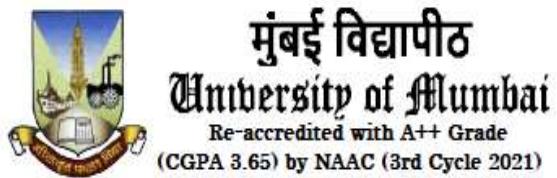


**UNIVERSITY OF MUMBAI**  
**DEPARTMENT OF COMPUTER SCIENCE**



M.Sc. Computer Science – Semester I  
**SOFTWARE DEFINED NETWORKING**  
JOURNAL  
2023-2024

Seat No. \_\_\_\_\_



UNIVERSITY OF MUMBAI  
DEPARTMENT OF COMPUTER SCIENCE

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Subject In-charge

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Head of Department

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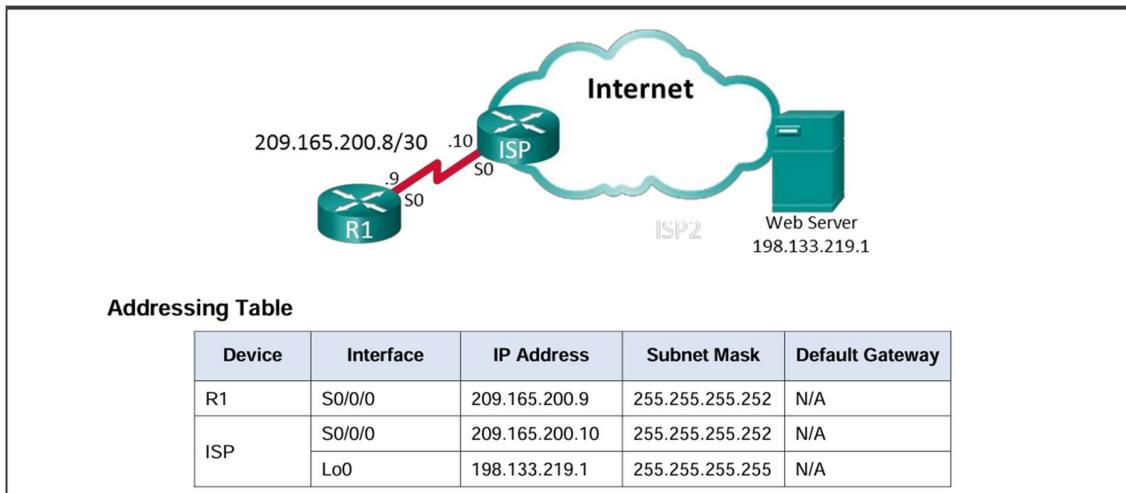
External Examiner

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## PRACTICAL-01

### Topology



### Aim:

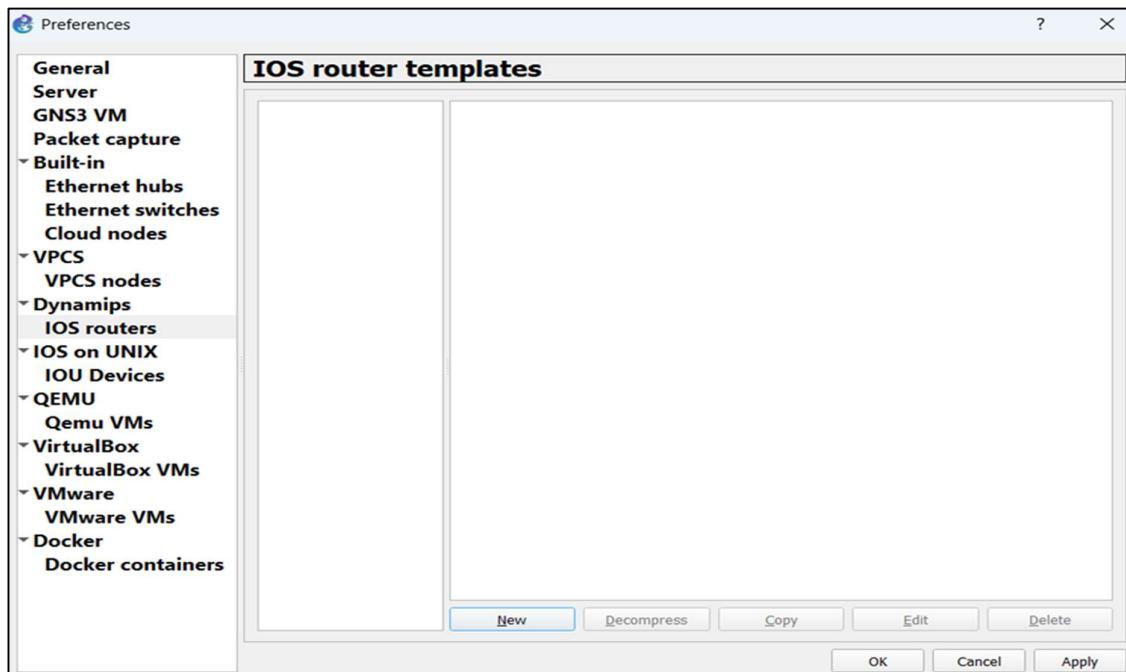
Implement IP SLA (IP Service Level Agreement)

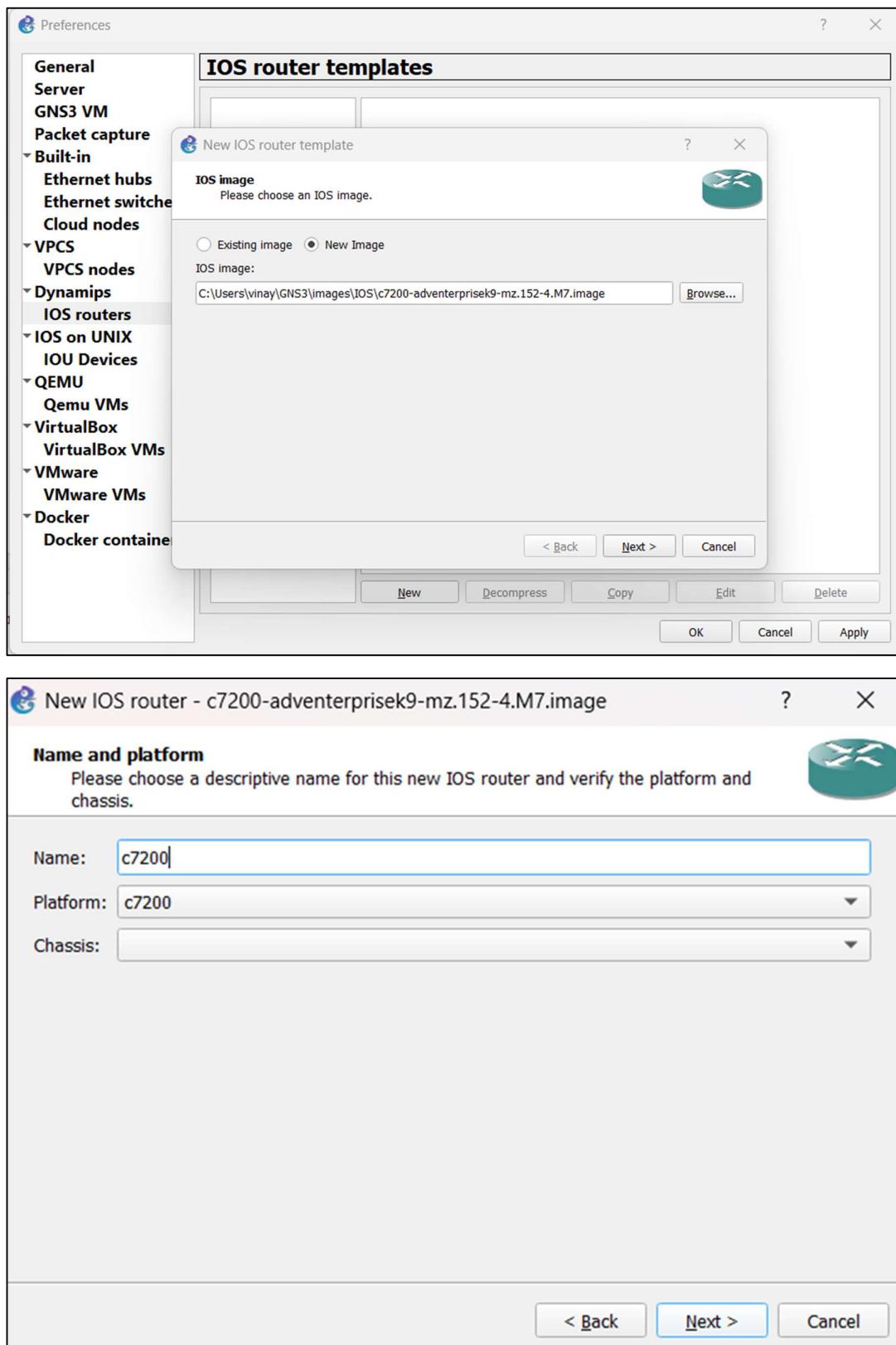
### Theory:

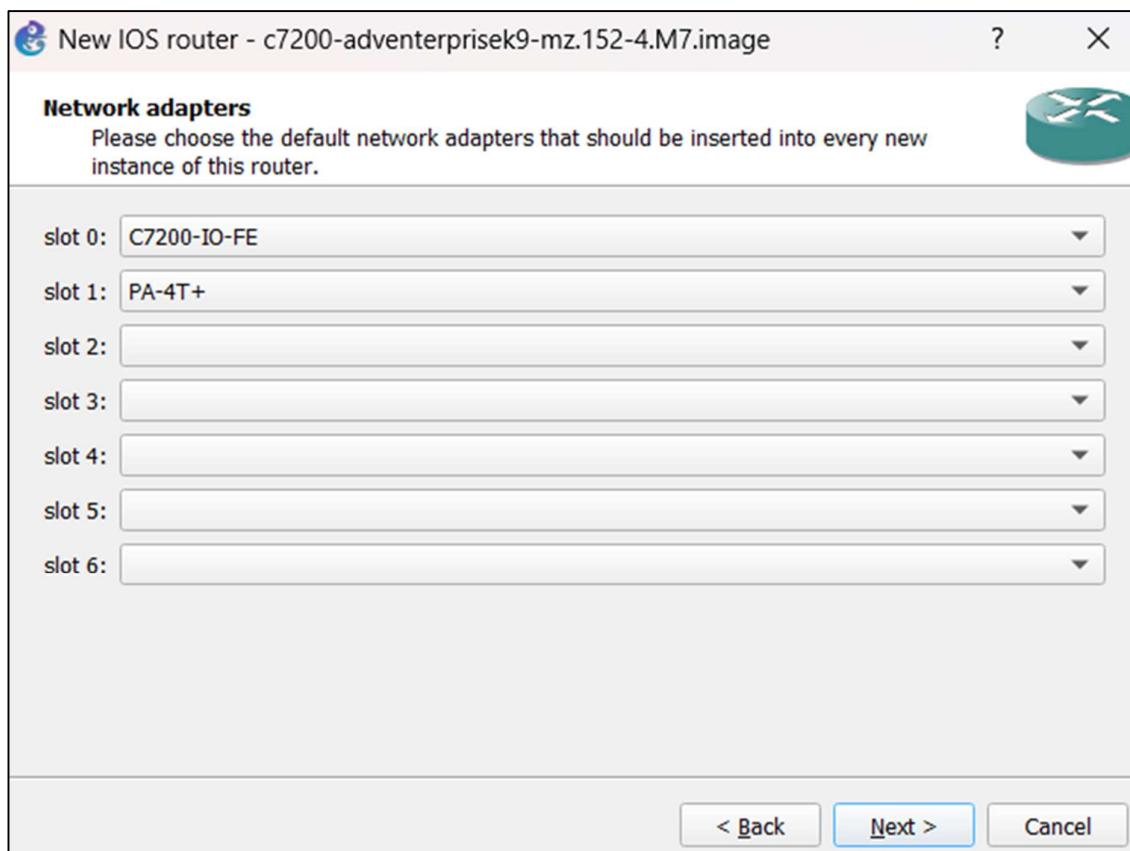
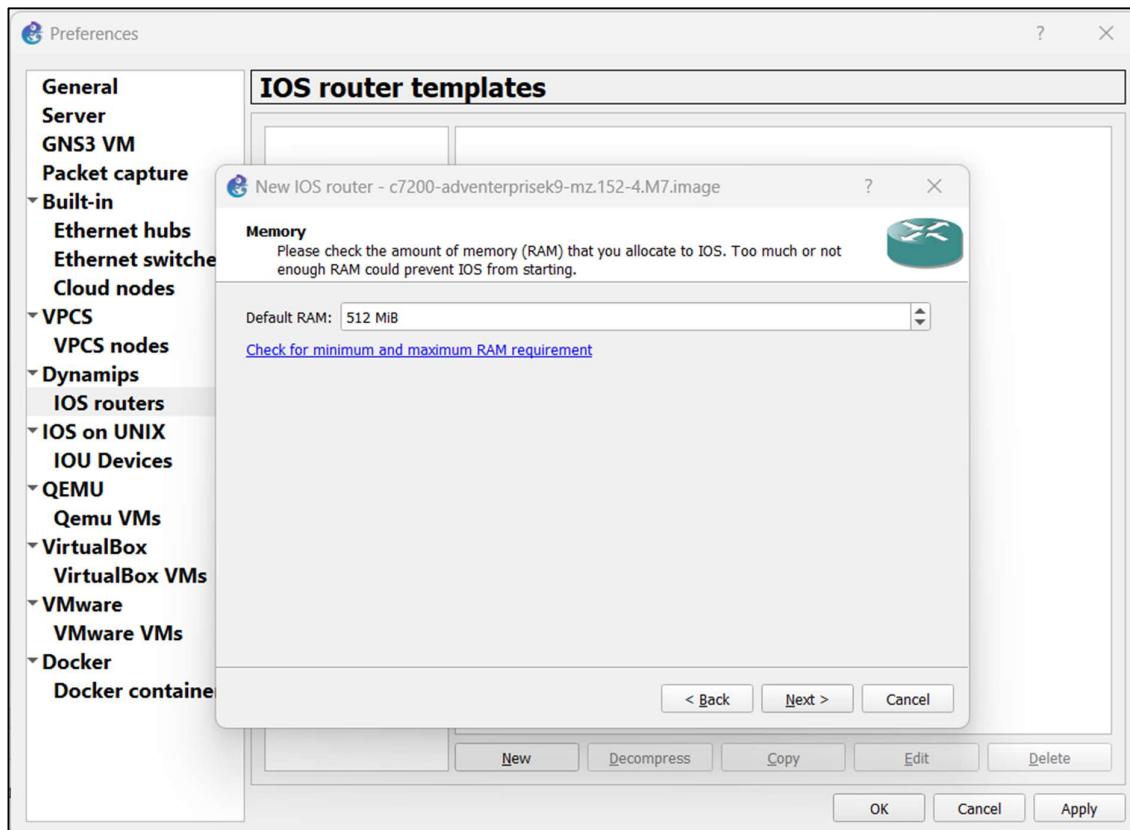
#### IP Service Level Agreement

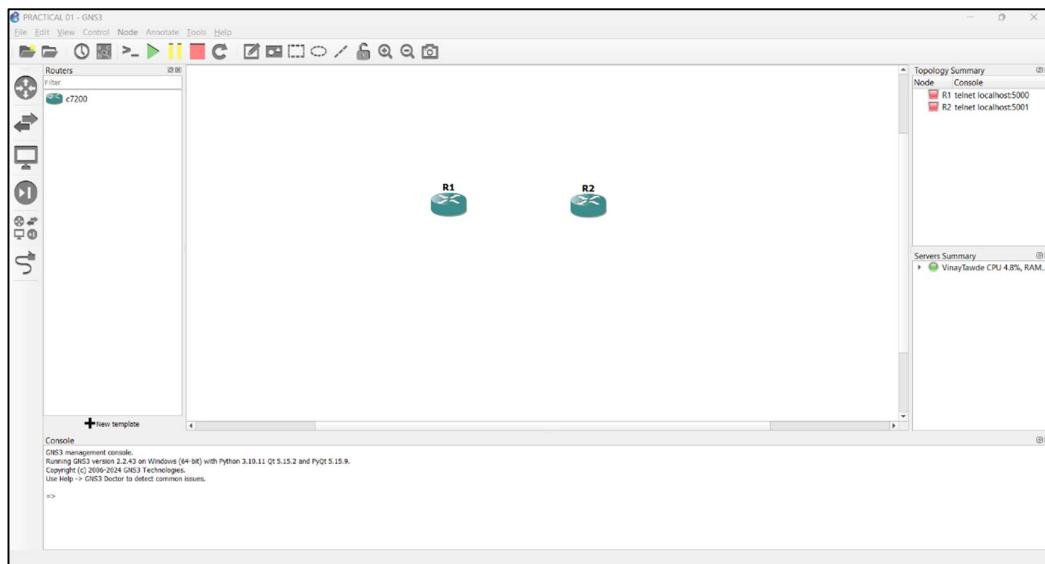
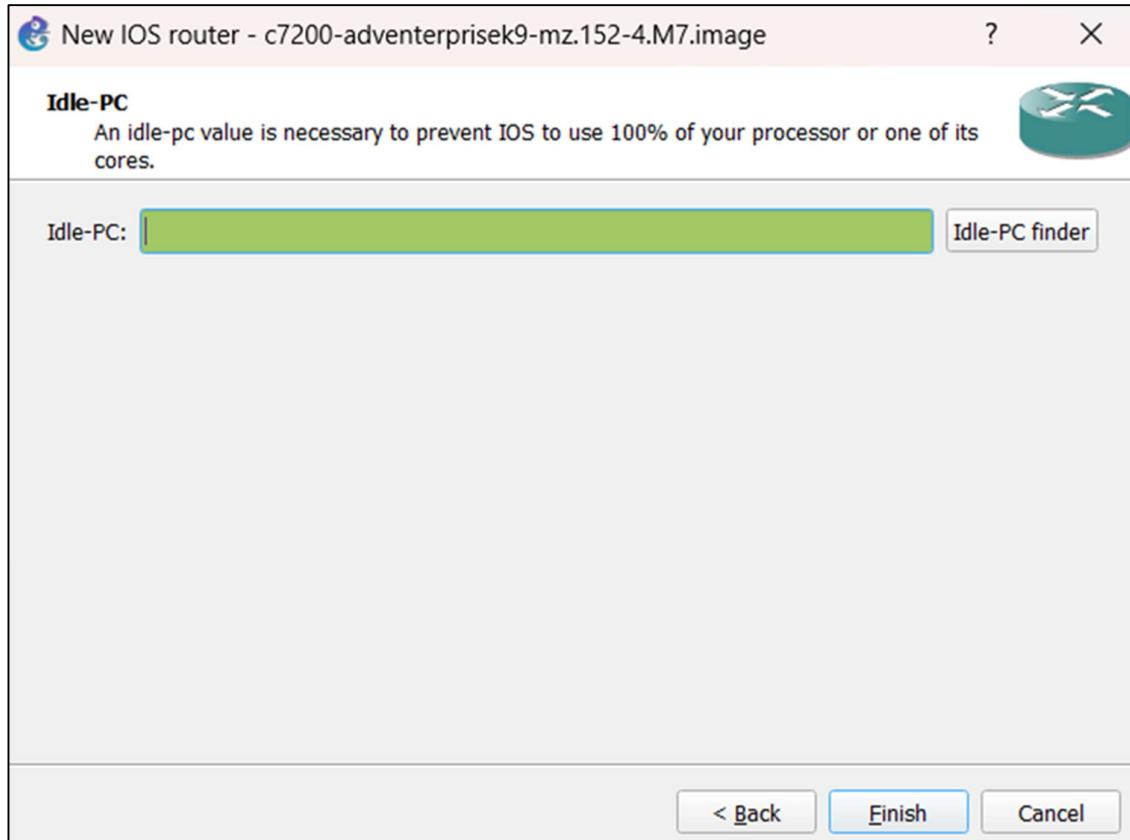
IP Service Level Agreement (IP SLA) is like a promise for your internet connection's performance. It sets expectations on speed and reliability, making it easier to manage and fix issues when needed.

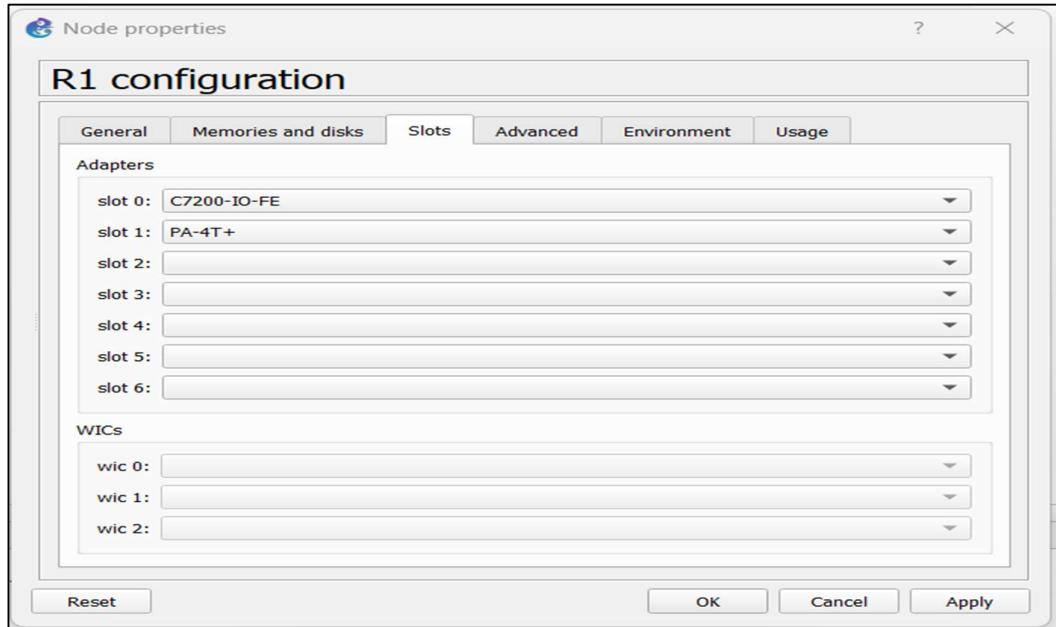
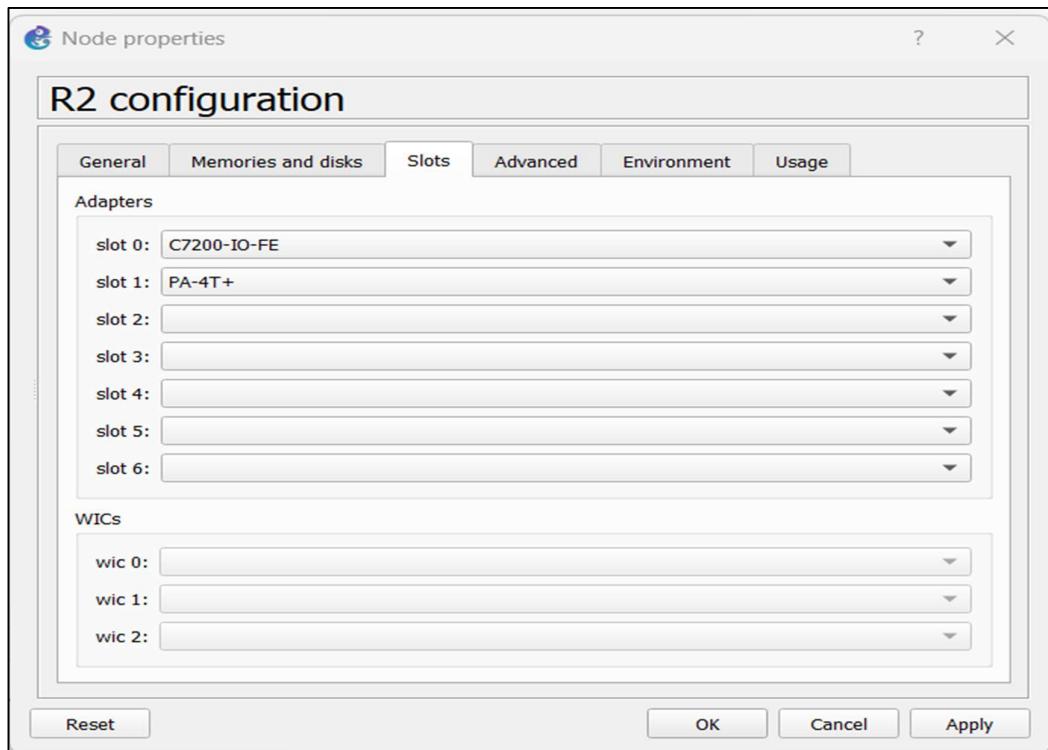
### Step 1:



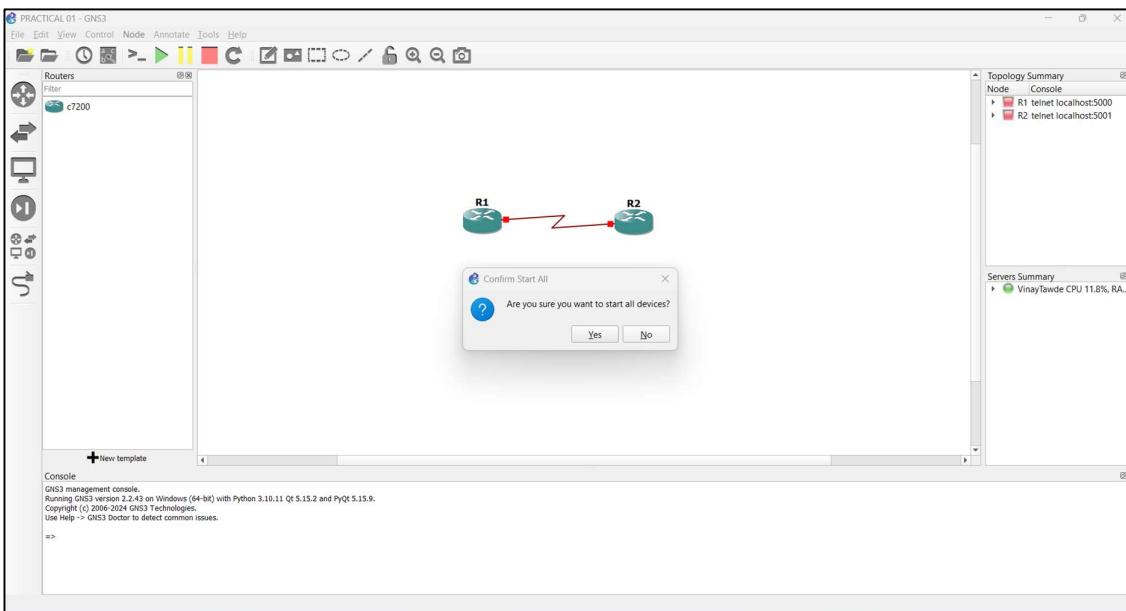
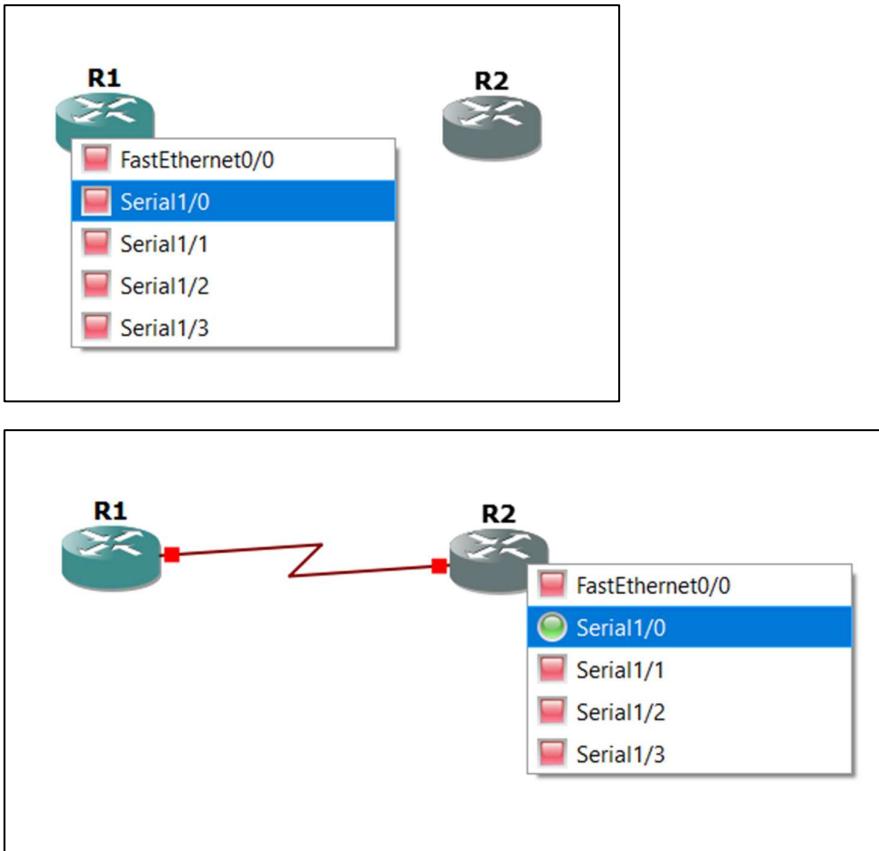






