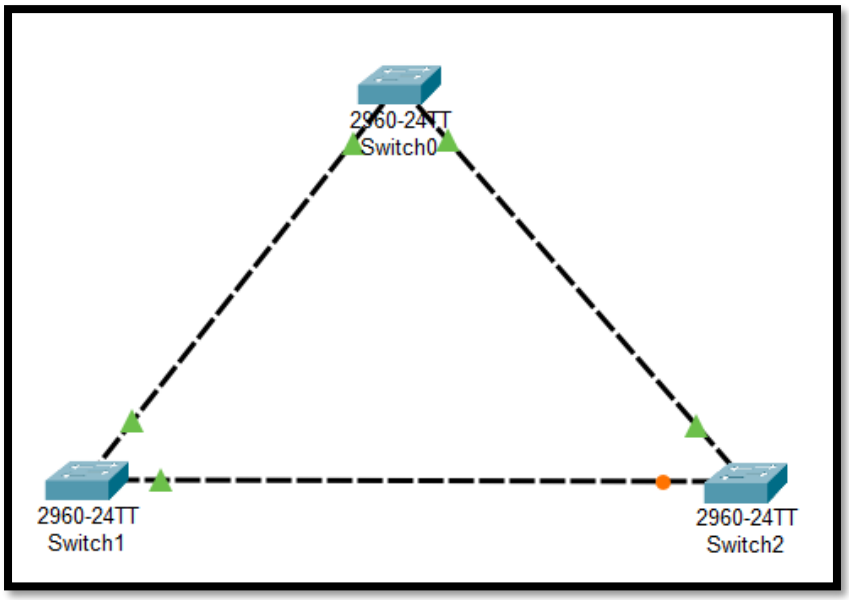
- 3 Cisco switches (e.g., S1, S2, S3)
- Ethernet cables
- Cisco Packet Tracer or GNS3

Expected Output:

- One switch elected as **Root Bridge**.
- Ports show states as **Root**, **Designated**, or **Alternate**.
- On link failure, RSTP reconfigures the topology within seconds.

Spanning Tree Protocol (STP)

Step 1: Open Cisco Packet Tracer, go to Network devices > Switches > add 3 switches of 2960.
Step 2: Go to Connections > select first wire and connect switches in a triangular (loop) topology as shown below:



Step 3: Goto Switch 0 and run following commands as shown in figure:
Switch>en
Switch#conf t
Switch(config)#spanning-tree vlan 1 root primary
Switch(config)#ex
Switch#show spanning-tree

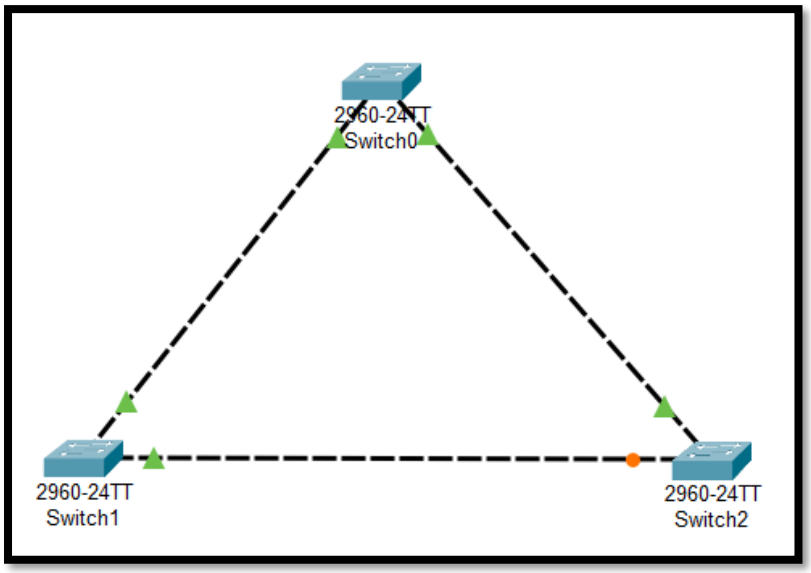
```
Switch>en
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#spanning-tree vlan 1 root primary
Switch(config)#^Z
Switch#
%SYS-5-CONFIG_I: Configured from console by console
show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    24577
              Address     0090.2146.B9D3
              This bridge is the root
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    24577  (priority 24576 sys-id-ext 1)
              Address     0090.2146.B9D3
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/2            Desg LSN 19        128.2    P2p
Fa0/1            Desg FWD 19        128.1    P2p
```