**Step 2:****Step 3:**

#### Step 4:



## Step 5:

R1

```

Press RETURN to get started!

*Feb 3 19:08:43.023: %IFMGR-7-NO_IFINDEX_FILE: Unable to open nvram:/ifIndex-table No such file or directory
*Feb 3 19:08:51.759: %LINEPROTO-5-UPDOWN: Line protocol on Interface VoIP-Nulle, changed state to up
*Feb 3 19:08:51.761: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
*Feb 3 19:08:51.767: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
*Feb 3 19:08:51.779: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
*Feb 3 19:08:51.795: %LINK-3-UPDOWN: Interface Serial1/2, changed state to up
*Feb 3 19:08:52.295: %SYS-5-CONFIG_I: Configured from memory by console
*Feb 3 19:08:52.555: %SYS-5-RESTART: System restarted --
Cisco IOS Software, Cisco IOS Software [C2800-ADVENTERPRISEK9-M], Version 15.2(4)M7, RELEASE SOFTWARE (fc2)
Technical support: http://www.cisco.com/techsupport
Copyright (c) 1986-2014 by Cisco Systems, Inc.
Compiled Thu 25-Sep-13 10:16 by prod_rel_team

*Feb 3 19:08:52.587: %SNMP-5-COLDSTART: SNMP agent on host R1 is undergoing a cold start
*Feb 3 19:08:52.635: %CRYPTO-6-ISAKMP: ON OFF; ISAKMP is OFF
*Feb 3 19:08:52.639: %CRYPTO-6-ISAKMP: ON OFF; ISAKMP is ON
*Feb 3 19:08:52.739: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to down
*Feb 3 19:08:52.767: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
*Feb 3 19:08:52.779: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to down
*Feb 3 19:08:52.795: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/2, changed state to down
*Feb 3 19:08:52.807: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/3, changed state to down
*Feb 3 19:08:53.955: %LINK-5-CHANGED: Interface FastEthernet0/0, changed state to administratively down
*Feb 3 19:08:54.323: %LINK-5-CHANGED: Interface Serial1/0, changed state to administratively down
*Feb 3 19:08:54.335: %LINK-5-CHANGED: Interface Serial1/1, changed state to administratively down
*Feb 3 19:08:54.343: %LINK-5-CHANGED: Interface Serial1/2, changed state to administratively down
*Feb 3 19:08:54.343: %LINK-5-CHANGED: Interface Serial1/3, changed state to administratively down

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int s1/0
R1(config-if)#ip address 209.165.200.9 255.255.255.252
R1(config-if)#no shutdown
R1(config-if)#
*Feb 3 19:10:39.851: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config-if)#
*Feb 3 19:10:40.855: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1(config-if)#ip route 0.0.0.0 0.0.0
*Feb 3 19:10:40.267: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
R1(config-if)#ip route 0.0.0.0 0.0.0.0 209.165.200.10
R1(config-if)#exit
R1#
*Feb 3 19:17:37.279: %SYS-5-CONFIG_I: Configured from console by console
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#hostname R1
R1(config)#[]

```

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## Step 6:

R2

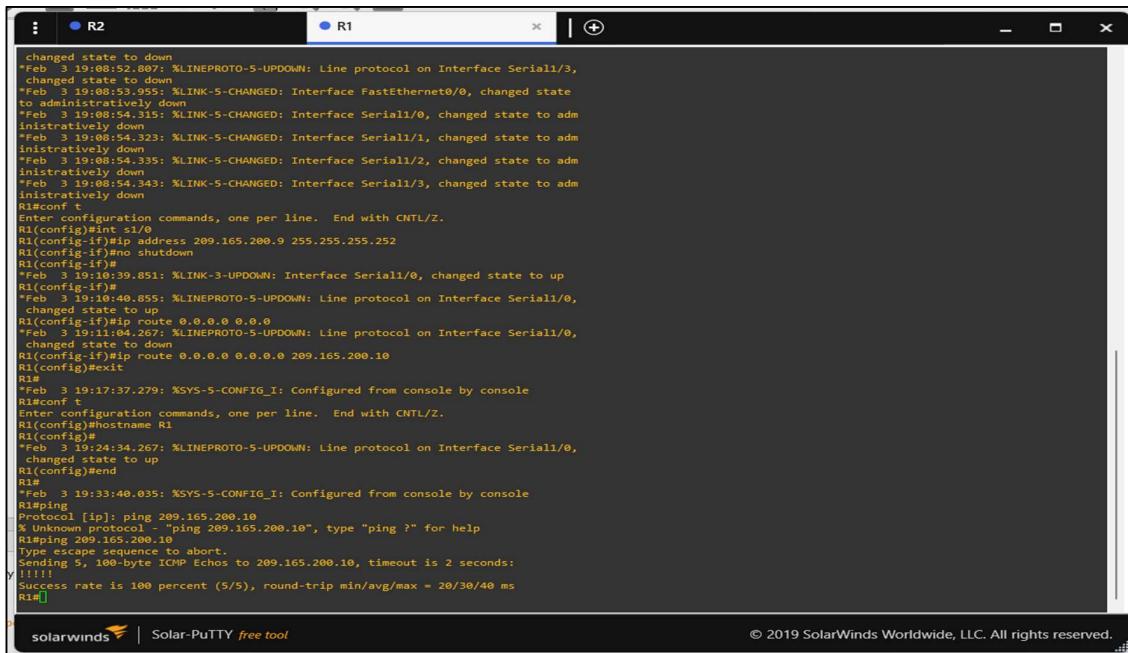
```

*Feb 3 18:56:23.787: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
*Feb 3 18:56:23.803: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to down
*Feb 3 18:56:23.819: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/2, changed state to down
*Feb 3 18:56:23.835: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/3, changed state to down
*Feb 3 18:56:24.939: %LINK-5-CHANGED: Interface FastEthernet0/0, changed state to administratively down
*Feb 3 18:56:25.279: %LINK-5-CHANGED: Interface Serial1/0, changed state to admin
*Feb 3 18:56:25.291: %LINK-5-CHANGED: Interface Serial1/1, changed state to admin
*Feb 3 18:56:25.299: %LINK-5-CHANGED: Interface Serial1/2, changed state to admin
*Feb 3 18:56:25.303: %LINK-5-CHANGED: Interface Serial1/3, changed state to admin
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#hostname ISP
ISP(config)#int s1/0
ISP(config-if)#ip address 209.165.200.10 255.255.255.252
ISP(config-if)#clock rate 4832000
ISP(config-if)#exit
ISP(config)#no ip domain-lookup
ISP(config)#int loopback 0
ISP(config-if)#
*Feb 3 19:22:48.315: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ISP(config-if)#ip address 198.133.219.1 255.255.255.255
ISP(config-if)#no shutdown
ISP(config-if)#exit
ISP(config)#int s1/0
ISP(config-if)#no shutdown
ISP(config-if)#exit
ISP(config)#
*Feb 3 19:24:17.403: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
ISP(config)#
*Feb 3 19:24:18.411: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
ISP(config)#end
ISP#
*Feb 3 19:24:57.175: %SYS-5-CONFIG_I: Configured from console by console
ISP#ping 198.133.219.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 198.133.219.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
ISP#[]

```

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## Step 7:



```

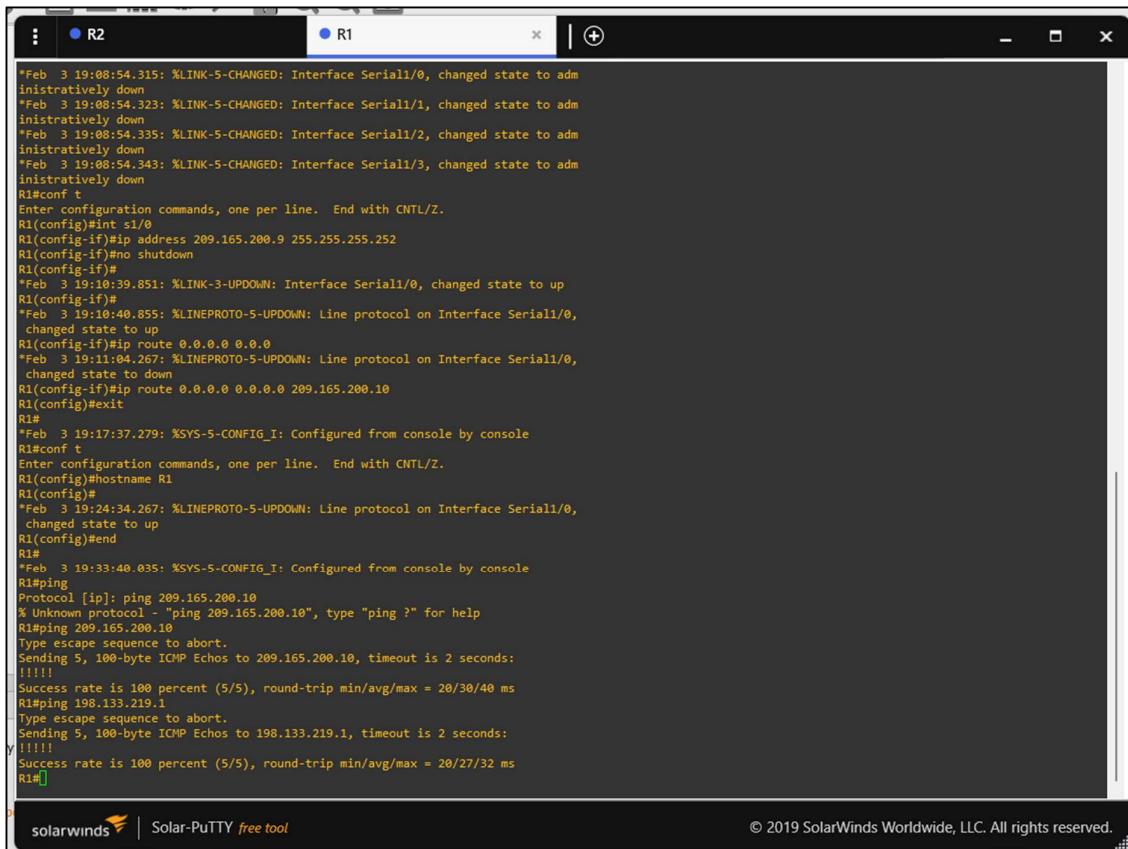
R2
R1

changed state to down
"Feb 3 19:08:52.807: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/3,
changed state to down
"Feb 3 19:08:53.055: %LINK-5-CHANGED: Interface FastEthernet0/0, changed state
to administratively down
"Feb 3 19:08:54.315: %LINK-5-CHANGED: Interface Serial1/0, changed state to adm
inistratively down
"Feb 3 19:08:54.323: %LINK-5-CHANGED: Interface Serial1/1, changed state to adm
inistratively down
"Feb 3 19:08:54.335: %LINK-5-CHANGED: Interface Serial1/2, changed state to adm
inistratively down
"Feb 3 19:08:54.343: %LINK-5-CHANGED: Interface Serial1/3, changed state to adm
inistratively down
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int s1/0
R1(config-if)#ip address 209.165.200.9 255.255.255.252
R1(config-if)#
R1(config-if)#
"Feb 3 19:10:39.851: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config-if)#
"Feb 3 19:10:40.855: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0,
changed state to up
R1(config-if)#ip route 0.0.0.0 0.0.0
"Feb 3 19:10:40.857: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0,
changed state to down
R1(config-if)#ip route 0.0.0.0 0.0.0.0 209.165.200.10
R1(config)#
R1#
"Feb 3 19:17:37.279: %SYS-5-CONFIG_I: Configured from console by console
R1(config)#
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#
R1(config)#
R1(config)#
"Feb 3 19:24:34.267: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0,
changed state to up
R1(config)#
R1#
"Feb 3 19:33:40.035: %SYS-5-CONFIG_I: Configured from console by console
R1(config)#
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#
R1(config)#
R1(config)#
"Feb 3 19:33:40.035: %SYS-5-CONFIG_I: Configured from console by console
R1#ping
Protocol [ip]: ping 209.165.200.10
% Unknown protocol - "ping 209.165.200.10", type "ping ?" for help
R1#ping 209.165.200.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.200.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/30/40 ms
R1#

```

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## Step 8:



```

R2
R1

changed state to down
"Feb 3 19:08:54.315: %LINK-5-CHANGED: Interface Serial1/0, changed state to adm
inistratively down
"Feb 3 19:08:54.323: %LINK-5-CHANGED: Interface Serial1/1, changed state to adm
inistratively down
"Feb 3 19:08:54.335: %LINK-5-CHANGED: Interface Serial1/2, changed state to adm
inistratively down
"Feb 3 19:08:54.343: %LINK-5-CHANGED: Interface Serial1/3, changed state to adm
inistratively down
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int s1/0
R1(config-if)#ip address 209.165.200.9 255.255.255.252
R1(config-if)#
R1(config-if)#
"Feb 3 19:10:39.851: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config-if)#
"Feb 3 19:10:40.855: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0,
changed state to up
R1(config-if)#ip route 0.0.0.0 0.0.0.0 209.165.200.10
R1(config)#
R1#
"Feb 3 19:17:37.279: %SYS-5-CONFIG_I: Configured from console by console
R1(config)#
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#
R1(config)#
R1(config)#
"Feb 3 19:24:34.267: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0,
changed state to up
R1(config)#
R1#
"Feb 3 19:33:40.035: %SYS-5-CONFIG_I: Configured from console by console
R1(config)#
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#
R1(config)#
R1(config)#
"Feb 3 19:33:40.035: %SYS-5-CONFIG_I: Configured from console by console
R1#ping
Protocol [ip]: ping 209.165.200.10
% Unknown protocol - "ping 209.165.200.10", type "ping ?" for help
R1#ping 209.165.200.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.200.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/30/40 ms
R1#ping 198.133.219.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 198.133.219.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/27/32 ms
R1#

```

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## Step 9:

```

Feb 3 19:33:40.035: %SYS-5-CONFIG_I: Configured from console by console
R1#ping
Protocol [ip]: ping 209.165.200.10
% Unknown protocol - "ping 209.165.200.10", type "ping ?" for help
R1#ping 209.165.200.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.200.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/30/40 ms
R1#ping 198.133.219.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 198.133.219.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/27/32 ms
R1#ip sla 22
^
% Invalid input detected at '^' marker.

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip sla 22
R1(config-ip-sla)#icmp-echo 198.133.219.1
R1(config-ip-sla-echo)#frequency 20
R1(config-ip-sla-echo)#ip sla schedule 22 start-time now life forever
R1(config)#end
R1#
*Feb 3 19:45:27.719: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip sla configuration
IP SLAs Infrastructure Engine-III
Entry number: 22
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: icmp-echo
Target address/Source address: 198.133.219.1/0.0.0.0
Type Of Service parameter: 0x0
Request size (ARR data portion): 28
Verify data: No
Vrf Name:
Schedule:
  Operation frequency (seconds): 20 (not considered if randomly scheduled)
  Next Scheduled Start Time: Start Time already passed
  Group Scheduled : FALSE
  Randomly Scheduled : FALSE
  Life (seconds): Forever
  Entry Ageout (seconds): never
  Recurring (Starting Everyday): FALSE
  Status of entry (SNMP RowStatus): Active
  Threshold (milliseconds): 5000
Distribution Statistics:
  Number of statistic hours kept: 2
--More-- [ ]

```

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## Step 10:

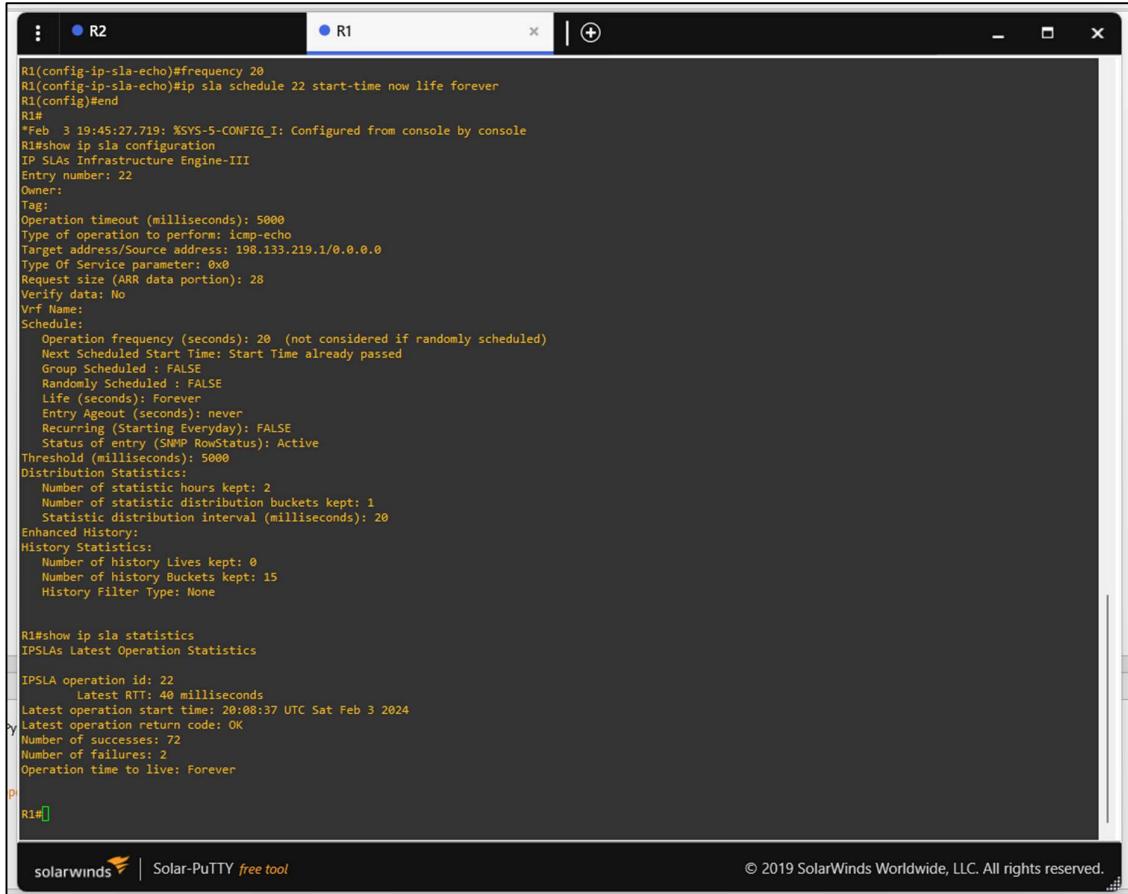
```

ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP(config)#int loopback 0
ISP(config-if)#shutdown
ISP(config-if)#
*Feb 3 20:03:08.887: %LINK-5-CHANGED: Interface Loopback0, changed state to administratively down
*Feb 3 20:03:09.887: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to down
ISP(config-if)#no shutdown
ISP(config-if)#
*Feb 3 20:03:47.543: %LINK-3-UPDOWN: Interface Loopback0, changed state to up
*Feb 3 20:03:48.543: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ISP(config-if)#

```

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### Step 11:



The screenshot shows two terminal windows side-by-side. The left window is titled 'R2' and displays the command 'R1(config-ip-sla-echo)#frequency 20'. The right window is titled 'R1' and displays the output of the 'show ip sla configuration' command. The output includes details about an SLA entry with ID 22, which was configured from the console. It specifies an ICMP-ECHO operation, a target address of 198.133.219.1, and a request size of 28 bytes. The entry has a verify data option set to 'No'. The schedule for this entry is defined with an operation frequency of 20 seconds. The distribution statistics show 2 hours kept and 1 bucket kept. The history statistics indicate 0 history lives kept and 15 history buckets kept. The latest operation statistics show a success rate of 72 successes and 2 failures, with an operation time to live of 'Forever'.

```
R1(config-ip-sla-echo)#frequency 20
R1(config-ip-sla-echo)#ip sla schedule 22 start-time now life forever
R1(config)#end
R1#
Feb 3 19:45:27.719: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip sla configuration
IP SLAs Infrastructure Engine-III
Entry number: 22
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: icmp-echo
Target address/Source address: 198.133.219.1/0.0.0.0
Type Of Service parameter: 0x0
Request size (ARR data portion): 28
Verify data: No
Vrf Name:
Schedule:
  Operation frequency (seconds): 20 (not considered if randomly scheduled)
  Next Scheduled Start Time: Start Time already passed
  Group Scheduled : FALSE
  Randomly Scheduled : FALSE
  Life (seconds): Forever
  Entry Ageout (seconds): never
  Recurring (Starting Everyday): FALSE
  Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 5000
Distribution Statistics:
  Number of statistic hours kept: 2
  Number of statistic distribution buckets kept: 1
  Statistic distribution interval (milliseconds): 20
Enhanced History:
History Statistics:
  Number of history Lives kept: 0
  Number of history Buckets kept: 15
  History Filter Type: None

R1#show ip sla statistics
IPSLAs Latest Operation Statistics
IPSLA operation id: 22
  Latest RTT: 40 milliseconds
  Latest operation start time: 20:08:37 UTC Sat Feb 3 2024
  Latest operation return code: OK
  Number of successes: 72
  Number of failures: 2
  Operation time to live: Forever
R1#
```

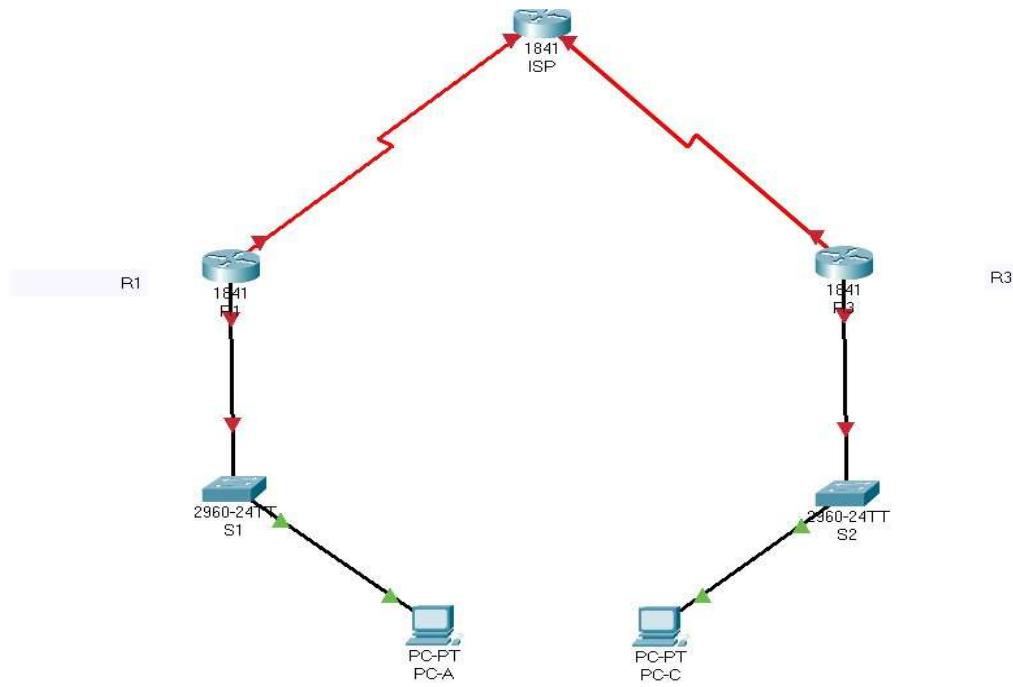
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**Conclusion:** The above practical Implementing the IP Service Level Agreement has been Implemented Successfully.

## PRACTICAL-02

**Topology:**



**Addressing Table:**

Device	Interfaces	IP ADD	Subnet Mask	Default Gateway
<b>R1</b>	<b>F0/1</b>	<b>192.168.10.1</b>	<b>255.255.255.0</b>	N/A
	<b>Lo0</b>	<b>192.168.20.1</b>	<b>255.255.255.0</b>	N/A
	<b>S/0/0/0</b>	<b>10.1.1.1</b>	<b>255.255.255.252</b>	N/A
<b>ISP</b>	<b>S/0/0/0</b>	<b>10.1.1.2</b>	<b>255.255.255.252</b>	N/A
	<b>S/0/0/1</b>	<b>20.2.2.2</b>	<b>255.255.255.252</b>	N/A
	<b>Lo0</b>	<b>209.165.200.225</b>	<b>255.255.255.224</b>	N/A
<b>R3</b>	<b>F0/1</b>	<b>192.165.30.1</b>	<b>255.255.255.0</b>	N/A
	<b>Lo0</b>	<b>192.168.40.1</b>	<b>255.255.255.0</b>	N/A
	<b>S/0/0/1</b>	<b>20.2.2.1</b>	<b>255.255.255.252</b>	N/A
<b>S1</b>	<b>VLAN 1</b>	<b>192.168.10.11</b>	<b>255.255.255.0</b>	<b>192.168.10.1</b>
<b>S2</b>	<b>VLAN 1</b>	<b>192.168.30.11</b>	<b>255.255.255.0</b>	<b>192.168.30.1</b>
<b>PC-A</b>	<b>NIC</b>	<b>192.168.10.3</b>	<b>255.255.255.0</b>	<b>192.168.10.1</b>
<b>PC-C</b>	<b>NIC</b>	<b>192.168.30.3</b>	<b>255.255.255.0</b>	<b>192.168.30.1</b>

**Aim:** Configuring and Verifying Standard IPv4 ACLs Topology.

- Set up the Topology and Initialize Devices.
- Configure Devices and Verify Connectivity.

### Theory:

Internet Protocol version 4 (IPv4)

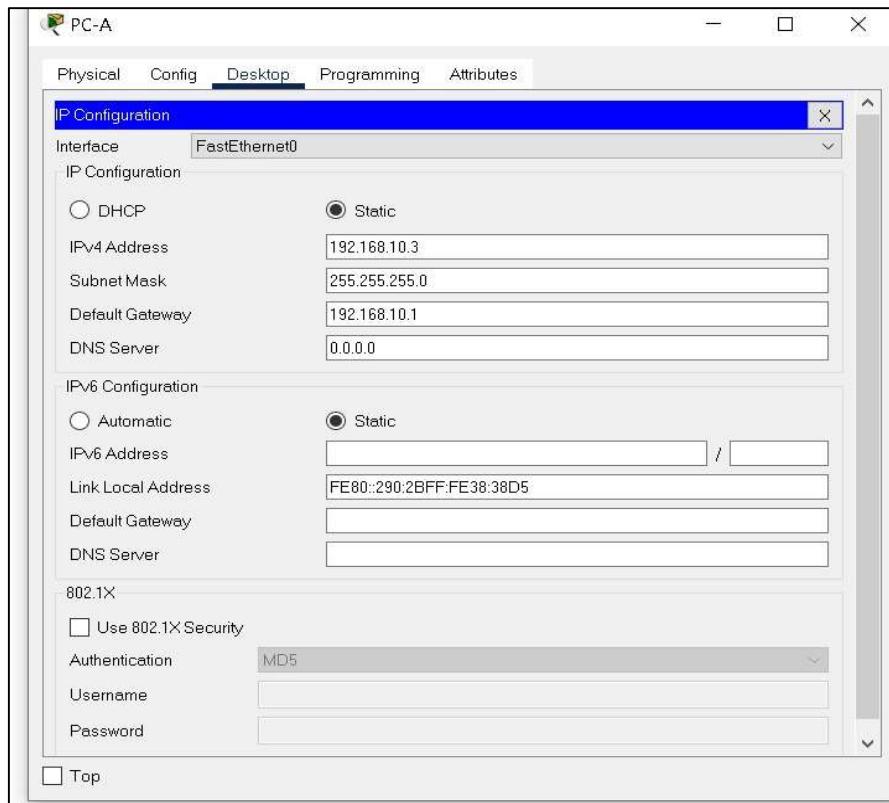
Internet Protocol version 4 (IPv4) is the fourth version of the Internet Protocol (IP). It is one of the core protocols of internetworking methods in the Internet and other packet-switched networks. IPv4 was first deployed for production on SATNET in 1982 and on the ARPANET in January 1983. It is still used to route most Internet traffic today.

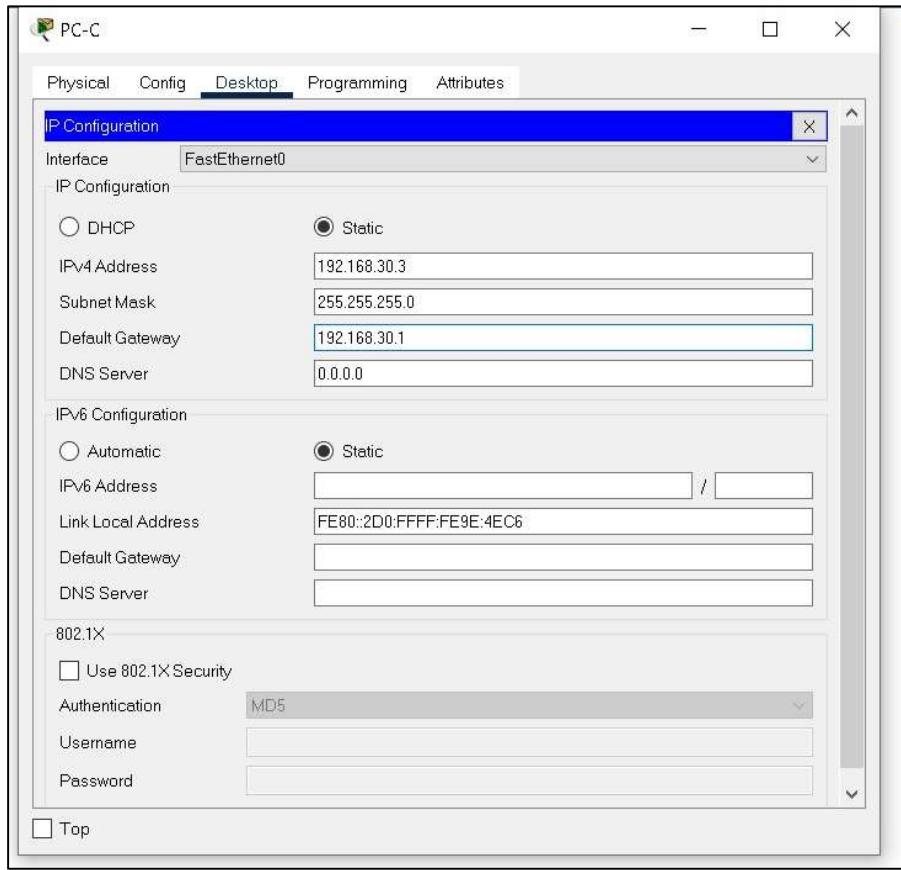
ACL (Access Control List)

An ACL (Access Control List) is a list of statements that are meant to either permit or deny the movement of data from the network layer and above. They are used to filter traffic in our networks as required by the security policy.

### a) Set up the Topology and Initialize Devices.

**Step 1:** In this step we will first do basic IP configuration of the PC-A and PC-C

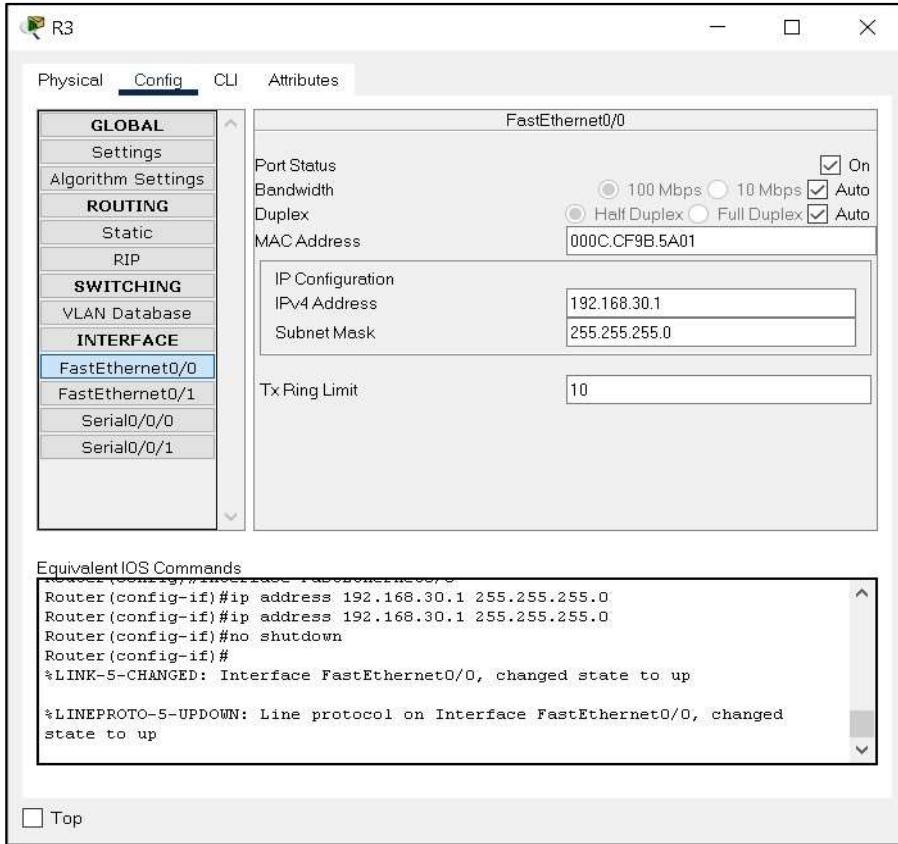
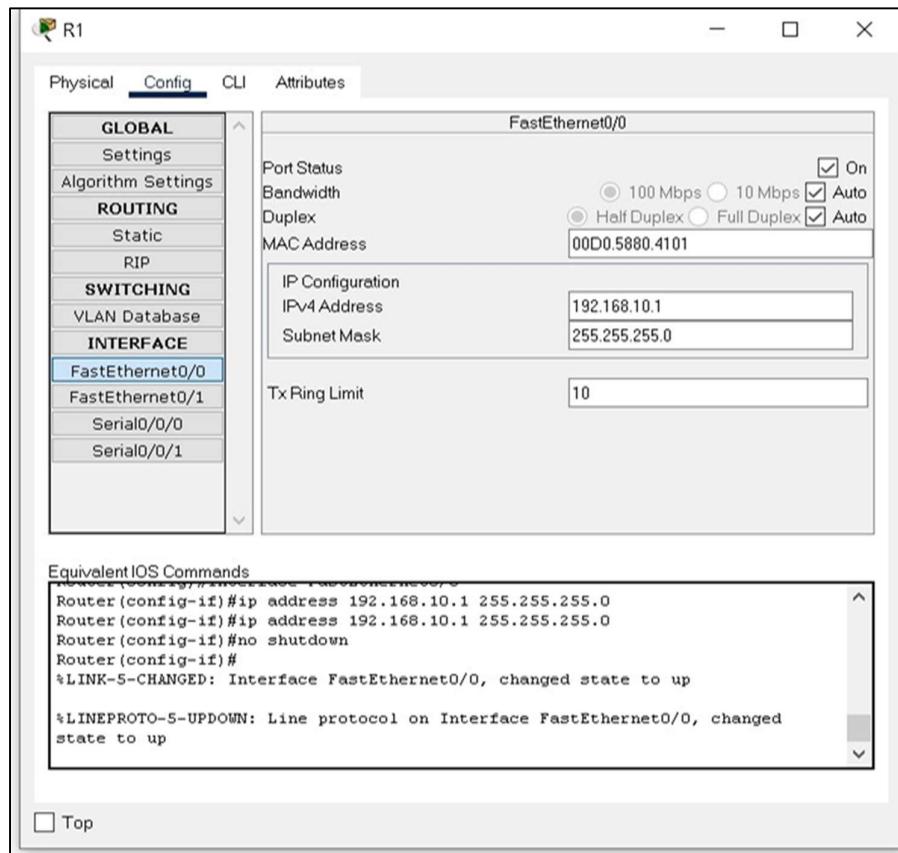


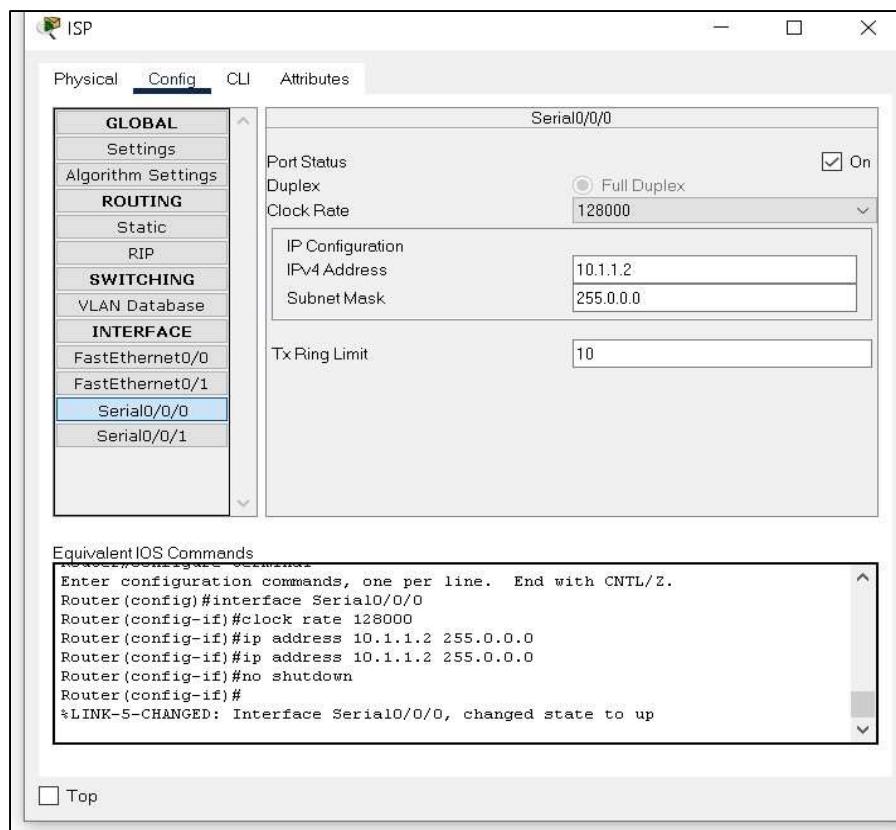
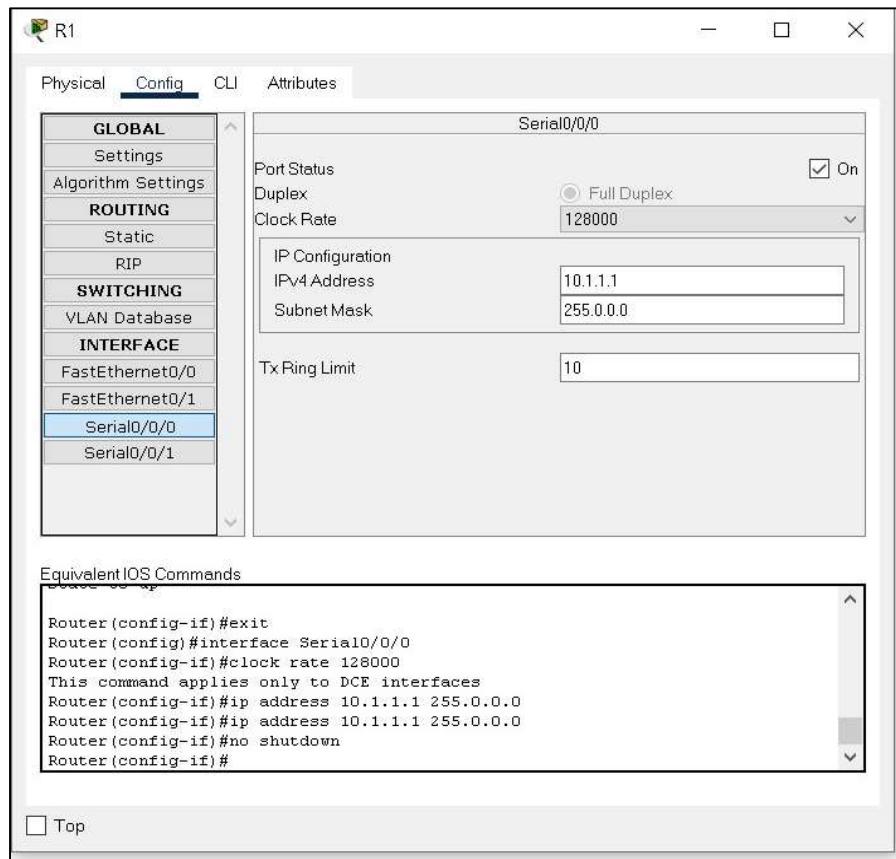


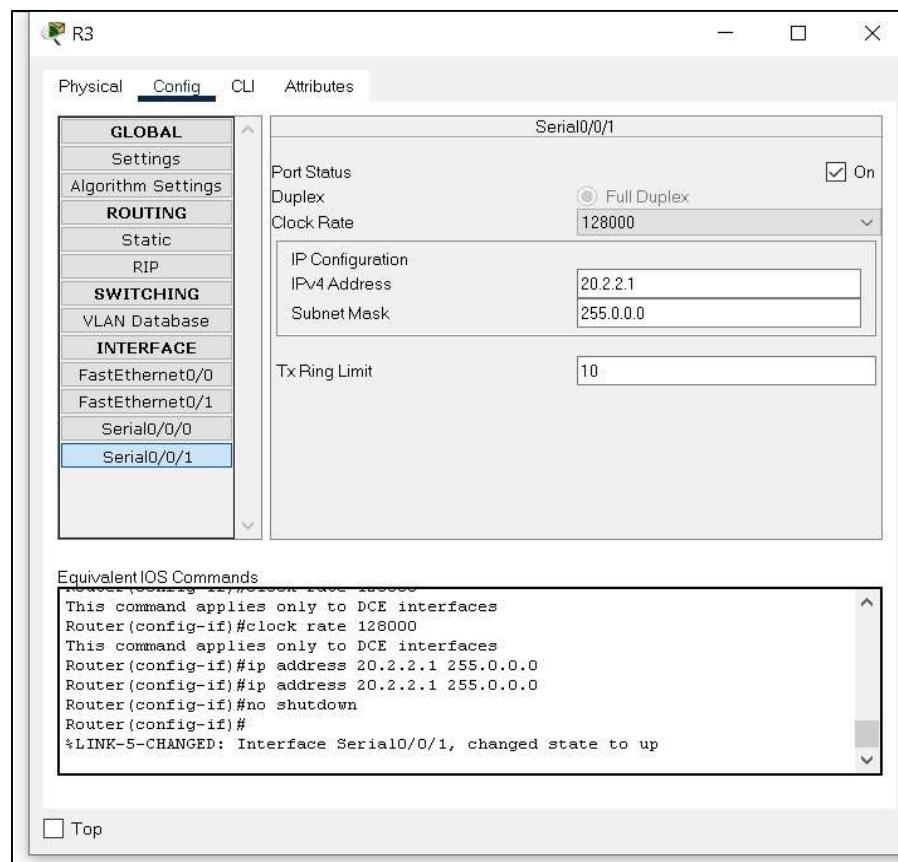
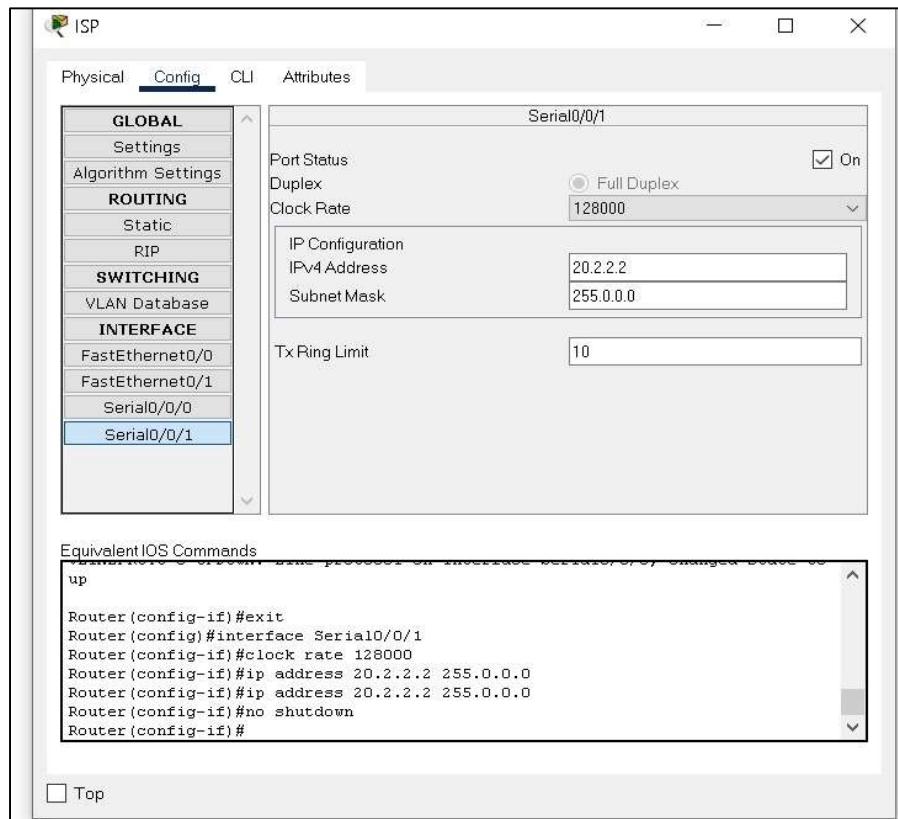
### Step 2:

1. In this step in which we will do the basic configuration of the routers R1, R3, and ISP.
2. We will Configure f0/0 port of R1 for switch S1, set IPv4 Add and make that port ON.
3. Also, for R3 on port f0/0 for switch S2 and make it ON
4. And then we configure s0/0 port of R1 to s0/0 port of ISP router
5. In next configure s0/1 port of ISP router to R3 port s0/1

**Note: clock rate of the all routers must be same**







### Step 3:

In this step, we will assign IP Add to router R1, R3, and ISP. Also, we set Loopback interfaces here in all 3 routers.

1. Go to the R1->CLI
2. Enable router->configure terminal (int lo0)
3. Set IP Add -> no shut for port on
4. Exit

The image displays two separate windows, each titled with the router's name (R1 and ISP) and showing the 'CLI' tab selected. Both windows are titled 'IOS Command Line Interface' and feature a text area where configuration commands are entered. A message at the top of each window reads 'Press RETURN to get started.' Below this, the command history shows the configuration of a Loopback interface (lo0) on both routers. The configuration steps include entering configuration mode, defining the loopback interface, changing its state to 'up', and assigning it an IP address (192.168.20.1 and 209.165.200.225 respectively). The routers also enable the 'no shut' command to ensure the interface remains active. At the bottom of each window, there are 'Copy' and 'Paste' buttons, and a checkbox labeled 'Top'.

```

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int lo0

Router(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to
up

Router(config-if)#ip add 192.168.20.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#exit
Router(config)#

```

```

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int lo0

Router(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to
up

Router(config-if)#ip add 209.165.200.225 255.255.255.254
Router(config-if)#no shut
Router(config-if)#exit
Router(config)#

```

```

Press RETURN to get started.

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int lo0
Router(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
Router(config-if)#ip add 192.168.40.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#exit
Router(config)#
Ctrl+F6 to exit CLI focus

```

Top

Copy      Paste

**Step 4:** Now in this step we will set VLAN interface Configuration of SWITCHes.

1. Enable switch
2. Configure terminal -> set VLAN interface
3. Set IP Add -> exit
4. Set default gateway -> then make again VLAN interface->no shut
5. Exit

```

%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int vlan 1
Switch(config-if)#ip add 192.168.10.11 255.255.255.0
Switch(config-if)#exit
Switch(config)#ip default-gateway 192.168.10.1
Switch(config)#int vlan 1
Switch(config-if)#no shut

Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up
Switch(config-if)#exit
Switch(config)#

```

Top

Copy      Paste

```
Switch#
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int vlan 1
Switch(config-if)#ip add 192.168.30.11 255.255.255.0
Switch(config-if)#exit
Switch(config)#ip default-gateway 192.168.30.1
Switch(config)#int vlan 1
Switch(config-if)#no shut

Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up

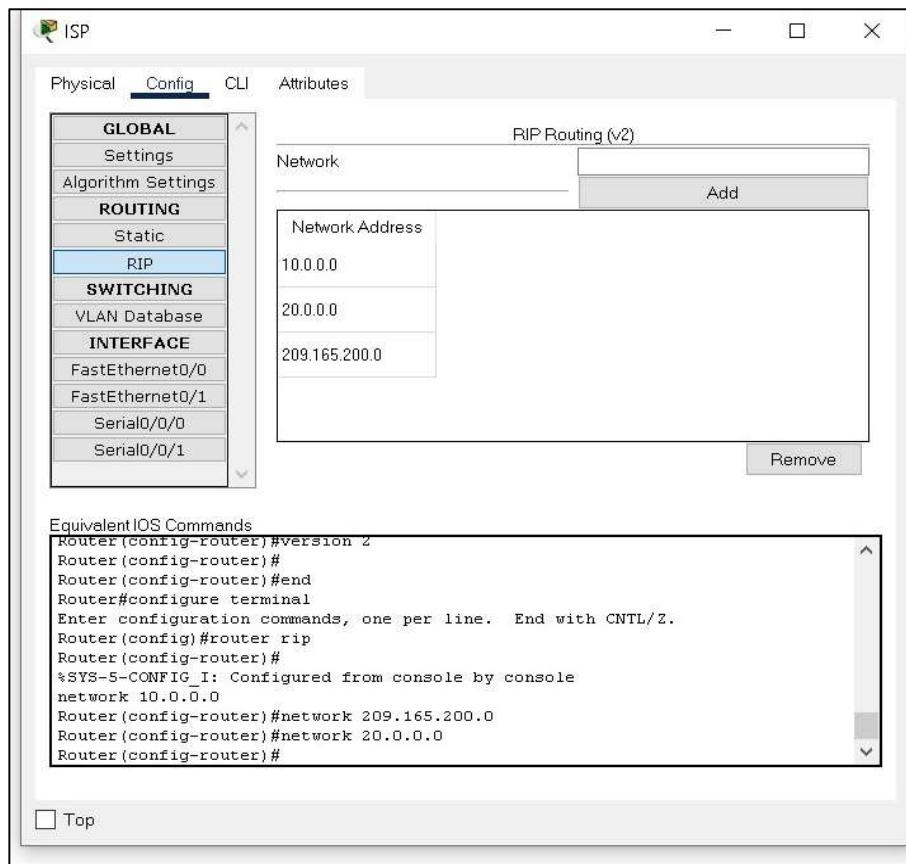
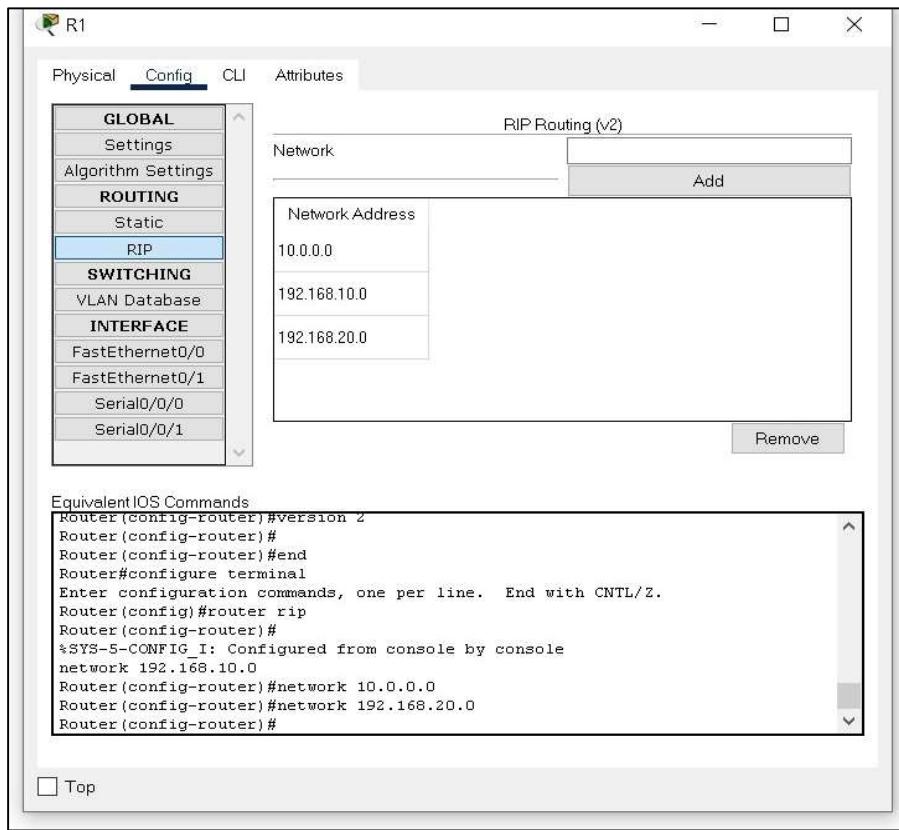
Switch(config-if)#exit
Switch(config)#

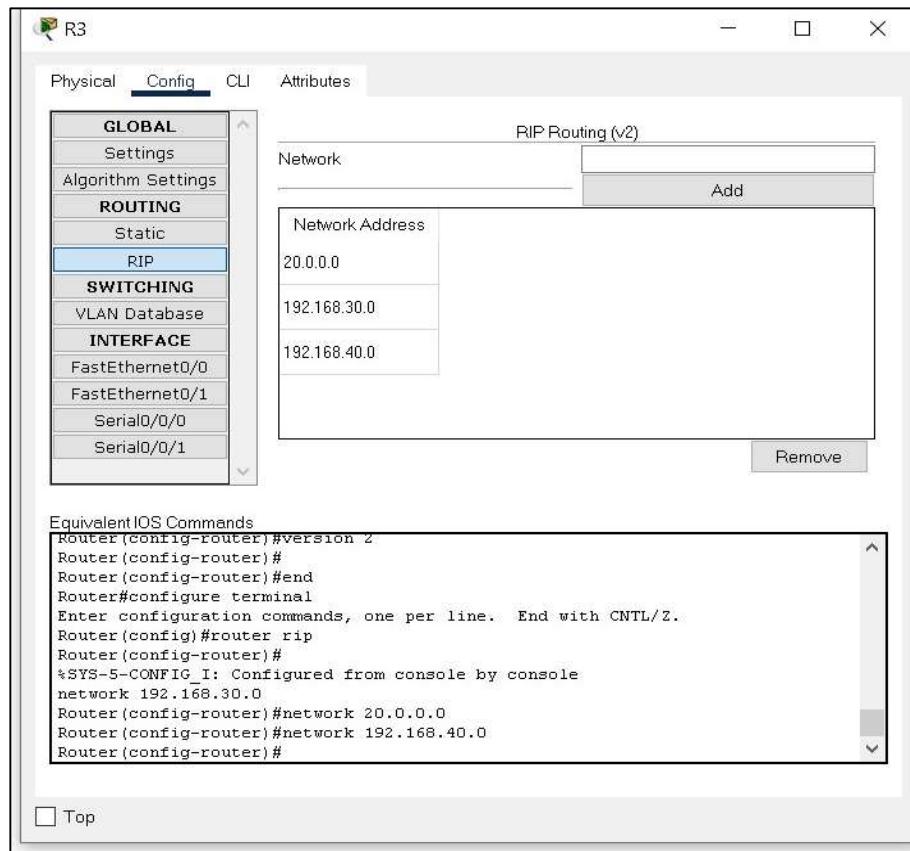
Ctrl+F6 to exit CLI focus
```

**Step 5:** Now in this step we will set RIP routing Protocol.

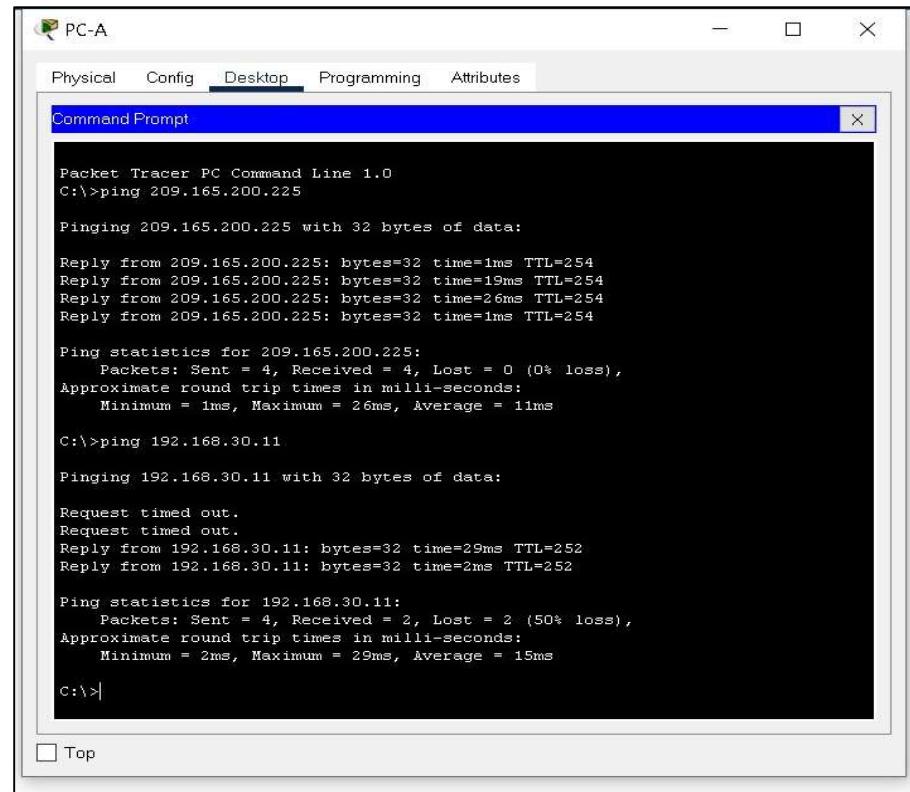
For that we will go to RIP setting of R1, R2 and ISP.