Rapid Spanning Tree Protocol (RSTP)

Step 1: Open Cisco Packet Tracer, go to Network devices > Switches > add 3 switches of 2960.
Step 2: Go to Connections > select first wire and connect switches in a triangular (loop) topology as shown below:



Step 3: Goto Switch 0 and run following commands as shown in figure:
Switch>en
Switch#conf t
Switch(config)#spanning-tree mode rapid-pvst
Switch(config)#ex
Switch#show spanning-tree

```
Switch>en
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#spanning-tree mode rapid-pvst
Switch(config)#ex
Switch#
%SYS-5-CONFIG_I: Configured from console by console
show spanning-tree
VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    24577
              Address     000A.F3E8.550E
              Cost        19
              Port        1(FastEthernet0/1)
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     00E0.8F30.0318
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Root LSN 19        128.1    P2p
Fa0/2            Desg LSN 19        128.2    P2p
```

Practical No. 6

Aim: a) Implement Ether Channel

b) Tune and Optimize Ether Channel Operations

Introduction:

EtherChannel allows multiple physical links between switches to operate as a single logical link, providing **increased bandwidth** and **redundancy**.
If one link fails, traffic automatically continues over the remaining links.
It can be configured manually (mode "on") or using negotiation protocols like **PAgP** or **LACP**.

Benefits:

- Load balancing of traffic
- Link redundancy
- Simplified management

Requirements:

- 2 Cisco switches (S1, S2)
- 2–3 FastEthernet cables
- Cisco Packet Tracer or GNS3

Expected Output:

- Both interfaces should form **Port-Channel 1**.
- The output shows **"SU" (Layer 2, in use)**.
- Traffic load-balances across links, and redundancy is maintained if one link fails.

Step 1: Open Cisco Packet Tracer, go to Network devices > Switches > add 2 switches of 2960.

Step 2: Go to Connections > select first wire and connect switches as shown below:

Step 3: Go to both switch's CLI and perform the following commands:

```
Switch>en
Switch#conf t
Switch(config)#int range fa0/1-4
Switch(config-if-range)#channel-group 1 mode on
Switch(config-if-range)#ex
Switch(config)#ex
Switch#show etherchannel summary
```

Switch0 Output:

```
Switch>en
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#int range fa0/1-4
Switch(config-if-range)#channel-group 1 mode on
Switch(config-if-range)#
Creating a port-channel interface Port-channel 1

%LINK-5-CHANGED: Interface Port-channel1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up
ex
Switch(config)#ex
Switch#
%SYS-5-CONFIG_I: Configured from console by console
show etherchannel summary
Flags:  D - down        P - in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------

1      Po1(SU)           -      Fa0/1(P) Fa0/2(P) Fa0/3(P) Fa0/4(D)
```

Switch1 Output:

```
Switch>en
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#int range fa0/1-4
Switch(config-if-range)#channel-group 1 mode on
Switch(config-if-range)#
Creating a port-channel interface Port-channel 1

%LINK-5-CHANGED: Interface Port-channel1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up
ex
Switch(config)#ex
Switch#
%SYS-5-CONFIG_I: Configured from console by console
show etherchannel summary
Flags:  D - down        P - in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------

1      Po1(SU)           -      Fa0/1(P) Fa0/2(P) Fa0/3(P) Fa0/4(D)
```