1. Enable version 2 in all routers
2. Add Network Add into RIP tab
3. Do same for all routers





**Step 6:** Now we will check the machines by running PING command in PC-A.



**Step 7:** Set some Authentication settings in routers and switches.

```

Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#
Router(config-router)#end
Router#configure terminal
Router(config)#router rip
Router(config-router)#
%SYS-5-CONFIG_I: Configured from console by console
network 192.168.10.0
Router(config-router)#network 10.0.0.0
Router(config-router)#network 192.168.20.0
Router(config-router)#exit
Router(config)#no ip domain-lookup
Router(config)# hostname R1
R1(config)# service password-encryption
R1(config)# enable secret class
R1(config)# banner motd #
Enter TEXT message. End with the character '#'.
Unauthorized access is strictly prohibited. #

R1(config)# Line con 0
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)# logging synchronous
R1(config-line)# line vty 0 4
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)#

```

Ctrl+F6 to exit CLI focus      Copy      Paste

Top

```

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#no ip domain-lookup
Switch(config)# service password-encryption
Switch(config)# enable secret class
Switch(config)# banner motd #
Enter TEXT message. End with the character '#'.
Unauthorized access is strictly prohibited. #

Switch(config)# Line con 0
Switch(config-line)# password cisco
Switch(config-line)# login
Switch(config-line)# logging synchronous
Switch(config-line)# line vty 0 15
Switch(config-line)# password cisco
Switch(config-line)# login
Switch(config-line)# exit
Switch(config)#

```

Ctrl+F6 to exit CLI focus      Copy      Paste

Top

```

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#no ip domain-lookup
Switch(config)# service password-encryption
Switch(config)# enable secret class
Switch(config)# banner motd #
Enter TEXT message. End with the character '#'.
Unauthorized access is strictly prohibited. #

Switch(config)# Line con 0
Switch(config-line)# password cisco
Switch(config-line)# login
Switch(config-line)# logging synchronous
Switch(config-line)# line vty 0 15
Switch(config-line)# password cisco
Switch(config-line)# login
Switch(config-line)# exit
Switch(config)#

```

Ctrl+F6 to exit CLI focus     

Top

### b) Configure Devices and Verify Connectivity.

**Step 1:** Here, we set some permission methods on R3

```

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#access-list 1 remark Allow R1 LANs Access
Router(config)#access-list 1 permit 192.168.10.0 0.0.0.255
Router(config)#access-list 1 permit 192.168.20.0 0.0.0.255
Router(config)#access-list 1 deny any
Router(config)#interface f0/1
Router(config-if)# ip access-group 1 out
Router(config-if)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show access-lists
Standard IP access list 1
  10 permit 192.168.10.0 0.0.0.255
  20 permit 192.168.20.0 0.0.0.255
  30 deny any
Router#

```

Ctrl+F6 to exit CLI focus     

Top

R3

Physical Config **CLI** Attributes

IOS Command Line Interface

```
Router#show access-lists
Standard IP access list 1
 10 permit 192.168.10.0 0.0.0.255
 20 permit 192.168.20.0 0.0.0.255
 30 deny any

Router#show int f0/1
FastEthernet0/1 is administratively down, line protocol is down (disabled)
  Hardware is Lance, address is 000c.cf9b.5a02 (bia 000c.cf9b.5a02)
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Full-duplex, 100Mb/s, media type is RJ45
  ARP type: ARP, 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 input packets with dribble condition detected
    0 packets output, 0 bytes, 0 underruns
    0 output errors, 0 collisions, 1 interface resets
    0 babbles, 0 late collision, 0 deferred
    0 lost carrier, 0 no carrier
--More--
```

Ctrl+F6 to exit CLI focus     

Top

R1

Physical Config **CLI** Attributes

IOS Command Line Interface

```
R1 con0 is now available

Press RETURN to get started.

Unauthorized access is strictly prohibited.

User Access Verification

Password: 
Password: 
```

Ctrl+F6 to exit CLI focus     

Top

```

R1(config)# banner motd #
Enter TEXT message. End with the character '#'.
Unauthorized access is strictly prohibited. #

R1(config)# Line con 0
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)# logging synchronous
R1(config-line)# line vty 0 4
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)#end
R1#
%SYS-5-CONFIG_I: Configured from console by console

R1#ping 192.168.30.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.30.3, timeout is 2
seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
2/7/18 ms

R1#

```

Ctrl+F6 to exit CLI focus     

Top

**Step 2:** We will check Target IP Add Operations On R1, R3.

```

2/7/18 ms

R1#ping
Protocol [ip]:
Target IP address: 192.168.30.3
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 192.168.20.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.30.3, timeout is 2
seconds:
Packet sent with a source address of 192.168.20.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
2/6/12 ms

R1#

```

Ctrl+F6 to exit CLI focus     

Top

R3

Physical Config **CLI** Attributes

IOS Command Line Interface

```
%SYS-5-CONFIG_I: Configured from console by console

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#access-list 1 remark Allow R1 LANs Access
Router(config)#access-list 1 deny 192.168.10.0 0.0.0.255
Router(config)# access-list 1 deny 192.168.20.0 0.0.0.255
Router(config)#access-list 1 allow any
^
% Invalid input detected at '^' marker.

Router(config)#access-list 1 deny any
Router(config)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show access-lists
Standard IP access list 1
  10 permit 192.168.10.0 0.0.0.255
  20 permit 192.168.20.0 0.0.0.255
  30 deny any
  40 deny 192.168.10.0 0.0.0.255
  50 deny 192.168.20.0 0.0.0.255

Router#
```

Ctrl+F6 to exit CLI focus     

Top

R1

Physical Config **CLI** Attributes

IOS Command Line Interface

```
Packet sent with a source address of 192.168.20.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
2/6/12 ms

R1#
R1#ping 192.168.30.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.30.3, timeout is 2
seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
2/6/10 ms

R1#ping 209.165.200.225

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.200.225, timeout is 2
seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
1/3/14 ms

R1#
```

Ctrl+F6 to exit CLI focus     

Top

## PRACTICAL-03

**Aim:** Perform

- 1) Implement SPAN Technologies (Switch Port Analyzer)
- 2) Implement SNMP and Syslog
- 3) Implement Flexible NetFlow

**Theory:**

**1) SPAN technologies:**

SPAN (Switched Port Analyzer) is a dedicated port on a switch that takes a mirrored copy of network traffic from within the switch to be sent to a destination. The destination is typically a monitoring device or other tools used for troubleshooting or traffic analysis. SPAN ports present a readily available mechanism through which to access detailed packet information.

**2) SNMP and Syslog:**

SNMP is an application layer protocol that uses UDP port number 161/162. SNMP is used to monitor the network, detect network faults, and sometimes even to configure remote devices.

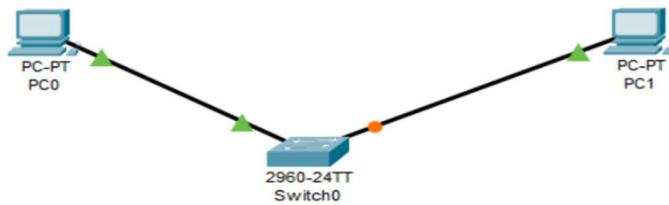
Syslog is a standard protocol for message logging that computer systems use to send event logs to a Syslog server for storage. On network devices, Syslog can be used to log events such as changes in interface status, system restarts, etc. A lot of different types of events can be logged. Logs are essential when troubleshooting issues, examining the cause of incidents, etc.

**3) Flexible NetFlow:**

Flexible NetFlow helps Cisco customers determine how to optimize resource usage, plan network capacity, and identify the optimal application layer for Quality of Service (QoS). It plays a vital role in network security by detecting Denial of Service (DoS) attacks and network-propagated worms.

## Implementation:

### Implement SPAN Technologies (Switch Port Analyzer)



### Address Table

Device	IP Address
PC0	10.0.0.2
PC1	10.0.0.3

### Commands:

```

monitor session 1 source int f0/0
monitor session 1 destination int f0/2
show monitor session 1
show monitor detail

```

Switch0

Physical Config CLI Attributes

IOS Command Line Interface

```

Power supply part number      : 341-0097-02
Motherboard serial number     : FOC10093R12
Power supply serial number    : AZS1007032H
Model revision number        : B0
Motherboard revision number   : B0
Model number                  : WS-C2960-24TT-L
System serial number          : FOC1010X104
Top Assembly Part Number     : 800-27221-02
Top Assembly Revision Number : A0
Version ID                   : V02
CCLI Code Number              : COM3L00BRA
Hardware Board Revision Number: 0x01

Switch Ports Model           : SW Version       : SW Image
----- : ----- : -----
*     1 26   WS-C2960-24TT-L  15.0(2)SE4    C2960-LANBASEK9-M

Cisco IOS Software, C2960 Software (C2960-LANBASEK9-M), Version 15.0(2)SE4, RELEASE
SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2013 by Cisco Systems, Inc.
Compiled Wed 26-Jun-13 02:49 by mnnguyen

Press RETURN to get started!

%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

```

Copy Paste

Top

Switch0

Physical Config CLI Attributes

IOS Command Line Interface

```
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

Switch>conf t
      ^
% Invalid input detected at '^' marker.

Switch>conf t
      ^
% Invalid input detected at '^' marker.

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#monitor session 1 source int f0/1
Switch(config)#monitor session 1 destination int f0/2
Switch(config)#end
Switch#
%SYS-5-CONFIG_I: Configured from console by console
show monitor session 1 int f0/1
      ^
% Invalid input detected at '^' marker.

Switch#show monitor session 1
Session 1
-----
Type          : Local Session
Description   :
Source Ports :
    Both      : Fa0/1
Destination Ports :
    Fa0/2
Encapsulation : Native
Ingress       : Disabled

Switch#show monitor detail
```

Top

Copy Paste

Switch0

Physical Config CLI Attributes

IOS Command Line Interface

```
% Invalid input detected at '^' marker.

Switch#show monitor session 1
Session 1
-----
Type          : Local Session
Description   :
Source Ports :
    Both      : Fa0/1
Destination Ports :
    Fa0/2
Encapsulation : Native
Ingress       : Disabled

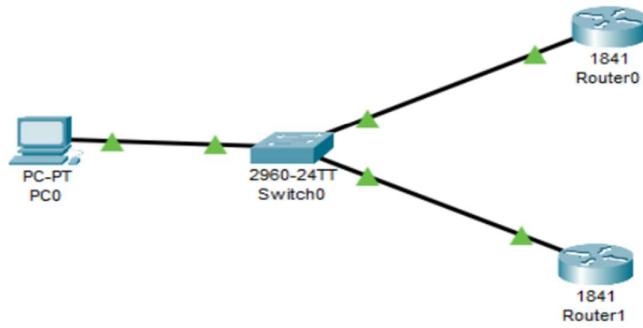
Switch#show monitor detail
Session 1
-----
Type          : Local Session
Description   :
Source Ports :
    RX Only   : None
    TX Only   : None
    Both      : Fa0/1
Source VLANs  :
    RX Only   : None
    TX Only   : None
    Both      : None
Source RSPAN VLAN :
Destination Ports :
    Fa0/2
Encapsulation : Native
Ingress       : Disabled
Filter VLANs  : None
Dest RSPAN VLAN : None

Switch#
```

Top

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## Implement SNMP



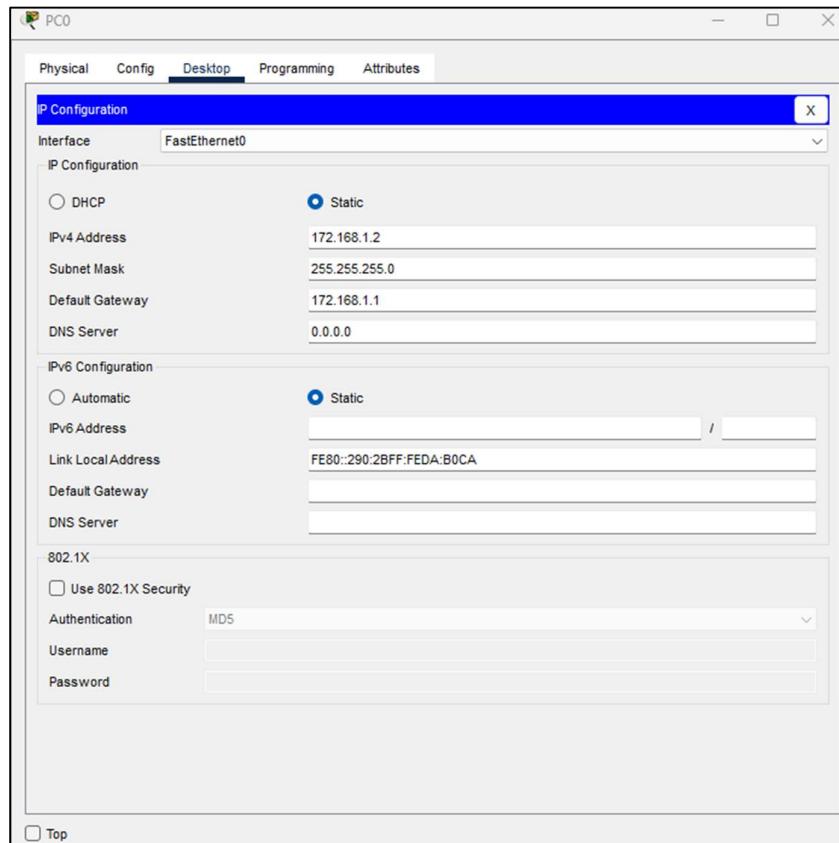
Device	Interface	IP Address
PC0	PC0	172.168.1.2 /172.168.1.1
R1	F0/0	172.168.1.1
R2	F0/0	172.168.2.1

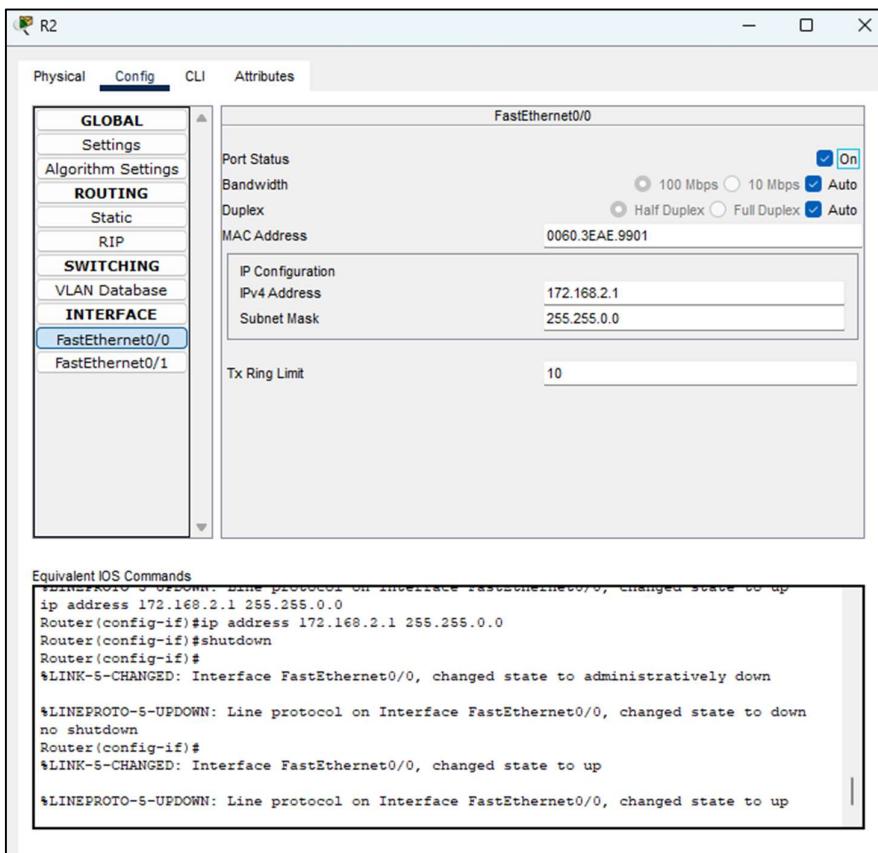
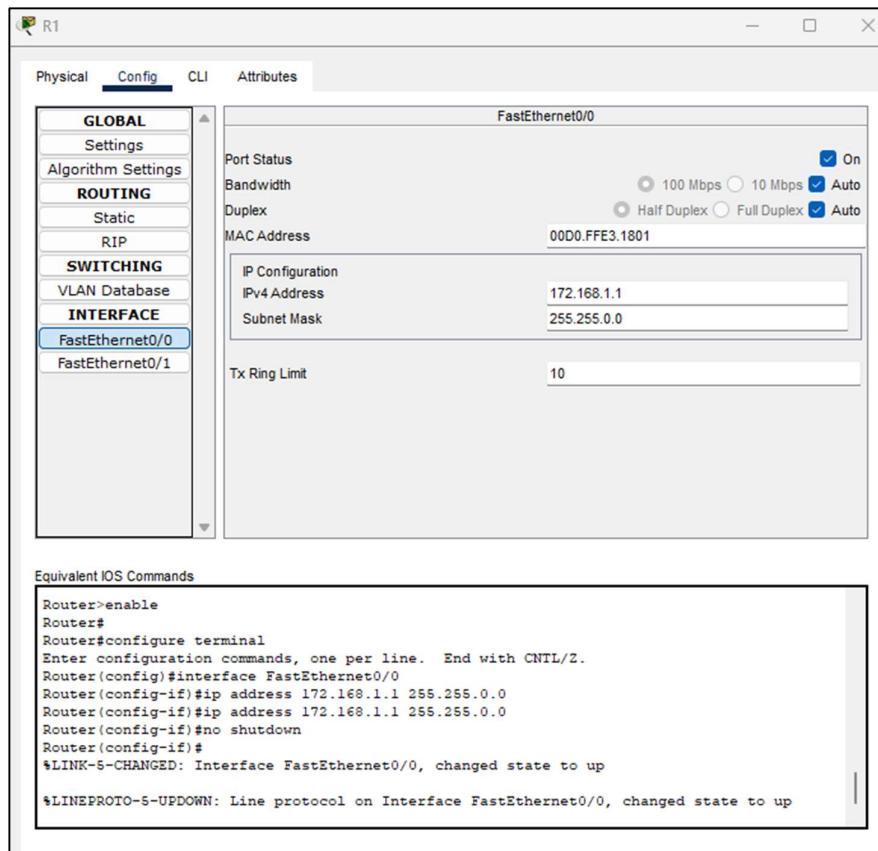
### Steps:

snmp-server community read ro

snmp-server community write rw

Goto MIB browser and do settings





**R1**

Physical Config **CLI** Attributes

IOS Command Line Interface

```

Router>enable
Router#
Router>configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 172.168.1.1 255.255.0.0
Router(config-if)#ip address 172.168.1.1 255.255.0.0
Router(config-if)#no shutdown
Router(config-if)#
$LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Router(config-if)#
Router(config-if)#exit
Router(config)#snmp-server community read ro
$SNMP-5-WARMSTART: SNMP agent on host Router is undergoing a warm start
Router(config)#snmp-server?
snmp-server?
Router(config)#snmp-server ?
    community Enable SNMP; set community string and access privs
Router(config)#snmp-server community ?
    WORD SNMP community string
Router(config)#snmp-server community read ?
    ro Read-only access with this community string
    rw Read-write access with this community string
    <cr>
Router(config)#snmp-server community read ro
Router(config)#snmp-server community write ?
    ro Read-only access with this community string
    rw Read-write access with this community string
    <cr>
Router(config)#snmp-server community write rw
Router(config)#

```

Copy Paste

**PC0**

Physical Config Desktop Programming Attributes

MB Browser

Address:	172.168.1.1	OID:							
Advanced...		Operations:	Get GO						
SNMP MIBs		Result Table							
> MIB Tree		<table border="1"> <thead> <tr> <th>Name/OID</th> <th>Value</th> <th>Type</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> </tr> </tbody> </table>		Name/OID	Value	Type			
Name/OID	Value	Type							
		<table border="1"> <tr> <td>Name :</td> <td></td> </tr> <tr> <td>OID :</td> <td></td> </tr> <tr> <td>Syntax :</td> <td></td> </tr> </table>		Name :		OID :		Syntax :	
Name :									
OID :									
Syntax :									

**Advanced**

Address: 172.168.1.1

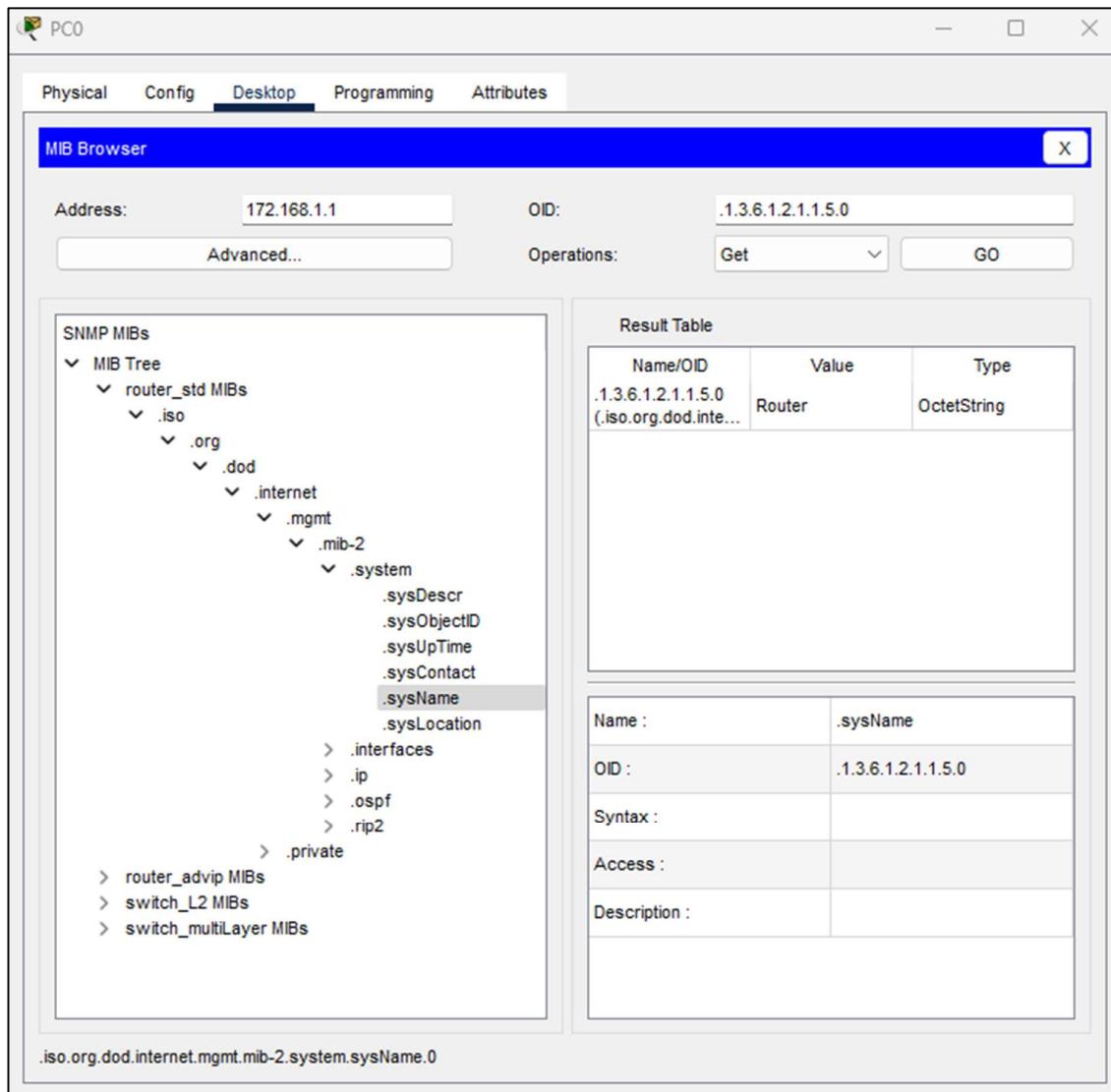
Port: 161

Read Community: **\*\*\*\*\***

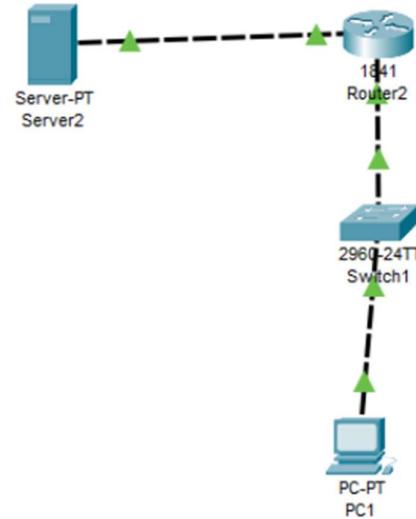
Write Community: **\*\*\*\*\***

SNMP Version: v1

OK Cancel



## Implement Syslog



Device	Interface	IP Address
PC1		30.0.0.2/30.0.0.1
R2	F0/0 server	10.0.0.1
	F0/1 PC1	30.0.0.1
server		10.0.0.2/10.0.0.1

service timestamps log datetime msec

int f0/0.1

check syslog of server

## Flow Simulator

int f0/0

ip flow ingress

ip flow egress

ip flow-export destination 10.0.0.2 99

ip flow-export source f0/0

show ip cache flow

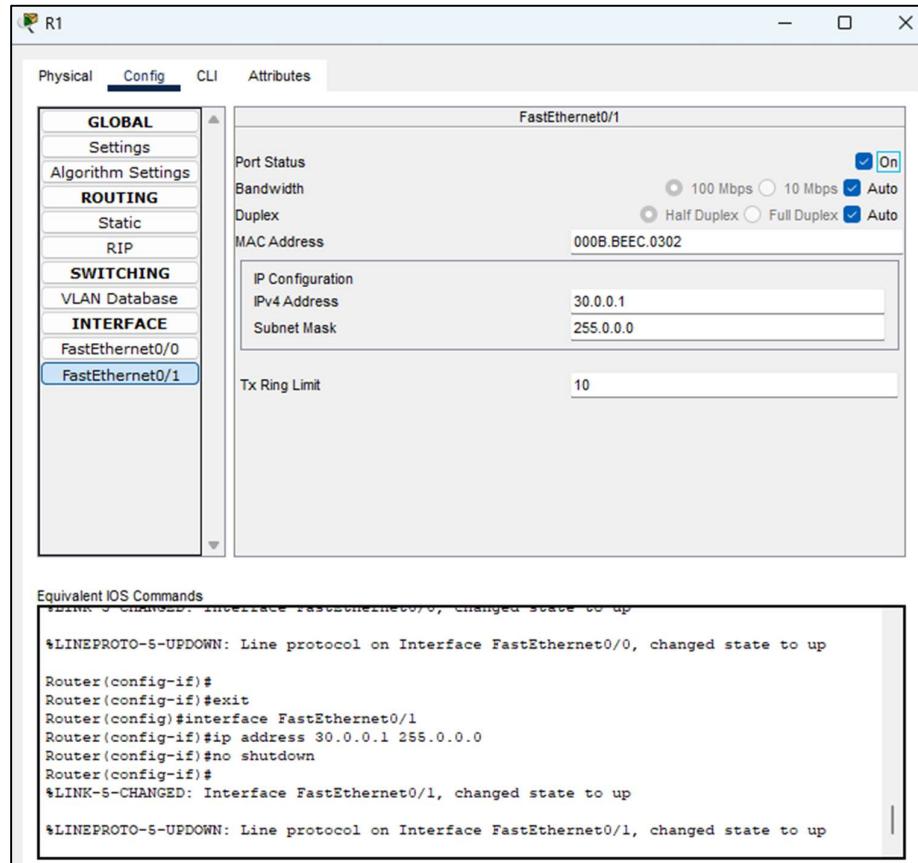
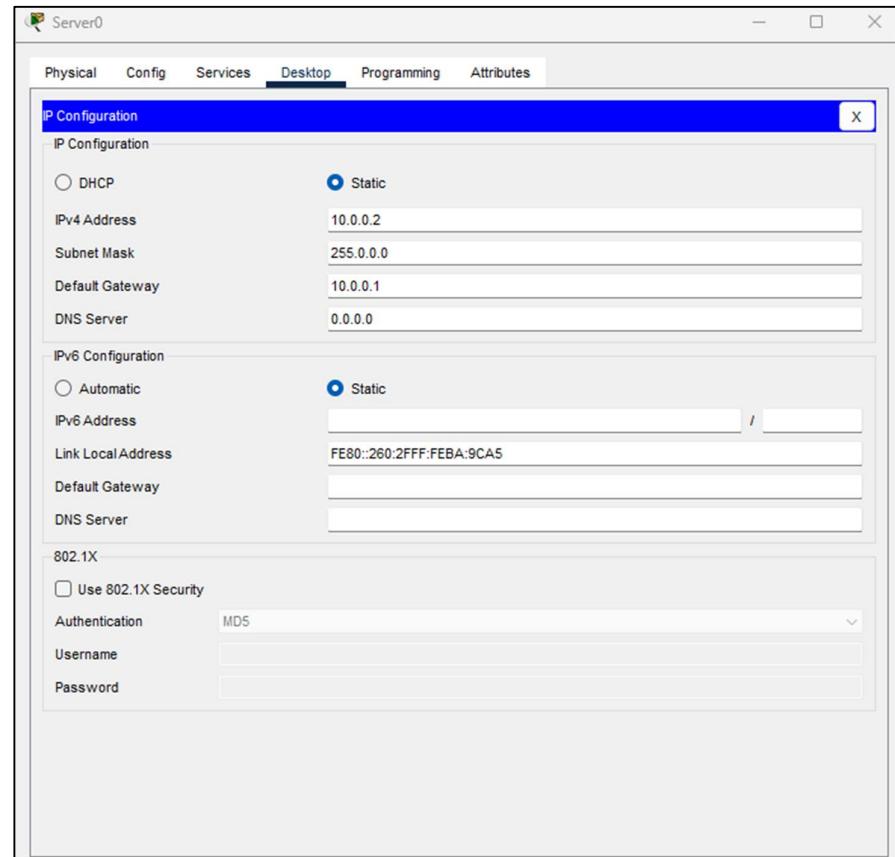
**PC0 Configuration (Top Window):**

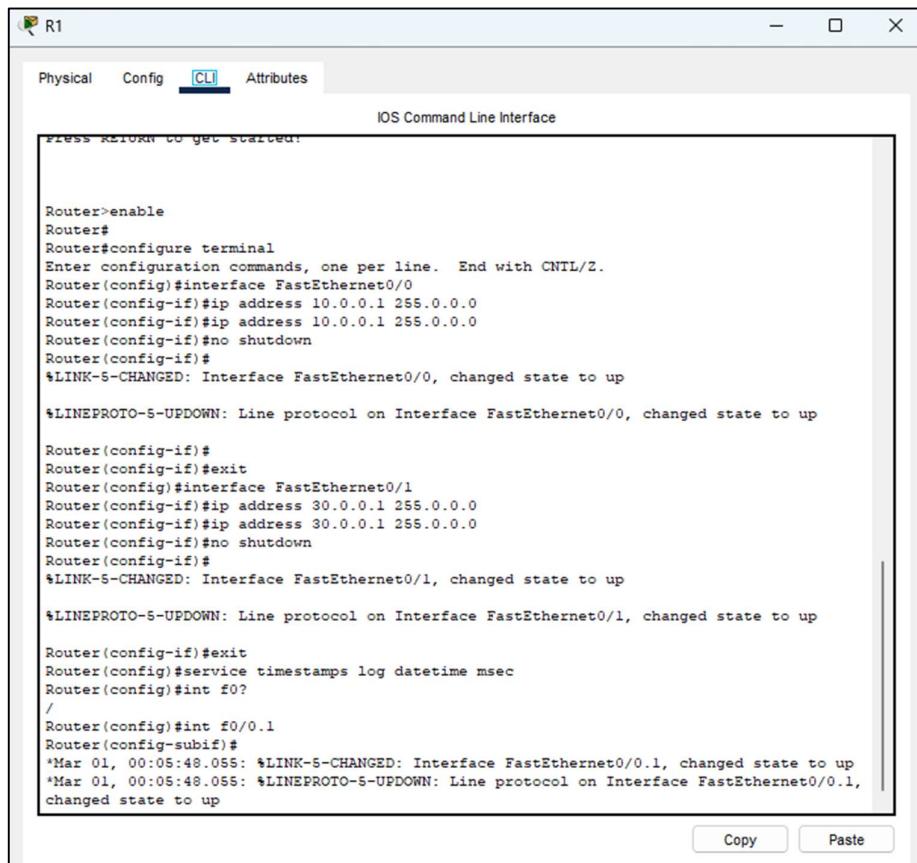
- Physical Tab:** Shows an interface named "FastEthernet0".
- Config Tab:** IP Configuration for "FastEthernet0" is set to Static with the following values:
  - IPv4 Address: 30.0.0.2
  - Subnet Mask: 255.0.0.0
  - Default Gateway: 30.0.0.1
  - DNS Server: 0.0.0.0
 IPv6 Configuration is also present but mostly empty or set to static.
- Programming Tab:** 802.1X settings are shown, including authentication (MD5), username, and password fields.

**R1 Configuration (Bottom Window):**

- Physical Tab:** Shows an interface named "FastEthernet0/0".
- Config Tab:** Configuration for "FastEthernet0/0" includes:
  - Port Status: On (checked)
  - Bandwidth: 100 Mbps (radio button selected)
  - Duplex: Auto (checked)
  - MAC Address: 000B.BECC.0301
  - IP Configuration: IPv4 Address: 10.0.0.1, Subnet Mask: 255.0.0.0
  - Tx Ring Limit: 10
- CLI Tab:** Displays equivalent IOS commands for the configuration:
 

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
```





```

R1
Physical Config CLI Attributes
IOS Command Line Interface
PRESS RETURN TO GET STARTED!

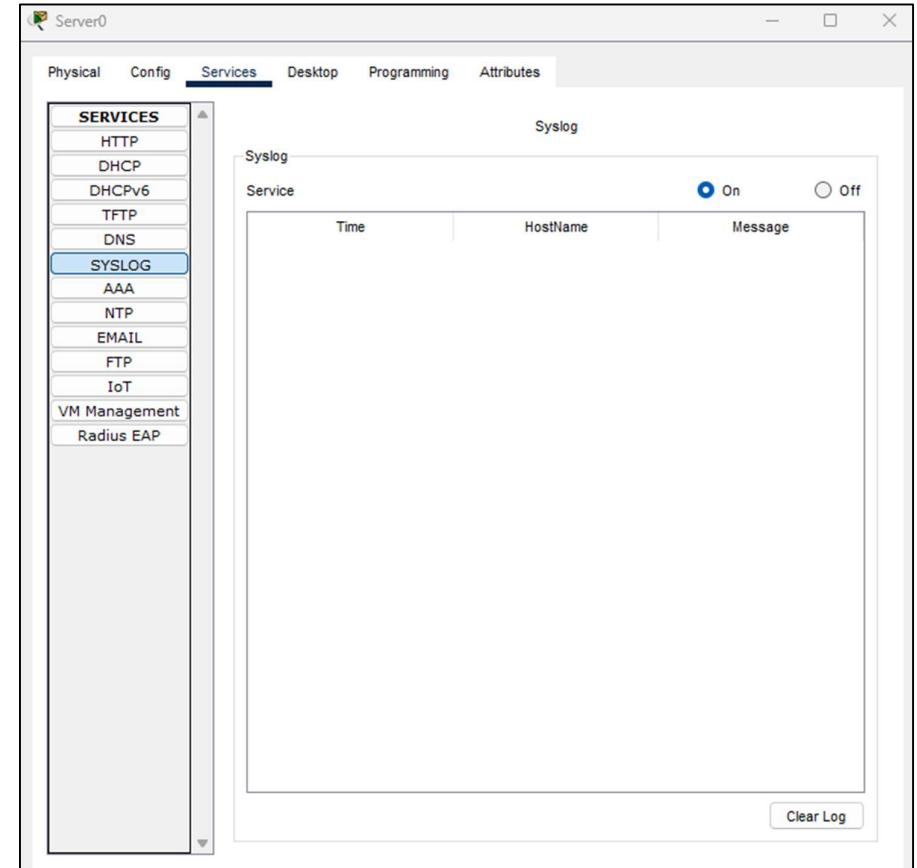
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
*LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/1
Router(config-if)#ip address 30.0.0.1 255.0.0.0
Router(config-if)#ip address 30.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
*LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

Router(config-if)#exit
Router(config)#service timestamps log datetime msec
Router(config)#int f0?
/
Router(config)#int f0/0.1
Router(config-subif)#
*Mar 01, 00:05:48.055: *LINK-5-CHANGED: Interface FastEthernet0/0.1, changed state to up
*Mar 01, 00:05:48.055: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.1, changed state to up

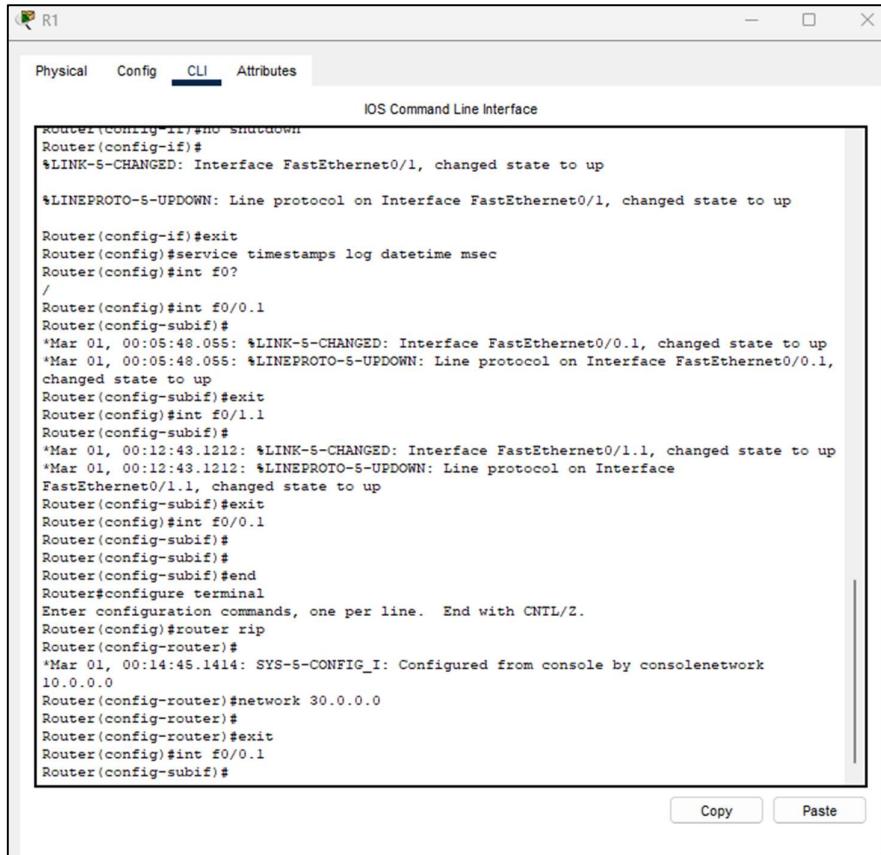
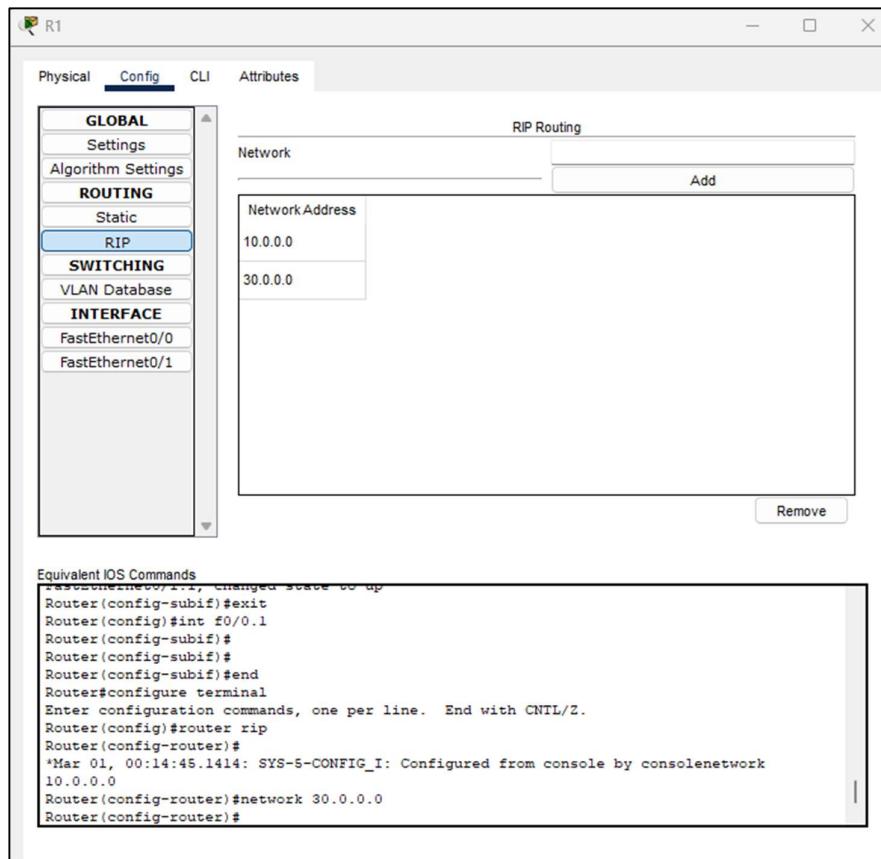
```

Copy Paste

Syslog		
Service	<input checked="" type="radio"/> On	<input type="radio"/> Off

Clear Log



### Flow simulator command:

```

Router(config-router)#network 30.0.0.0
Router(config-router)#
Router(config-router)#exit
Router(config)#int f0/0.1
Router(config-subif)#exit
Router(config)#int f0/0
Router(config-if)#ip flow ingress
Router(config-if)#ip flow egress
Router(config-if)#ip flow-export destination 10.0.0.2 99
Router(config)#ip flow-export source f0/0
Router(config)#end
Router#
*Mar 01, 00:29:03.2929: SYS-5-CONFIG_I: Configured from console by console
Router#show ip cache flow
IP packet size distribution (0 total packets):
  1-32   64   96   128   160   192   224   256   288   320   352   384   416   448   480
  .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000
  512   544   576   1024   1536   2048   2560   3072   3584   4096   4608
  .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000

IP Flow Switching Cache, 278544 bytes
  0 active, 4096 inactive, 0 added
  3 aging polls, 0 flow alloc failures
  Active flows timeout in 30 minutes
  Inactive flows timeout in 15 seconds
IP Sub Flow Cache, 34056 bytes
  0 active, 1024 inactive, 0 added, 0 added to flow
  0 alloc failures, 0 force free
  1 chunk, 1 chunk added
  last clearing of statistics never
Protocol      Total    Flows   Packets Bytes  Packets Active(Sec) Idle(Sec)
-----       Flows     /Sec    /Flow  /Pkt   /Sec    /Flow     /Flow
Total:          0       0.0      0     0.0      0.0      0.0      0.0
SrcIf      SrcIPAddress      DstIf      DstIPAddress      Pr SrcP DstP  Pkts
Router#

```

**Conclusion:** We have successfully implemented,

- Implement SPAN Technologies (Switch Port Analyzer)
- Implement SNMP and Syslog
- Implement Flexible NetFlow

## PRACTICAL-04

- Aim:**
- a) Implement a GRE Tunnel
  - b) Implement VTP
  - c) Implement NAT

**Theory:**

Generic Routing Encapsulation Tunnel

A GRE (Generic Routing Encapsulation) tunnel is a method of sending network data securely over the internet by encapsulating it in a virtual "envelope." This helps create private communication channels between different locations or networks. It's often used for connecting remote offices or ensuring data travels safely over the internet.

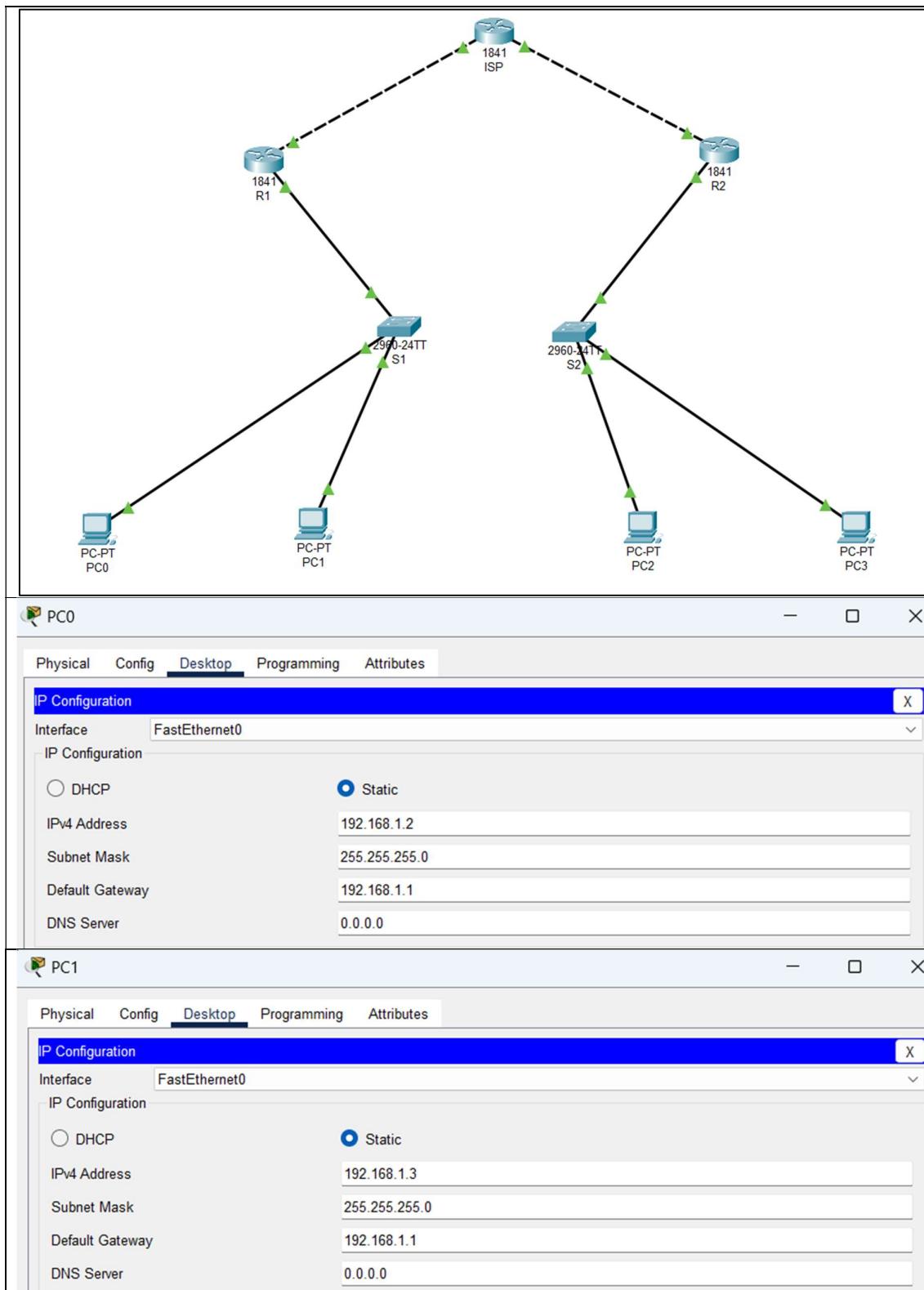
VLAN Trunking Protocol

A VTP is a networking protocol that manages and synchronizes VLAN information in a network. It helps ensure consistency in VLAN configurations across devices, simplifying the process of adding, removing, or modifying VLANs in a network.

Network Address Translation

A NAT is a technique used in computer networking to allow multiple devices in a local network to share a single public IP address. It helps conserve IP addresses and enhances security by masking the internal network structure from the external world.

- a) Implement a GRE Tunnel



**PC2 Configuration:**

- Interface: FastEthernet0
- IP Configuration Type: Static
- IPv4 Address: 192.168.2.2
- Subnet Mask: 255.255.255.0
- Default Gateway: 192.168.2.1
- DNS Server: 0.0.0.0

**PC3 Configuration:**

- Interface: FastEthernet0
- IP Configuration Type: Static
- IPv4 Address: 192.168.2.3
- Subnet Mask: 255.255.255.0
- Default Gateway: 192.168.2.1
- DNS Server: 0.0.0.0

**R1 Configuration:**

- Selected Interface: FastEthernet0/0
- Port Status: On (checked)
- Bandwidth: 100 Mbps (checked)
- Duplex: Auto (checked)
- MAC Address: 0001.C9BB.1801
- IP Configuration:
  - IPv4 Address: 192.168.1.1
  - Subnet Mask: 255.255.255.0
- Tx Ring Limit: 10

**R1**

Physical	Config	CLI	Attributes
<b>GLOBAL</b>			
Settings			
Algorithm Settings			
<b>ROUTING</b>			
Static			
RIP			
<b>SWITCHING</b>			
VLAN Database			
<b>INTERFACE</b>			
FastEthernet0/0			
FastEthernet0/1			

**FastEthernet0/1**

Port Status	On
Bandwidth	<input checked="" type="radio"/> 100 Mbps <input type="radio"/> 10 Mbps <input checked="" type="checkbox"/> Auto
Duplex	<input type="radio"/> Half Duplex <input checked="" type="radio"/> Full Duplex <input checked="" type="checkbox"/> Auto
MAC Address	0001.C9BB.1802
IP Configuration	
IPv4 Address	10.0.0.1
Subnet Mask	255.0.0.0
Tx Ring Limit	10

**ISP**

Physical	Config	CLI	Attributes
<b>GLOBAL</b>			
Settings			
Algorithm Settings			
<b>ROUTING</b>			
Static			
RIP			
<b>SWITCHING</b>			
VLAN Database			
<b>INTERFACE</b>			
FastEthernet0/0			
FastEthernet0/1			

**FastEthernet0/0**

Port Status	On
Bandwidth	<input checked="" type="radio"/> 100 Mbps <input type="radio"/> 10 Mbps <input checked="" type="checkbox"/> Auto
Duplex	<input type="radio"/> Half Duplex <input checked="" type="radio"/> Full Duplex <input checked="" type="checkbox"/> Auto
MAC Address	0003.E42C.7201
IP Configuration	
IPv4 Address	10.0.0.2
Subnet Mask	255.0.0.0
Tx Ring Limit	10

**R2**

Physical	Config	CLI	Attributes
<b>GLOBAL</b>			
Settings			
Algorithm Settings			
<b>ROUTING</b>			
Static			
RIP			
<b>SWITCHING</b>			
VLAN Database			
<b>INTERFACE</b>			
FastEthernet0/0			
FastEthernet0/1			

**FastEthernet0/0**

Port Status	On
Bandwidth	<input checked="" type="radio"/> 100 Mbps <input type="radio"/> 10 Mbps <input checked="" type="checkbox"/> Auto
Duplex	<input type="radio"/> Half Duplex <input checked="" type="radio"/> Full Duplex <input checked="" type="checkbox"/> Auto
MAC Address	00E0.B016.D301
IP Configuration	
IPv4 Address	192.168.2.1
Subnet Mask	255.255.255.0
Tx Ring Limit	10

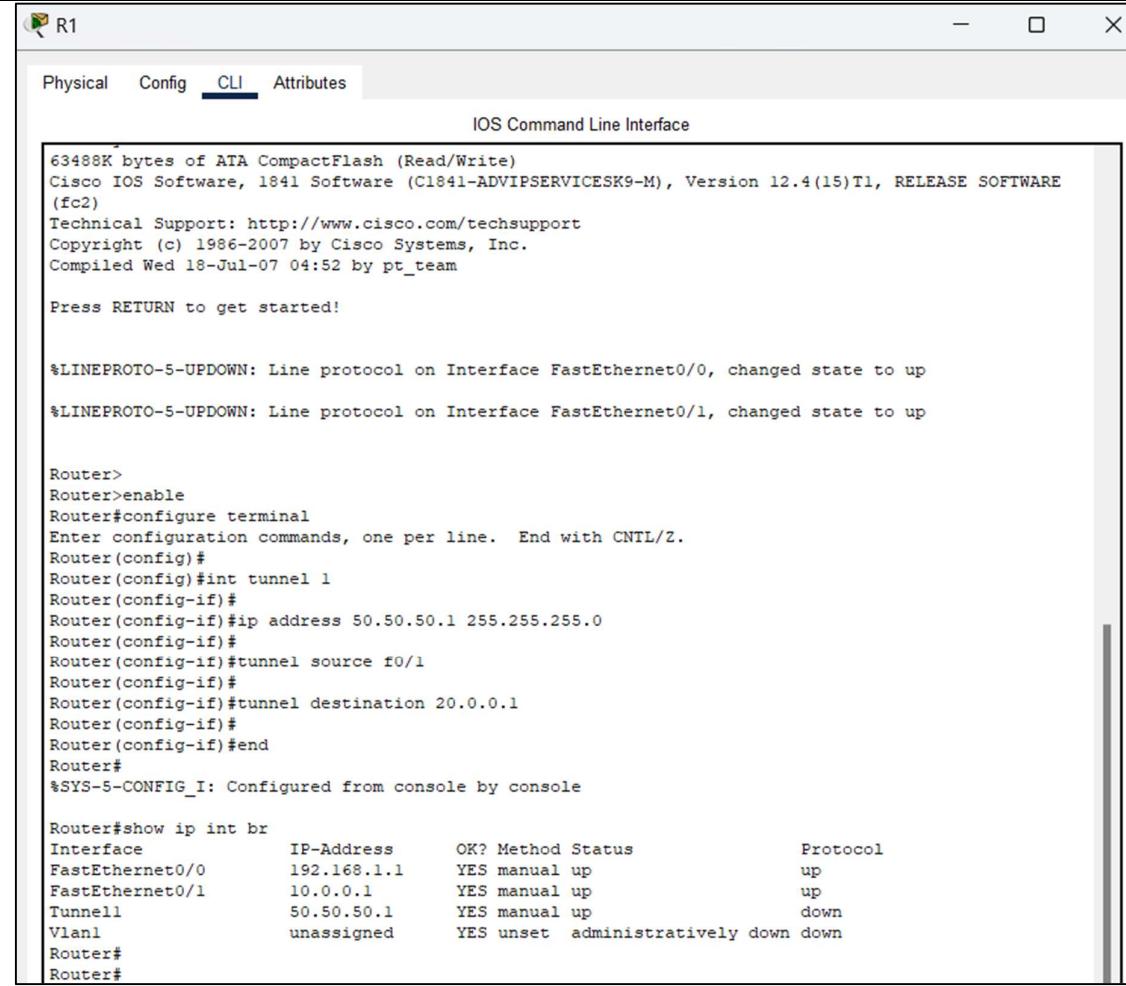
The image displays two separate network configuration windows, one for router R2 and one for router ISP, both showing the configuration for the FastEthernet0/1 interface.

**R2 Configuration:**

- Port Status:** On (checked)
- Bandwidth:** 100 Mbps (checked)
- Duplex:** Full Duplex (checked)
- MAC Address:** 00E0.B016.D302
- IP Configuration:**
  - IPv4 Address:** 20.0.0.1
  - Subnet Mask:** 255.0.0.0
- Tx Ring Limit:** 10

**ISP Configuration:**

- Port Status:** On (checked)
- Bandwidth:** 100 Mbps (checked)
- Duplex:** Full Duplex (checked)
- MAC Address:** 0003.E42C.7202
- IP Configuration:**
  - IPv4 Address:** 20.0.0.2
  - Subnet Mask:** 255.0.0.0
- Tx Ring Limit:** 10



The screenshot shows a terminal window titled 'R1'. The tab bar at the top has four tabs: 'Physical', 'Config', 'CLI' (which is selected), and 'Attributes'. Below the tabs is a header 'IOS Command Line Interface'. The main area displays the following text:

```

63488K bytes of ATA CompactFlash (Read/Write)
Cisco IOS Software, 1841 Software (C1841-ADVIPSERVICESK9-M), Version 12.4(15)T1, RELEASE SOFTWARE
(fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2007 by Cisco Systems, Inc.
Compiled Wed Jul 18 04:52 by pt_team

Press RETURN to get started!

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

Router>
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#int tunnel 1
Router(config-if)#
Router(config-if)#ip address 50.50.50.1 255.255.255.0
Router(config-if)#
Router(config-if)#tunnel source f0/1
Router(config-if)#
Router(config-if)#tunnel destination 20.0.0.1
Router(config-if)#
Router(config-if)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show ip int br
Interface          IP-Address      OK? Method Status        Protocol
FastEthernet0/0    192.168.1.1    YES manual up           up
FastEthernet0/1    10.0.0.1       YES manual up           up
Tunnel1           50.50.50.1    YES manual up           down
Vlan1             unassigned     YES unset administratively down down
Router#
Router#

```

R2

Physical Config **CLI** Attributes

IOS Command Line Interface

```

Router>
Router>
Router>
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#int tunnel 1

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

Router(config-if)#ip address 50.50.50.2 255.255.255.0
Router(config-if)#
Router(config-if)#tunnel source f0/1
Router(config-if)#
Router(config-if)#tunnel destination 10.0.0.1
Router(config-if)#
Router(config-if)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show ip int br
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/0    192.168.2.1   YES manual up        up
FastEthernet0/1    20.0.0.1     YES manual up        up
Tunnell           50.50.50.2   YES manual up        down
Vlan1             unassigned    YES unset administratively down down
Router#
Router#

```

R1

Physical Config **CLI** Attributes

IOS Command Line Interface

```

Router>
Router>
Router>enable
Router#
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#int tunnel 1
Router(config-if)#
Router(config-if)#no shutdown
Router(config-if)#

```

R2

Physical Config **CLI** Attributes

IOS Command Line Interface

```

Router#
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#int tunnel 1
Router(config-if)#
Router(config-if)#no shutdown
Router(config-if)#

```

Set RIP

The image displays three separate windows of a network configuration interface, labeled R1, ISP, and R2, showing the RIP Routing configuration for each router.

**R1 Configuration:**

- Left Sidebar:** GLOBAL, Settings, Algorithm Settings, **ROUTING** (Static, RIP), **SWITCHING**, VLAN Database, INTERFACE, FastEthernet0/0, FastEthernet0/1.
- Right Panel:** RIP Routing tab selected. Network Address table:
  - Row 1: 10.0.0.0
  - Row 2: 192.168.1.0

**ISP Configuration:**

- Left Sidebar:** GLOBAL, Settings, Algorithm Settings, **ROUTING** (Static, RIP selected), **SWITCHING**, VLAN Database, INTERFACE, FastEthernet0/0, FastEthernet0/1.
- Right Panel:** RIP Routing tab selected. Network Address table:
  - Row 1: 10.0.0.0
  - Row 2: 20.0.0.0

**R2 Configuration:**

- Left Sidebar:** GLOBAL, Settings, Algorithm Settings, **ROUTING** (Static, RIP), **SWITCHING**, VLAN Database, INTERFACE, FastEthernet0/0, FastEthernet0/1.
- Right Panel:** RIP Routing tab selected. Network Address table:
  - Row 1: 20.0.0.0
  - Row 2: 192.168.2.0

PC0

Physical Config Desktop Programming Attributes

Command Prompt

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

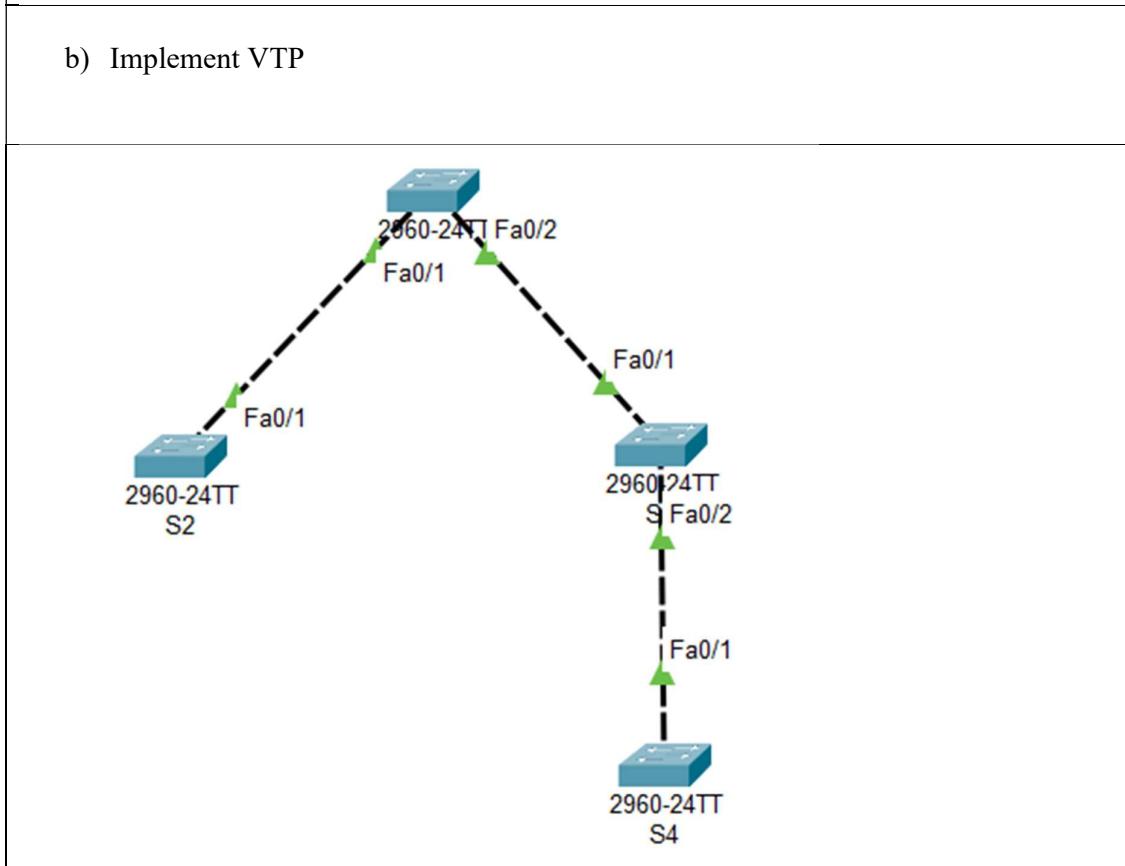
Pinging 192.168.2.3 with 32 bytes of data:

Request timed out.
Reply from 192.168.2.3: bytes=32 time<1ms TTL=125
Reply from 192.168.2.3: bytes=32 time<1ms TTL=125
Reply from 192.168.2.3: bytes=32 time<1ms TTL=125

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 = 1ms, Average = 0ms
```

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
<span style="color:red;">●</span>	Failed	PC0	PC2	ICMP	<span style="background-color:#ccc;"></span>	0.000	N	0	(edit)	<span style="color:red;">(delete)</span>
<span style="color:green;">●</span>	Successful	PC0	PC2	ICMP	<span style="background-color:#f00;"></span>	0.000	N	1	(edit)	<span style="color:green;">(delete)</span>

b) Implement VTP



S1

Physical Config **CLI** Attributes

IOS Command Line Interface

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

Switch>
Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#
Switch(config)#int f0/1
Switch(config-if)#switchport mode trunk

Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

Switch(config-if)#exit
Switch(config)#
Switch(config)#int f0/2
Switch(config-if)#switchport mode trunk

Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

Switch(config-if)#exit
Switch(config)#exit
Switch#
```

**Copy** **Paste**

S1

Physical Config **CLI** Attributes

IOS Command Line Interface

```
Switch#show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name :
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0002.4A77.9200
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local updater ID is 0.0.0.0 (no valid interface found)

Feature VLAN :
-----
VTP Operating Mode : Server
Maximum VLANs supported locally : 255
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0x7D 0x5A 0xA6 0x0E 0x9A 0x72 0xA0 0x3A
              0xF0 0x58 0x10 0x6C 0x9C 0x0F 0xA0 0xF7
Switch#
Switch#
```

```
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int f0/1
Switch(config-if)#vtp mode server
Device mode already VTP SERVER.
Switch(config)#
Switch(config)#vtp domain VTPServer
Changing VTP domain name from NULL to VTPServer
Switch(config)#end
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show vtp status
VTP Version capable      : 1 to 2|
VTP version running     : 1
VTP Domain Name          : VTPServer
VTP Pruning Mode         : Disabled
VTP Traps Generation    : Disabled
Device ID                : 0002.4A77.9200
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local updater ID is 0.0.0.0 (no valid interface found)

Feature VLAN :
-----
VTP Operating Mode       : Server
Maximum VLANs supported locally : 255
Number of existing VLANs   : 5
Configuration Revision    : 0
MDS digest               : 0xB8 0x02 0x0F 0x8B 0xD8 0xFA 0x0B 0x13
                           : 0xD1 0x7E 0x67 0x30 0xA2 0xC6 0x78 0x9F
Switch#
```

S1

Physical Config **CLI** Attributes

---

```

Switch#show vtp status
VTP Version capable      : 1 to 2
VTP version running      : 1
VTP Domain Name          : VTPServer
VTP Pruning Mode         : Disabled
VTP Traps Generation     : Disabled
Device ID                : 0002.4A77.9200
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local updater ID is 0.0.0.0 (no valid interface found)

Feature VLAN :
-----
VTP Operating Mode       : Server
Maximum VLANs supported locally : 255
Number of existing VLANs   : 5
Configuration Revision    : 0
MD5 digest               : 0xB8 0x02 0x0F 0x8B 0xD8 0xFA 0x0B 0x13
                           0xD1 0x7E 0x67 0x30 0xA2 0xC6 0x78 0x9F

Switch#
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int f0/1
Switch(config-if)#vlan 10
Switch(config-vlan)#Name University
Switch(config-vlan)#end
Switch#
SYS-5-CONFIG_I: Configured from console by console

Switch#show vtp status
VTP Version capable      : 1 to 2
VTP version running      : 1
VTP Domain Name          : VTPServer
VTP Pruning Mode         : Disabled
VTP Traps Generation     : Disabled
Device ID                : 0002.4A77.9200
Configuration last modified by 0.0.0.0 at 3-1-93 00:35:28
Local updater ID is 0.0.0.0 (no valid interface found)

Feature VLAN :
-----
VTP Operating Mode       : Server
Maximum VLANs supported locally : 255
Number of existing VLANs   : 6
Configuration Revision    : 2
MD5 digest               : 0xC2 0xF9 0x29 0x39 0xBE 0x84 0x8D 0x0B
                           0x95 0x3F 0x0E 0x67 0x33 0x62 0x85 0x6F

```

Switch#show vlan								
VLAN	Name	Status	Ports					
1	default	active	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	University	active						
1002	fdmi-default	active						
1003	token-ring-default	active						
1004	fdmnet-default	active						
1005	trnet-default	active						
VLAN	Type	SAID	MTU	Parent	RingNo	BridgeNo	Stp	BrdgMode Transl Trans2
1	enet	100001	1500	-	-	-	-	0 0
10	enet	100010	1500	-	-	-	-	0 0
1002	fdmi	101002	1500	-	-	-	-	0 0
1003	tr	101003	1500	-	-	-	-	0 0
1004	fdmnet	101004	1500	-	-	ieee	-	0 0
1005	trnet	101005	1500	-	-	ibm	-	0 0
VLAN	Type	SAID	MTU	Parent	RingNo	BridgeNo	Stp	BrdgMode Transl Trans2
Remote SPAN VLANs								
Primary	Secondary	Type	Ports					

S2

Physical Config **CLI** Attributes

---

```

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int f0/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#end
Switch#
SYS-5-CONFIG_I: Configured from console by console

Switch#show vtp status
VTP Version capable      : 1 to 2
VTP version running      : 1
VTP Domain Name          : VTPServer
VTP Pruning Mode         : Disabled
VTP Traps Generation     : Disabled
Device ID                : 0060.5C08.2B00
Configuration last modified by 0.0.0.0 at 3-1-93 00:35:28
Local updater ID is 0.0.0.0 (no valid interface found)

Feature VLAN :
-----
VTP Operating Mode       : Server
Maximum VLANs supported locally : 255
Number of existing VLANs   : 6
Configuration Revision    : 2
MD5 digest               : 0xC2 0xF9 0x29 0x39 0xBE 0x84 0x8D 0x0B
                           0x95 0x3F 0x0E 0x67 0x33 0x62 0x85 0x6F

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#vtp mode client
Setting device to VTP CLIENT mode.
Switch(config)#end
Switch#
SYS-5-CONFIG_I: Configured from console by console

Switch#show vtp status
VTP Version capable      : 1 to 2
VTP version running      : 1
VTP Domain Name          : VTPServer
VTP Pruning Mode         : Disabled
VTP Traps Generation     : Disabled
Device ID                : 0060.5C08.2B00
Configuration last modified by 0.0.0.0 at 3-1-93 00:35:28

Feature VLAN :
-----
VTP Operating Mode       : Client
Maximum VLANs supported locally : 255
Number of existing VLANs   : 6
Configuration Revision    : 2
MD5 digest               : 0xC2 0xF9 0x29 0x39 0xBE 0x84 0x8D 0x0B
                           0x95 0x3F 0x0E 0x67 0x33 0x62 0x85 0x6F

```

---

```

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int f0/1
Switch(config-if)#vtp domain VTPClient
Changing VTP domain name from VTPServer to VTPClient
Switch(config)#end
Switch#
%SYS-5-CONFIG_I: Configured from console by console

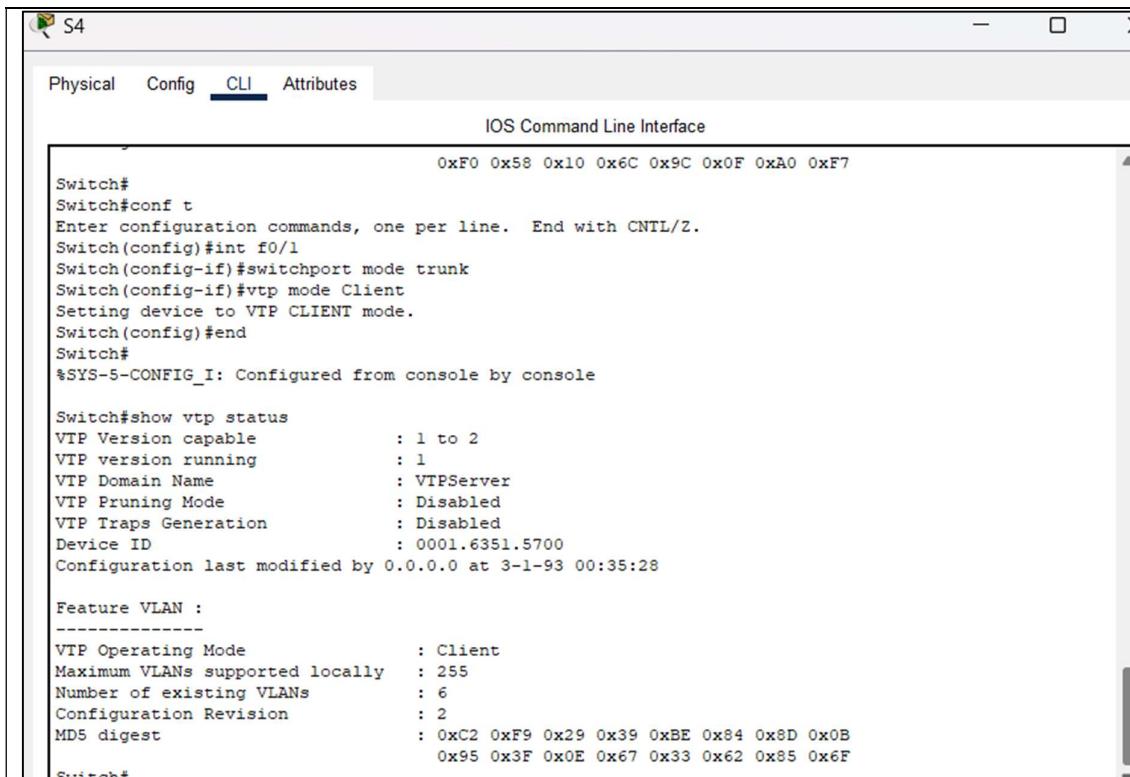
Switch#show vtp status
VTP Version capable      : 1 to 2
VTP version running      : 1
VTP Domain Name          : VTPClient
VTP Pruning Mode         : Disabled
VTP Traps Generation     : Disabled
Device ID                : 0060.5C08.2B00
Configuration last modified by 0.0.0.0 at 3-1-93 00:35:28

Feature VLAN :
-----
VTP Operating Mode       : Client
Maximum VLANs supported locally : 255
Number of existing VLANs   : 6
Configuration Revision    : 0
MD5 digest               : 0x3B OxBE Ox1E Ox08 Ox69 OxD0 Ox7D Ox46
                           OxOD Ox87 OxFD OxAE Ox66 OxCF Ox5B Ox20

```

S3

Physical	Config	CLI	Attributes
IOS Command Line Interface			
<pre>%SPANTREE-2-RECV_PVID_ERR: Received 802.1Q BPDU on non trunk FastEthernet0/1 VLAN1.  %SPANTREE-2-BLOCK_PVID_LOCAL: Blocking FastEthernet0/1 on VLAN0001. Inconsistent port type.  %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up  Switch&gt; Switch&gt;en Switch#conf t Enter configuration commands, one per line. End with CNTL/Z. Switch(config)#int f0/1 Switch(config-if)#switchport mode trunk Switch(config-if)# Switch(config-if)#vtp mode transparent Setting device to VTP TRANSPARENT mode. Switch(config)#end Switch# %SYS-5-CONFIG_I: Configured from console by console  Switch#show vtp status VTP Version capable      : 1 to 2 VTP version running      : 1 VTP Domain Name          : VTPClient VTP Pruning Mode         : Disabled VTP Traps Generation     : Disabled Device ID                : 0060.5C08.2B00 Configuration last modified by 0.0.0.0 at 3-1-93 00:35:28  Feature VLAN : ----- VTP Operating Mode       : Transparent Maximum VLANs supported locally : 255 Number of existing VLANs   : 6 Configuration Revision    : 0 MD5 digest               : 0xA4 Ox0C Ox3A OxD4 Ox1B OxBA OxB5 OxFB                            OxFF Ox2F Ox51 OxBA OxC6 Ox7F OxB5 OxC3  Switch# Switch#</pre>			



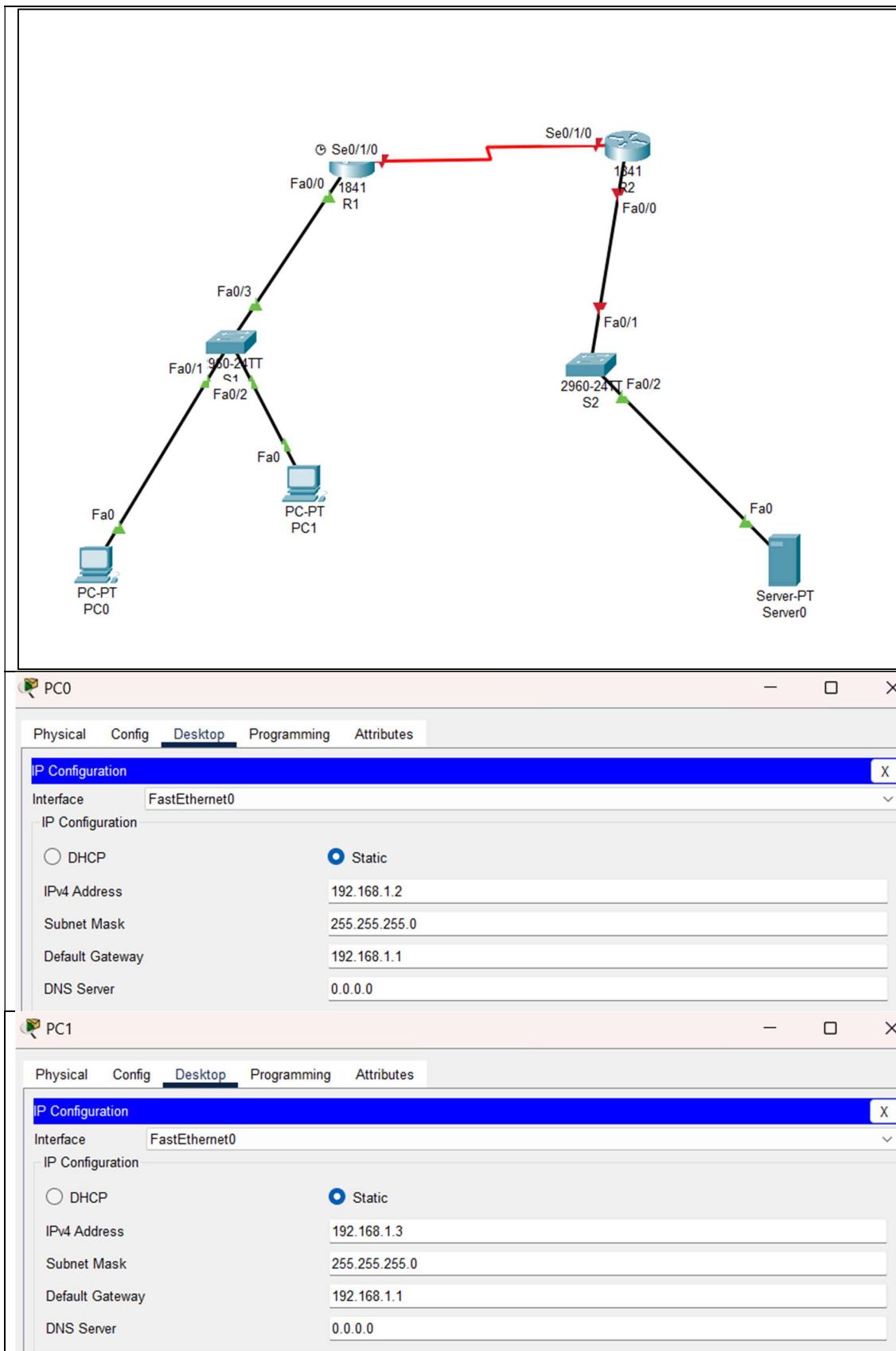
The screenshot shows a Cisco IOS Command Line Interface window titled "S4". The tab "CLI" is selected. The output displays the following configuration and status information:

```
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int f0/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#vtp mode Client
Setting device to VTP CLIENT mode.
Switch(config)#end
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show vtp status
VTP Version capable      : 1 to 2
VTP version running     : 1
VTP Domain Name          : VTPServer
VTP Pruning Mode         : Disabled
VTP Traps Generation    : Disabled
Device ID                : 0001.6351.5700
Configuration last modified by 0.0.0.0 at 3-1-93 00:35:28

Feature VLAN :
-----
VTP Operating Mode       : Client
Maximum VLANs supported locally : 255
Number of existing VLANs   : 6
Configuration Revision    : 2
MD5 digest               : 0xC2 0xF9 0x29 0x39 0xBE 0x84 0x8D 0x0B
                           0x95 0x3F 0x0E 0x67 0x33 0x62 0x85 0x6F
Switch#
```

c) Implement NAT



**R1**

Physical Config CLI Attributes

**GLOBAL**

- Settings
- Algorithm Settings

**ROUTING**

- Static
- RIP

**SWITCHING**

- VLAN Database

**INTERFACE**

- FastEthernet0/0
- FastEthernet0/1
- Serial0/1/0
- Serial0/1/1

**FastEthernet0/0**

Port Status	On
Bandwidth	<input checked="" type="radio"/> 100 Mbps <input type="radio"/> 10 Mbps <input checked="" type="checkbox"/> Auto
Duplex	<input type="radio"/> Half Duplex <input checked="" type="radio"/> Full Duplex <input checked="" type="checkbox"/> Auto
MAC Address	00D0.974D.4301
IP Configuration	
IPv4 Address	192.168.1.1
Subnet Mask	255.255.255.0
Tx Ring Limit	10

**R1**

Physical Config CLI Attributes

**GLOBAL**

- Settings
- Algorithm Settings

**ROUTING**

- Static
- RIP

**SWITCHING**

- VLAN Database

**INTERFACE**

- FastEthernet0/0
- FastEthernet0/1
- Serial0/1/0
- Serial0/1/1

**Serial0/1/0**

Port Status	<input checked="" type="radio"/> On
Duplex	<input checked="" type="radio"/> Full Duplex
Clock Rate	2000000
IP Configuration	
IPv4 Address	10.0.0.1
Subnet Mask	255.0.0.0
Tx Ring Limit	10

**R2**

Physical Config CLI Attributes

**GLOBAL**

- Settings
- Algorithm Settings

**ROUTING**

- Static
- RIP

**SWITCHING**

- VLAN Database

**INTERFACE**

- FastEthernet0/0
- FastEthernet0/1
- Serial0/1/0
- Serial0/1/1

**FastEthernet0/0**

Port Status	On
Bandwidth	<input checked="" type="radio"/> 100 Mbps <input type="radio"/> 10 Mbps <input checked="" type="checkbox"/> Auto
Duplex	<input type="radio"/> Half Duplex <input checked="" type="radio"/> Full Duplex <input checked="" type="checkbox"/> Auto
MAC Address	00E0.A335.8A01
IP Configuration	
IPv4 Address	172.16.1.1
Subnet Mask	255.255.0.0
Tx Ring Limit	10

**R2 Configuration (Config tab):**

- GLOBAL:** Settings, Algorithm Settings
- ROUTING:** Static, RIP
- SWITCHING:** VLAN Database
- INTERFACE:** FastEthernet0/0, FastEthernet0/1, **Serial0/1/0** (selected), Serial0/1/1

**Serial0/1/0 Port Configuration:**

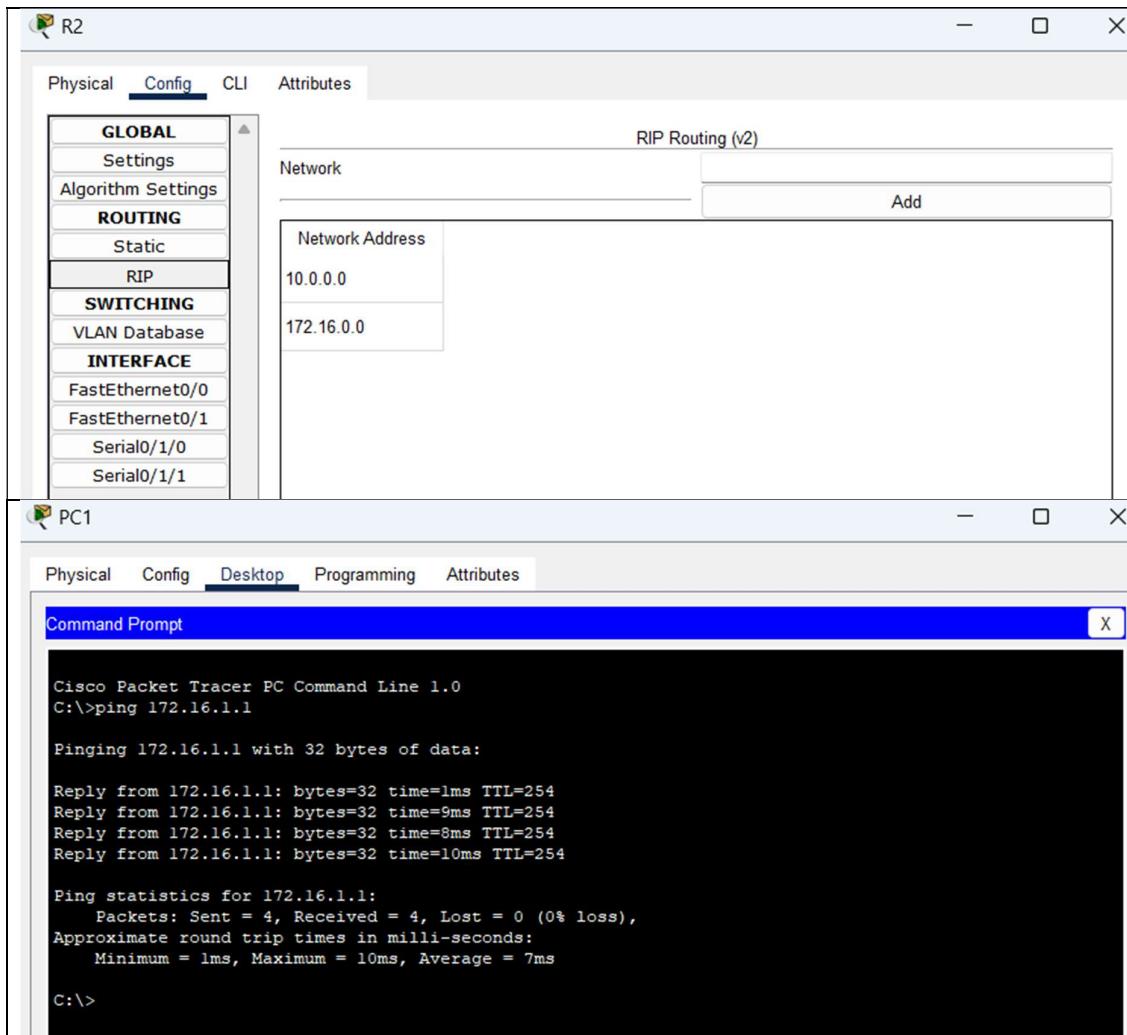
- Port Status: On (checked)
- Duplex: Full Duplex
- Clock Rate: 1200
- IP Configuration: IPv4 Address 10.0.0.2, Subnet Mask 255.0.0.0
- Tx Ring Limit: 10

**Server0 Configuration (Desktop tab):**

- IP Configuration:**
  - IP Configuration: Static selected
  - IPv4 Address: 172.16.1.2
  - Subnet Mask: 255.255.0.0
  - Default Gateway: 172.16.1.1
  - DNS Server: 0.0.0.0

**RIP Configuration (R1 Router):**

- ROUTING:** Static, RIP
- RIP Routing (v2):**
  - Network: 10.0.0.0 (Network Address: 10.0.0.0, 192.168.1.0)
  - Add button



R1

Physical Config **CLI** Attributes

---

```

Router(config-router)#exit
Router(config)#int f0/0
Router(config-if)#ip nat inside
Router(config-if)#exit
Router(config)#int s0/1/0
Router(config-if)#ip nat outside
Router(config-if)#exit
Router(config)#ip nat inside source static 192.168.1.2 10.0.0.1
Router(config)#ip nat inside source static 192.168.1.3 10.0.0.1
Router(config)#
Router(config)#ip nat outside source static 10.0.0.1 10.0.0.2
Router(config)#
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show nat tr
      ^
% Invalid input detected at '^' marker.

Router#show ip nat tr
Pro Inside global      Inside local      Outside local      Outside global
--- 10.0.0.1           192.168.1.3     ---             ---
--- ---                  ---              10.0.0.2          10.0.0.1

Router#show ip nat ?
  statistics      Translation statistics
  translations   Translation entries
Router#show ip nat statistics
Total translations: 2 (2 static, 0 dynamic, 0 extended)
Outside Interfaces: Serial0/1/0
Inside Interfaces: FastEthernet0/0
Hits: 0 Misses: 37
Expired translations: 0
Dynamic mappings:
Router#

```

PC0

Physical Config **Desktop** Programming Attributes

Command Prompt

```

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 172.16.1.2

Pinging 172.16.1.2 with 32 bytes of data:

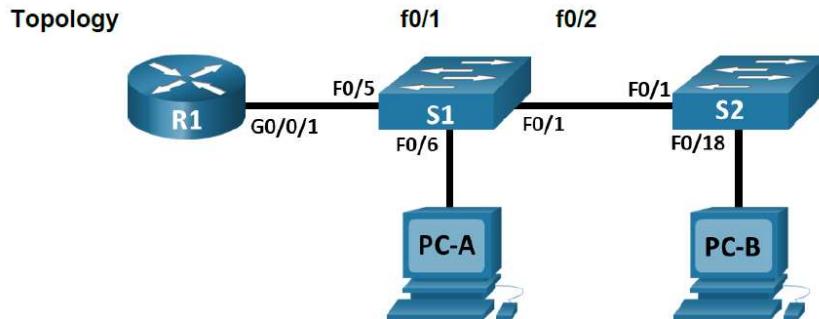
Reply from 172.16.1.2: bytes=32 time=20ms TTL=126
Reply from 172.16.1.2: bytes=32 time=2ms TTL=126
Reply from 172.16.1.2: bytes=32 time=1ms TTL=126
Reply from 172.16.1.2: bytes=32 time=1ms TTL=126

Ping statistics for 172.16.1.2:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
  Minimum = 1ms, Maximum = 20ms, Average = 6ms

C:\>

```

## PRACTICAL-05



**Addressing Table**

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0/1.10	192.168.10.1	255.255.255.0	N/A
	G0/0/1.20	192.168.20.1	255.255.255.0	
	G0/0/1.30	192.168.30.1	255.255.255.0	
	G0/0/1.1000	N/A	N/A	
S1	VLAN 10	192.168.10.11	255.255.255.0	192.168.10.1
S2	VLAN 10	192.168.10.12	255.255.255.0	192.168.10.1
PC-A	NIC	192.168.20.3	255.255.255.0	192.168.20.1
PC-B	NIC	192.168.30.3	255.255.255.0	192.168.30.1

**VLAN Table**

VLAN	Name	Interface Assigned
10	Management	S1: VLAN 10 S2: VLAN 10
20	Sales	S1: F0/3
30	Operations	S2: F0/2
999	Parking_Lot	S1: F0/4-24, G0/1-2 S2: F0/3-24, G0/1-2
1000	Native	N/A

### Aim:

Implement Inter-VLAN Routing

### Theory:

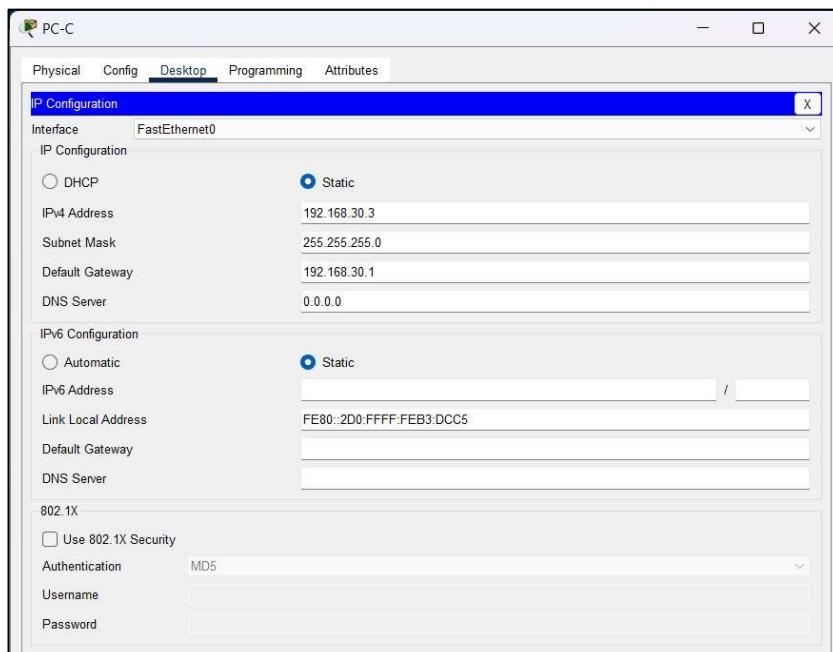
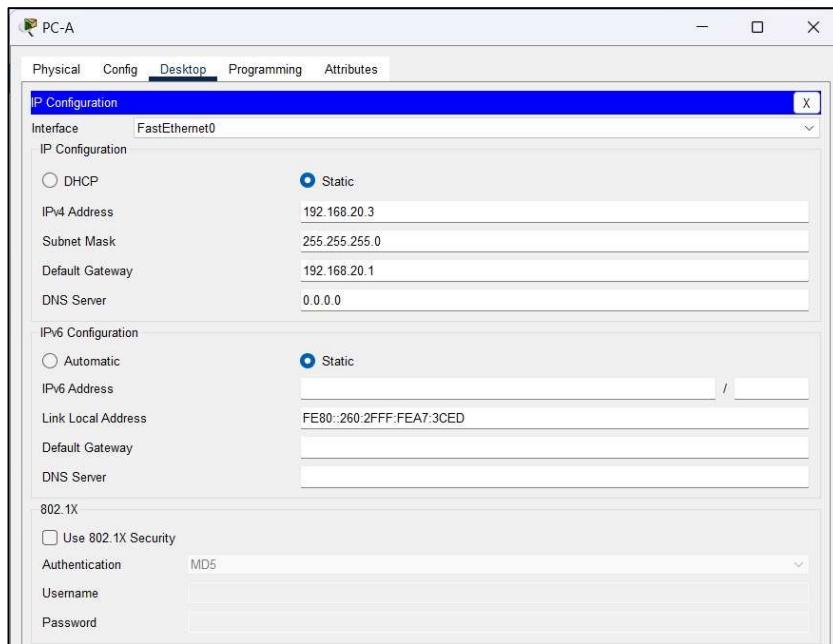
Modern switches use virtual local-area networks (VLANs) to improve network performance by separating large Layer 2 broadcast domains into smaller ones. VLANs can also be used as a security measure by separating sensitive data traffic from the rest of the network. In general, VLANs make it easier to design a network to support the goals of an organization. Communication between VLANs requires a device operating at Layer 3 of the OSI model. Adding an inter-VLAN router allows the organization to segregate and separate broadcast domains while simultaneously allowing them to communicate with each other.

VLAN trunks are used to span VLANs across multiple devices. Trunks allow the traffic from multiple VLANs to travel over a single link, while keeping the VLAN identification and segmentation intact. A particular kind of inter-VLAN routing, called “Router-on-a-Stick”, uses a trunk from the router to the switch to enable all VLANs to pass to the router.

### **Procedure:**

**Step 1:** Cable the network as shown in the topology.

**Step 2:** Configure PC hosts as follows:



### Step 3: Create VLANs on both switches

```

S1>en
S1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S1(config)#hostname S1
S1(config)#vlan 10
S1(config-vlan)#name Management
S1(config-vlan)#exit
S1(config)#vlan 20
S1(config-vlan)#name Sales
S1(config-vlan)#exit
S1(config)#vlan 30
S1(config-vlan)#name Operations
S1(config-vlan)#exit
S1(config)#vlan 999
S1(config-vlan)#name Parking_Lot
S1(config-vlan)#exit
S1(config)#vlan 1000
S1(config-vlan)#name Native
S1(config-vlan)#exit
S1(config)#end
S1#
%SYS-5-CONFIG_I: Configured from console by console

S1#show vlan br

VLAN Name          Status    Ports
----- -----
1    default        active    Fa0/1
10   Management    active    Fa0/3
20   Sales          active    Fa0/3
30   Operations    active    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
999  Parking_Lot  active
1000 Native       active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active

```

Top

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```

S1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S1(config)#int vlan 10
S1(config-if)#
%LINK-5-CHANGED: Interface Vlan10, changed state to up

S1(config-if)#ip address 192.168.10.11 255.255.255.0
S1(config-if)#exit
S1(config)#ip default-gateway 192.168.10.1
S1(config)#int vla 10
S1(config-if)#no shutdown
S1(config-if)#exit
S1(config)#end
S1#
%SYS-5-CONFIG_I: Configured from console by console

S1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S1(config)#int range f0/4-24, g0/1-2
S1(config-if-range)#switchport mode access
S1(config-if-range)#switchport access vlan 999
S1(config-if-range)#shutdown

%LINK-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/5, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/7, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/8, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/9, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/10, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/11, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/12, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/13, changed state to administratively down

```

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S1

Physical Config **CLI** Attributes

IOS Command Line Interface

```
%LINK-5-CHANGED: Interface FastEthernet0/8, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/9, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/10, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/11, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/12, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/13, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/14, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/15, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/16, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/17, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/18, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/19, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/20, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/21, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/22, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/23, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/24, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to administratively down
S1(config-if-range)exit
S1(config)#end
S1#
*SYS-5-CONFIG_I: Configured from console by console
```

Top

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S2

Physical Config **CLI** Attributes

IOS Command Line Interface

```
S2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S2(config)#hostname S2
S2(config)#vlan 10
S2(config-vlan)#name Management
S2(config-vlan)#exit
S2(config)#vlan 20
S2(config-vlan)#name Sales
S2(config-vlan)#exit
S2(config)#vlan 30
S2(config-vlan)#name Operations
S2(config-vlan)#exit
S2(config)#vlan 999
S2(config-vlan)#name Parking_Lot
S2(config-vlan)#exit
S2(config)#vlan 1000
S2(config-vlan)#name Native
S2(config-vlan)#exit
S2(config)#end
S2#
*SYS-5-CONFIG_I: Configured from console by console

S2#show vlan br

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   Management    active
20   Sales         active
30   Operations    active
999  Parking_Lot  active
1000 Native       active
1002 fddi-default active
1003 token-ring-default active
1004 fddnet-default active
1005 trnet-default active
```

Top

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```

S2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S2(config)#int vlan 10
S2(config-if)#
%LINK-5-CHANGED: Interface Vlan10, changed state to up

S2(config-if)#ip address 192.168.10.12 255.255.255.0
S2(config-if)#exit
S2(config)#ip default-gateway 192.168.10.1
S2(config)#int vlan 10
S2(config-if)#no shutdown
S2(config-if)#exit
S2(config)#int range f0/3-24, g0/1-2
S2(config-if-range)#switchport mode access
S2(config-if-range)#switchport access vlan 999
S2(config-if-range)#shutdown

%LINK-5-CHANGED: Interface FastEthernet0/3, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/5, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/7, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/8, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/9, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/10, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/11, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/12, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/13, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/14, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/15, changed state to administratively down

```

```

%LINK-5-CHANGED: Interface FastEthernet0/18, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/19, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/20, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/21, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/22, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/23, changed state to administratively down
%LINK-5-CHANGED: Interface FastEthernet0/24, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to administratively down
S2(config-if-range)#end
S2#
%SYS-5-CONFIG_I: Configured from console by console

S2#show vlan br

VLAN Name          Status    Ports
----- -----
1    default        active    Fa0/1, Fa0/2
10   Management     active
20   Sales          active
30   Operations     active
999  Parking_Lot   active    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, Gi0/1, Gi0/2
1000 Native       active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active

```

#### Step 4: Assign VLAN to the correct switch interfaces

```

S1>en
S1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S1(config)#int f0/3
S1(config-if)#switchport mode access
S1(config-if)#switchport access vlan 20
S1(config-if)#exit
S1(config)#end
S1#
%SYS-5-CONFIG_I: Configured from console by console

S1#show vlan br

VLAN Name          Status    Ports
---- -----
1   default         active    Fa0/1, Fa0/2
10  Management      active    Fa0/3
20  Sales           active    Fa0/4
30  Operations      active    Fa0/5, Fa0/6, Fa0/7
999 Parking_Lot    active    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
1000 Native        active
1002 fddi-default  active
1003 token-ring-default  active
1004 fddinet-default active
1005 trnet-default  active
S1#

```

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Top

S2

Physical    Config    **CLI**    Attributes

IOS Command Line Interface

```

30  Operations      active    Fa0/3, Fa0/4, Fa0/5, Fa0/6
999 Parking_Lot    active    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
1000 Native        active
1002 fddi-default  active
1003 token-ring-default  active
1004 fddinet-default active
1005 trnet-default  active
S2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S2(config)#int f0/2
S2(config-if)#switchport mode access
S2(config-if)#switchport access vlan 30
S2(config-if)#exit
S2(config)#end
S2#
%SYS-5-CONFIG_I: Configured from console by console

S2#show vlan br

VLAN Name          Status    Ports
---- -----
1   default         active    Fa0/1
10  Management      active
20  Sales           active    Fa0/2
30  Operations      active    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
1000 Native        active
1002 fddi-default  active
1003 token-ring-default  active
1004 fddinet-default active
1005 trnet-default  active
S2#

```

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Windows Taskbar: Search, File Explorer, Task View, Taskbar Icons, Google Chrome, WhatsApp, File Explorer, Taskbar Icons.

S2

Physical    Config    **CLI**    Attributes

IOS Command Line Interface

```

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan10, changed state to up
%SPAN TREE-2-RECV_PVID_ERR: Received BPDU with inconsistent peer vlan id 1000 on FastEthernet0/1
VLAN1.
%SPAN TREE-2-BLOCK_PVID_LOCAL: Blocking FastEthernet0/1 on VLAN0001. Inconsistent local vlan.

```

### Step 5: Manually configure trunk interface F0/1 on switch S1 and S2.

```

S1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S1(config)#int f0/2
S1(config-if)#switchport mode access
S1(config-if)#switchport mode trunk

S1(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan10, changed state to up

S1(config-if)#switchport trunk native vlan 1000
S1(config-if)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on FastEthernet0/2 (1000), with S2
FastEthernet0/1 (1).

S1(config-if)#switchport trunk allowed vlan 1000
S1(config-if)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on FastEthernet0/2 (1000), with S2
FastEthernet0/1 (1).

S1(config-if)#switchport trunk allowed vlan 10,20,30,1000
S1(config-if)#
 Top

```

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```

S2(config-if)#switchport trunk native vlan 1000
S2(config-if)#switchport trunk allowed vlan 10,20,30,1000
S2(config-if)#exit
S2(config)#
S2#
%SYS-5-CONFIG_I: Configured from console by console

S2#show vlan br

VLAN Name          Status    Ports
---- -----
1    default        active
10   Management    active
20   Sales          active
30   Operations    active    Fa0/2
999  Parking_Lot  active    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

1000 Native       active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active
S2#

```

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### Step 6: Configure the Router.

```

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int f0/0.10
Router(config-subif)#description vlan 10
Router(config-subif)#encapsulation dot1q 10
Router(config-subif)#ip address 192.168.10.1 255.255.255.0
Router(config-subif)#exit
Router(config)#int f0/0.20
Router(config-subif)#description vlan 20
Router(config-subif)#encapsulation dot1q 20
Router(config-subif)#ip address 192.168.20.1 255.255.255.0
Router(config-subif)#exit
Router(config)#int f0/0.30
Router(config-subif)#description vlan 30
Router(config-subif)#
% Invalid input detected at '``' marker.

Router(config-subif)#description vlan 30
Router(config-subif)#encapsulation dot1q 30
Router(config-subif)#ip address 192.168.30.1 255.255.255.0
Router(config-subif)#exit
Router(config)#int f0/0.1000
Router(config-subif)#description NATIVE
Router(config-subif)#encapsulation dot1q 1000 native
Router(config-subif)#exit
Router(config)#int f0/0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/0.10, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.10, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/0.20, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.20, changed state to up

```

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```

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/0.10, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.10, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/0.20, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.20, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/0.30, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.30, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/0.1000, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.1000, changed state to up

```

Router(config-if)#exit

```

R1
Physical Config CLI Attributes
IOS Command Line Interface
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console

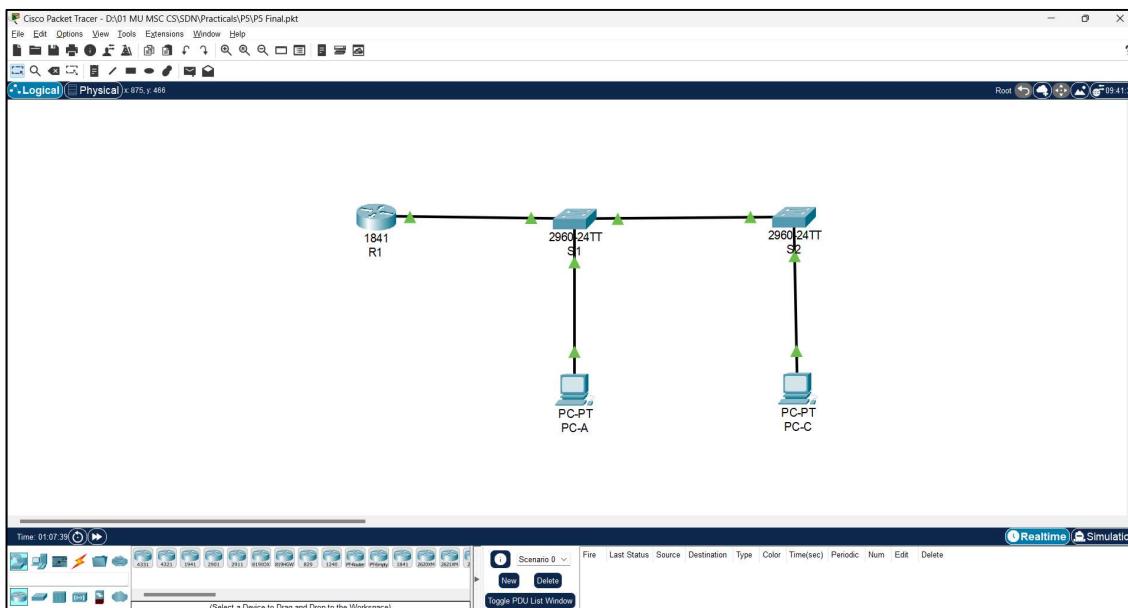
Router#show ip int br
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES unset up           up
FastEthernet0/0.10 192.168.10.1   YES manual up        up
FastEthernet0/0.20 192.168.20.1   YES manual up        up
FastEthernet0/0.30 192.168.30.1   YES manual up        up
FastEthernet0/0.1000 unassigned     YES unset up           up
FastEthernet0/1    unassigned     YES unset administratively down down
Vlan1              unassigned     YES unset administratively down down
Router#show ip int br
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES unset up           up
FastEthernet0/0.10 192.168.10.1   YES manual up        up
FastEthernet0/0.20 192.168.20.1   YES manual up        up
FastEthernet0/0.30 192.168.30.1   YES manual up        up
FastEthernet0/0.1000 unassigned    YES unset up           up
FastEthernet0/1    unassigned    YES unset administratively down down
Vlan1              unassigned    YES unset administratively down down
Router#

```

**Step 8:** Next, we make 3 pings to ensure the routing is working perfectly:

- Ping from PC-A to its default gateway.
- Ping from PC-A to PC-B
- Ping from PC-A to S2

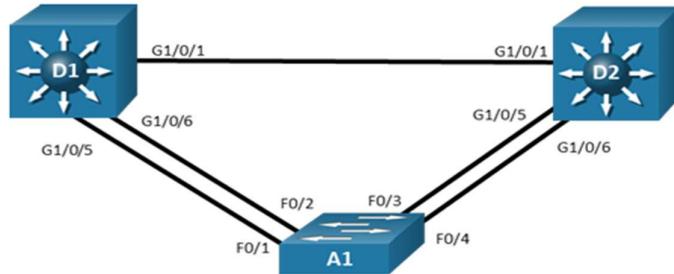
All were executed successfully.



**Conclusion:** The above practical Implementing Inter-VLAN Routing has been completed Successfully.

## PRACTICAL-06

### Topology



### Addressing Table

Device	Interface	IPv4 Address
D1	VLAN1	10.0.0.1/8
D2	VLAN1	10.0.0.2/8
A1	VLAN1	10.0.0.3/8

**Aim:** Observe STP Topology Changes and Implement RSTP

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

### Theory:

#### Spanning Tree Protocol

STP Topology is like a traffic controller for computer networks. It organizes the connections to prevent traffic jams (network loops), ensuring a smooth and efficient flow of data without causing problems.

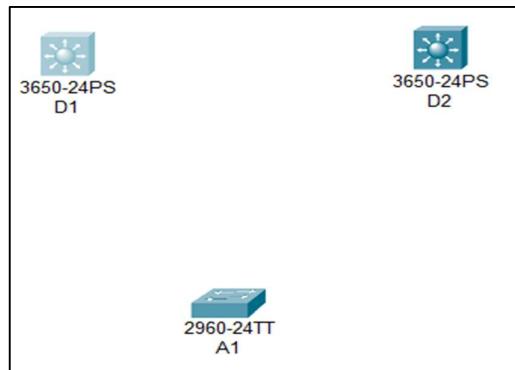
#### Rapid Spanning Tree Protocol

RSTP (Rapid Spanning Tree Protocol) is like a speedy traffic manager for computer networks. It swiftly adjusts to changes in the network to keep data flowing smoothly, ensuring a fast and reliable connection without any unnecessary slowdowns.

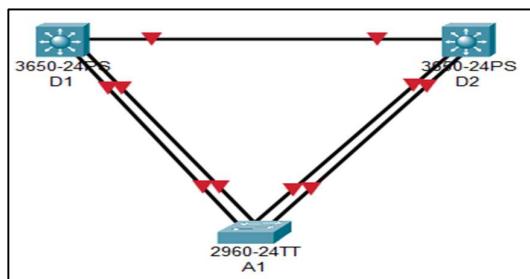
#### Multiple Spanning Tree

MST (Multiple Spanning Tree) is like having separate traffic plans for different parts of a city. It helps manage network traffic more efficiently by allowing different areas to organize themselves without causing congestion in the entire network.

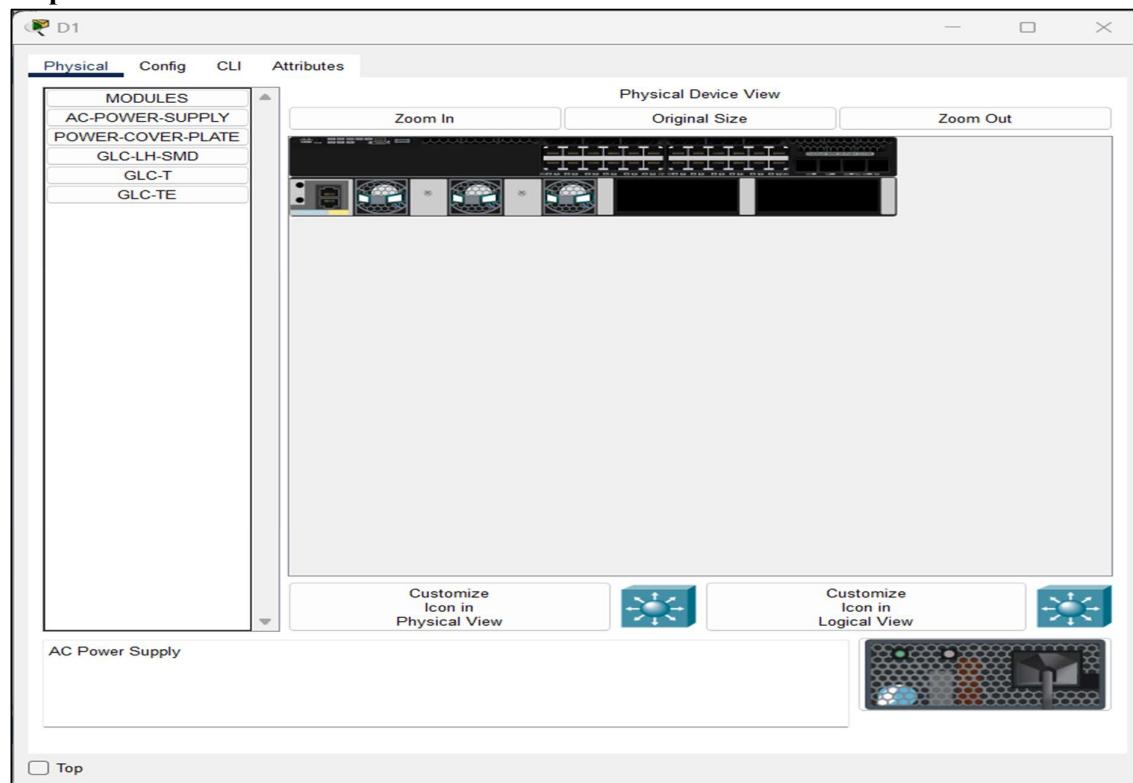
### Step 1:

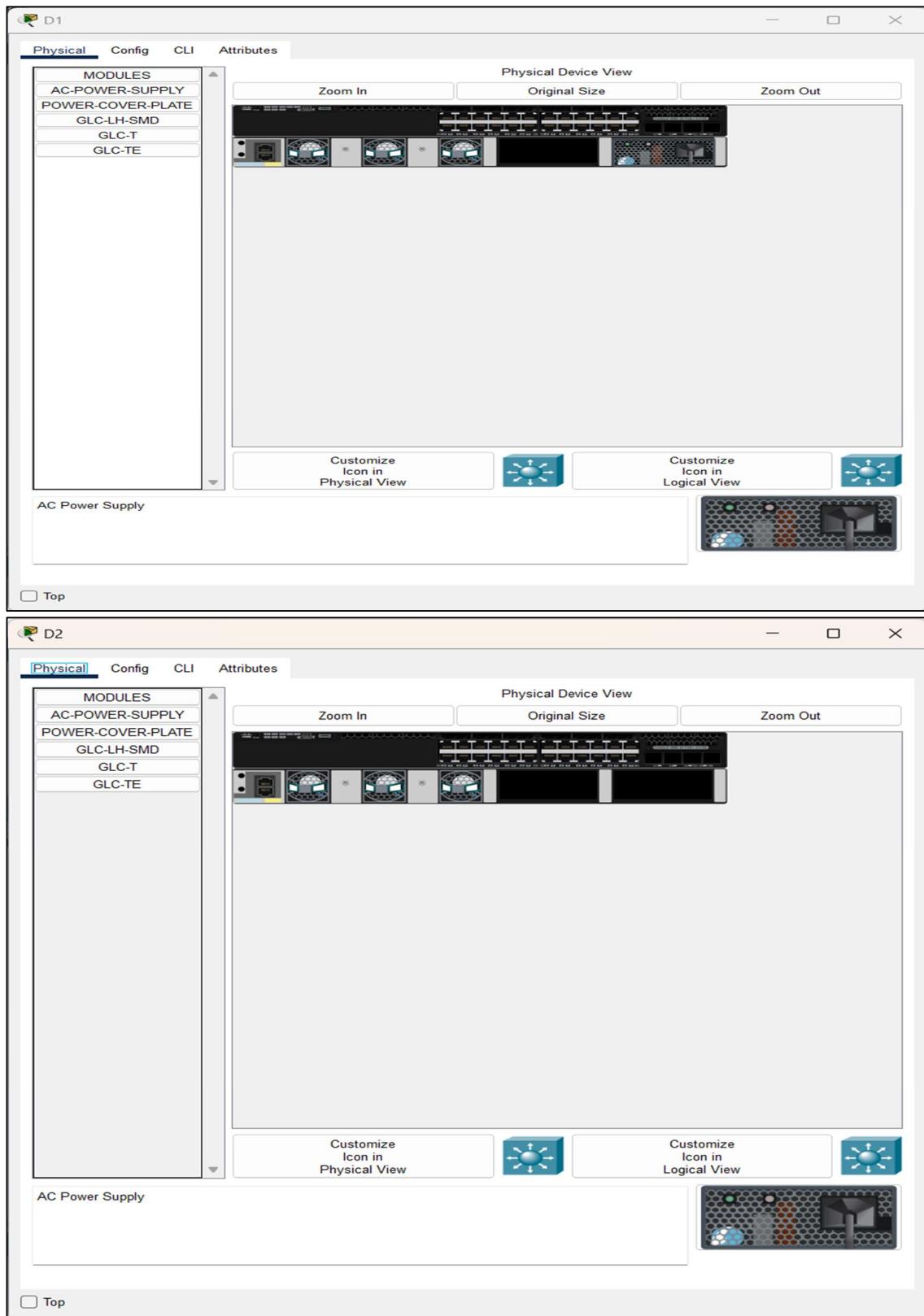


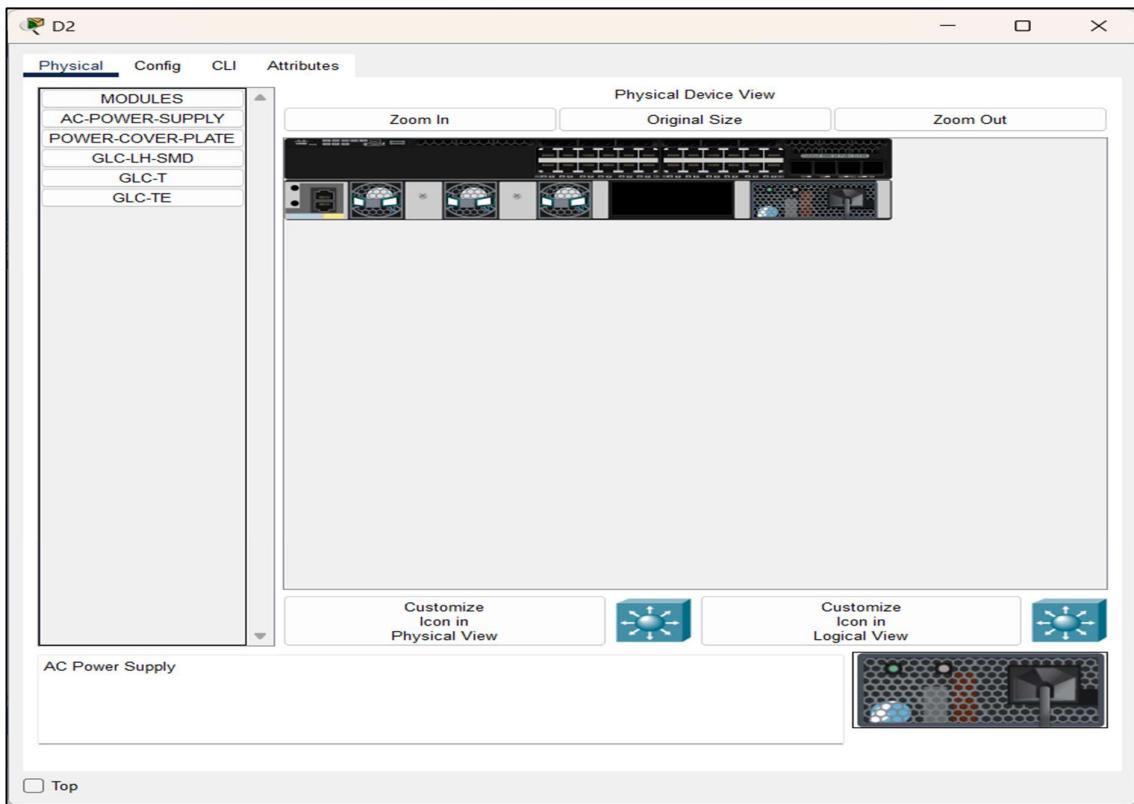
### Step 2:



### Step 3:







#### Step 4:

D1

Physical Config **CLI** Attributes

IOS Command Line Interface

```

--- System Configuration Dialog ---

Would you like to enter the initial configuration dialog? [yes/no]:
%LINK-5-CHANGED: Interface GigabitEthernet1/0/5, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/5, changed state to up
%LINK-5-CHANGED: Interface GigabitEthernet1/0/6, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/6, changed state to up
%LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to up
% Please answer 'yes' or 'no'.
Would you like to enter the initial configuration dialog? [yes/no]: no

Press RETURN to get started!

Switch>en
Switch>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname D1
D1(config)#spanning-tree mode pvst
D1(config)#banner motd # D1, STP Topology Change and RSTP Lab
Enter TEXT message. End with the character '#'.

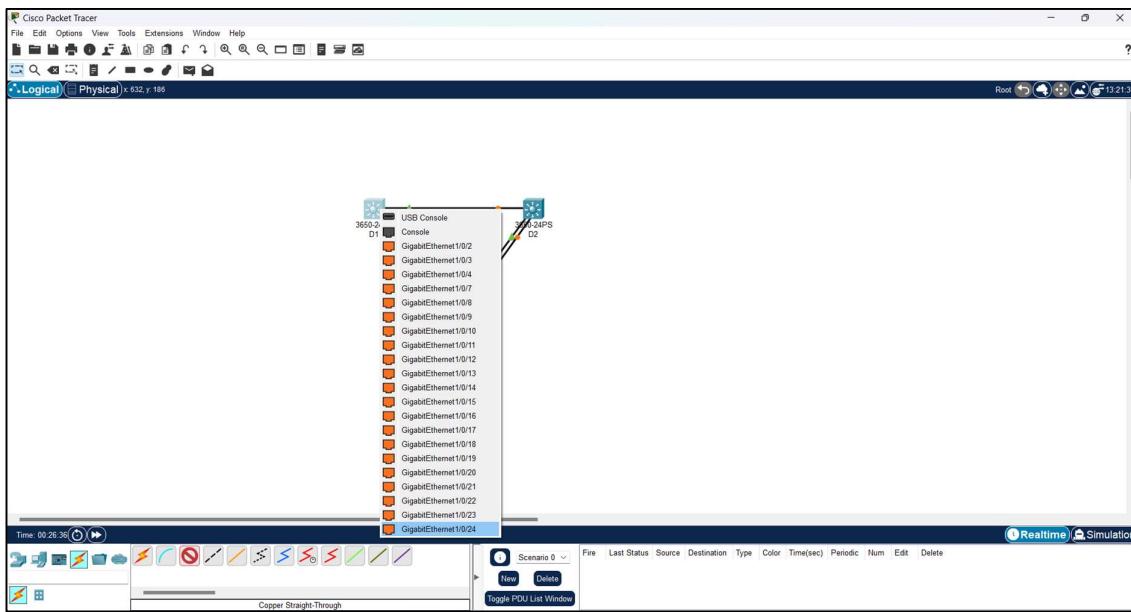
#
D1(config)#banner motd # D1, STP Topology Change and RSTP Lab#
D1(config)#line con 0
D1(config-line)#exec-timeout 0 0
D1(config-line)#logging synchronous
D1(config-line)#exit
D1(config)#

```

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### Step 5:



```

D1
Physical Config CLI Attributes
IOS Command Line Interface

% Please answer 'yes' or 'no'.
Would you like to enter the initial configuration dialog? [yes/no]: no

Press RETURN to get started!

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname D1
D1(config)#spanning-tree mode pvst
D1(config)#banner motd # D1, STP Topology Change and RSTP Lab
Enter TEXT message. End with the character '#'.

#
D1(config)#banner motd # D1, STP Topology Change and RSTP Lab#
D1(config)#banner motd # D1, STP Topology Change and RSTP Lab #
D1(config)#line con 0
D1(config-line)#exec-timeout 0 0
D1(config-line)#logging synchronous
D1(config-line)#exit
D1(config)#int range gi/0/1-24
D1(config-if-range)#shutdown

%LINK-5-CHANGED: Interface GigabitEthernet1/0/2, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/3, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/4, changed state to administratively down

%LINK-5-CHANGED: Interface GigabitEthernet1/0/7, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/8, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/9, changed state to administratively down

```

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D1

Physical Config **CLI** Attributes

IOS Command Line Interface

```
%LINK-5-CHANGED: Interface GigabitEthernet1/0/10, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/11, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/12, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/13, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/14, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/15, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/16, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/17, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/18, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/19, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/20, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/21, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/22, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/23, changed state to administratively down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/24, changed state to administratively down
D1(config-if-range)#
%LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/5, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/5, changed state to down
%LINK-5-CHANGED: Interface GigabitEthernet1/0/6, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/6, changed state to down
```

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### Step 6:

```
D1(config-if-range)#int range g1/0/1,g1/0/5-6
D1(config-if-range)#no shutdown

D1(config-if-range)#
%LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to up
%LINK-5-CHANGED: Interface GigabitEthernet1/0/5, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/5, changed state to up
%LINK-5-CHANGED: Interface GigabitEthernet1/0/6, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/6, changed state to up
D1(config-if-range)#exit
D1(config)#vlan 2
D1(config-vlan)#name SecondVLAN
D1(config-vlan)#exit
D1(config)#int vlan 1
D1(config-if)#ip address 10.0.0.1 255.0.0.0
D1(config-if)#no shutdown

D1(config-if)#
%LINK-5-CHANGED: Interface Vlan1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up
D1(config-if)#exit
D1(config)#

 Top
```

### Step 7:

```
*LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to up
* Please answer 'yes' or 'no'.
Would you like to enter the initial configuration dialog? [yes/no]: no

Press RETURN to get started!

Switch>en
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#hostname D2
D2(config)#banner motd # D2, STP Topology Change and RSTP Lab #
D2(config)#spanning-tree mode pvst
D2(config)#line con 0
D2(config-line)#exec-timeout 0 0
D2(config-line)#logging synchronous
D2(config-line)#exit
D2(config)#int range g1/0/1,g1/0/5-6
D2(config-if-range)#no shutdown
^
* Invalid input detected at '^' marker.

D2(config-if-range)#no shutdown
D2(config-if-range)#exit
D2(config)#vlan 2
D2(config-vlan)#name SecondVLAN
D2(config-vlan)#exit
D2(config)#int vlan 1
D2(config-if)#ip address 10.0.0.2 255.0.0.0
D2(config-if)#no shutdown

D2(config-if)#
%LINK-5-CHANGED: Interface Vlan1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up
D2(config-if)#exit
D2(config)#

 Top
```

## Step 8:

A1

Physical Config **CLI** Attributes

IOS Command Line Interface

```

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname A1
A1(config)#banner motd # A1, STP Topology Change and RSTP Lab #
A1(config)#spanning-tree mode pvst
A1(config)#line con 0
A1(config-line)#exec-timeout 0 0
A1(config-line)#logging synchronous
A1(config-line)#exit
A1(config)#int range f0/1-24,g0/1-2
A1(config-if-range)#shutdown

*LINK-5-CHANGED: Interface FastEthernet0/5, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/7, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/8, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/9, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/10, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/11, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/12, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/13, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/14, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/15, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/16, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/17, changed state to administratively down

```

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A1

Physical Config **CLI** Attributes

IOS Command Line Interface

```

*LINK-5-CHANGED: Interface FastEthernet0/18, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/19, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/20, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/21, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/22, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/23, changed state to administratively down
*LINK-5-CHANGED: Interface FastEthernet0/24, changed state to administratively down
*LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to administratively down
*LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to administratively down
A1(config-if-range)#
*LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down

*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
*LINK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
*LINK-5-CHANGED: Interface FastEthernet0/3, changed state to administratively down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
*LINK-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down

A1(config-if-range)#exit
A1(config)#int range f0/1-4
A1(config-if-range)#switchport mode trunk
A1(config-if-range)#no shutdown


```

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A1

Physical Config **CLI** Attributes

IOS Command Line Interface

```

Al(config-if-range)#
*LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/3, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/4, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up

Al(config-if-range)#exit
Al(config)#vlan 2
Al(config-vlan)#name SecondVLAN
Al(config-vlan)#exit
Al(config)#int vlan 1
Al(config-if)#ip address 10.0.0.3 255.0.0.0
Al(config-if)#no shutdown

Al(config-if)#
*LINK-5-CHANGED: Interface Vlan1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up

Al(config-if)#exit
Al(config)#end
Al#
*SYS-5-CONFIG_I: Configured from console by console

Al#show ip int br
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/1    unassigned      YES manual up           up
FastEthernet0/2    unassigned      YES manual up           up
FastEthernet0/3    unassigned      YES manual up           up
FastEthernet0/4    unassigned      YES manual up           up
FastEthernet0/5    unassigned      YES manual administratively down down

```

Top

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A1

Physical Config **CLI** Attributes

IOS Command Line Interface

```

Al(config-if-range)#
*LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/3, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/4, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up

Al(config-if-range)#exit
Al(config)#vlan 2
Al(config-vlan)#name SecondVLAN
Al(config-vlan)#exit
Al(config)#int vlan 1
Al(config-if)#ip address 10.0.0.3 255.0.0.0
Al(config-if)#no shutdown

Al(config-if)#
*LINK-5-CHANGED: Interface Vlan1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up

Al(config-if)#exit
Al(config)#end
Al#
*SYS-5-CONFIG_I: Configured from console by console

Al#show ip int br
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/1    unassigned      YES manual up           up
FastEthernet0/2    unassigned      YES manual up           up
FastEthernet0/3    unassigned      YES manual up           up
FastEthernet0/4    unassigned      YES manual up           up
FastEthernet0/5    unassigned      YES manual administratively down down
FastEthernet0/6    unassigned      YES manual administratively down down
FastEthernet0/7    unassigned      YES manual administratively down down
FastEthernet0/8    unassigned      YES manual administratively down down
FastEthernet0/9    unassigned      YES manual administratively down down
FastEthernet0/10   unassigned      YES manual administratively down down
FastEthernet0/11   unassigned      YES manual administratively down down
FastEthernet0/12   unassigned      YES manual administratively down down
FastEthernet0/13   unassigned      YES manual administratively down down
FastEthernet0/14   unassigned      YES manual administratively down down
FastEthernet0/15   unassigned      YES manual administratively down down
FastEthernet0/16   unassigned      YES manual administratively down down
FastEthernet0/17   unassigned      YES manual administratively down down
FastEthernet0/18   unassigned      YES manual administratively down down
FastEthernet0/19   unassigned      YES manual administratively down down
FastEthernet0/20   unassigned      YES manual administratively down down
FastEthernet0/21   unassigned      YES manual administratively down down
--More--

```

Top

**Copy** | **Paste**

A1

Physical Config **CLI** Attributes

IOS Command Line Interface

```
GigabitEthernet0/2      unassigned      YES manual administratively down down
Vlan1                  10.0.0.3       YES manual up          up
A1#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority     32769
              Address      0090.2B41.5432
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority     32769 (priority 32768 sys-id-ext 1)
              Address      0090.2B41.5432
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time   20

  Interface   Role Sts Cost      Prio.Nbr Type
  ----- -----
  Fa0/4        Desg FWD 19      128.4    P2p
  Fa0/1        Desg FWD 19      128.1    P2p
  Fa0/2        Desg FWD 19      128.2    P2p
  Fa0/3        Desg FWD 19      128.3    P2p

VLAN0002
  Spanning tree enabled protocol ieee
  Root ID    Priority     32770
              Address      0090.2B41.5432
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority     32770 (priority 32768 sys-id-ext 2)
              Address      0090.2B41.5432
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time   20

  Interface   Role Sts Cost      Prio.Nbr Type
  ----- -----
  Fa0/4        Desg FWD 19      128.4    P2p
  Fa0/1        Desg FWD 19      128.1    P2p
  Fa0/2        Desg FWD 19      128.2    P2p
  Fa0/3        Desg FWD 19      128.3    P2p

A1#

```

Top

```
Al#show version | include MAC
Base ethernet MAC Address      : 00:90:2B:41:54:32
Al#

```

Top

### Step 9:

```

D1(config)#end
D1#
%SYS-5-CONFIG_I: Configured from console by console

D1#show spanning-tree active
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority 32769
  Address   0090.2B41.5432
  Cost      19
  Port      5(GigabitEthernet1/0/5)
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
  Address   00D0.58A4.DAB4
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
  Aging Time 20

  Interface Role Sts Cost Prio.Nbr Type
  ----- -- -- -- -- --
  G1/0/1   Desg FWD 4    128.1   P2p
  G1/0/5   Root FWD 19   128.5   P2p
  G1/0/6   Altn BLK 19   128.6   P2p

VLAN0002
  Spanning tree enabled protocol ieee
  Root ID    Priority 32770
  Address   0090.2B41.5432
  Cost      19
  Port      5(GigabitEthernet1/0/5)
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID Priority 32770 (priority 32768 sys-id-ext 2)
  Address   00D0.58A4.DAB4
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
  Aging Time 20

  Interface Role Sts Cost Prio.Nbr Type
  ----- -- -- -- -- --
  G1/0/5   Root FWD 19   128.5   P2p
  G1/0/6   Altn BLK 19   128.6   P2p

```

### Step 10:

```

D2(config)#end
D2#
%SYS-5-CONFIG_I: Configured from console by console

D2#show spanning-tree active
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority 32769
  Address   0090.2B41.5432
  Cost      19
  Port      5(GigabitEthernet1/0/5)
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
  Address   00E0.B045.2847
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
  Aging Time 20

  Interface Role Sts Cost Prio.Nbr Type
  ----- -- -- -- -- --
  G1/0/1   Altn BLK 4    128.1   P2p
  G1/0/6   Altn BLK 19   128.6   P2p
  G1/0/5   Root FWD 19   128.5   P2p

VLAN0002
  Spanning tree enabled protocol ieee
  Root ID    Priority 32770
  Address   0090.2B41.5432
  Cost      19
  Port      5(GigabitEthernet1/0/5)
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID Priority 32770 (priority 32768 sys-id-ext 2)
  Address   00E0.B045.2847
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
  Aging Time 20

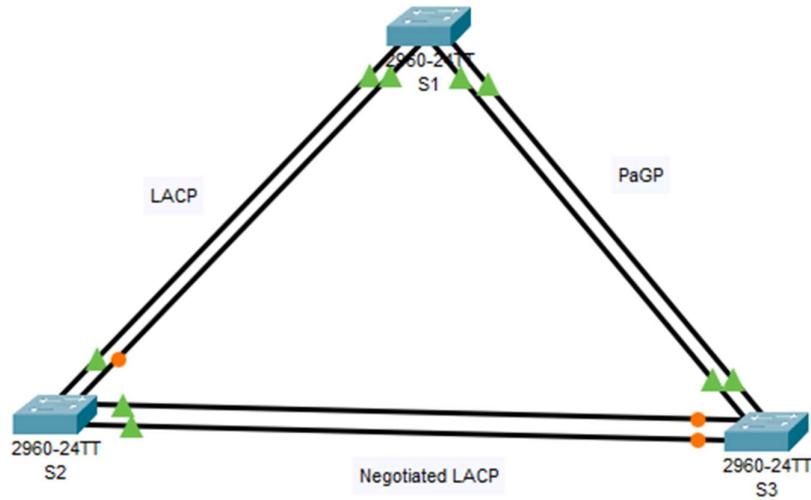
  Interface Role Sts Cost Prio.Nbr Type
  ----- -- -- -- -- --
  G1/0/6   Altn BLK 19   128.6   P2p
  G1/0/5   Root FWD 19   128.5   P2p

```

**Conclusion:** The above Practical Observing the STP Topology Changes and Implementing RSTP has been Implemented Successfully.

## PRACTICAL-07

### Packet Tracer - Configure EtherChannel2



**Aim:**

- Implement Ether Channel
- Tune and Optimize Ether Channel Operations

**Theory:**

**EtherChannel**

EtherChannel, also known as Link Aggregation, is a networking technology used to combine multiple physical Ethernet links into a single logical link. This logical link increases bandwidth, enhances redundancy, and improves network performance.

**Objectives:**

- Configure Basic Switch Settings.
- Configure an EtherChannel with Cisco PAgP Part
- Configure an 802.3ad LACP EtherChannel
- Configure a Redundant EtherChannel Link

**Background:**

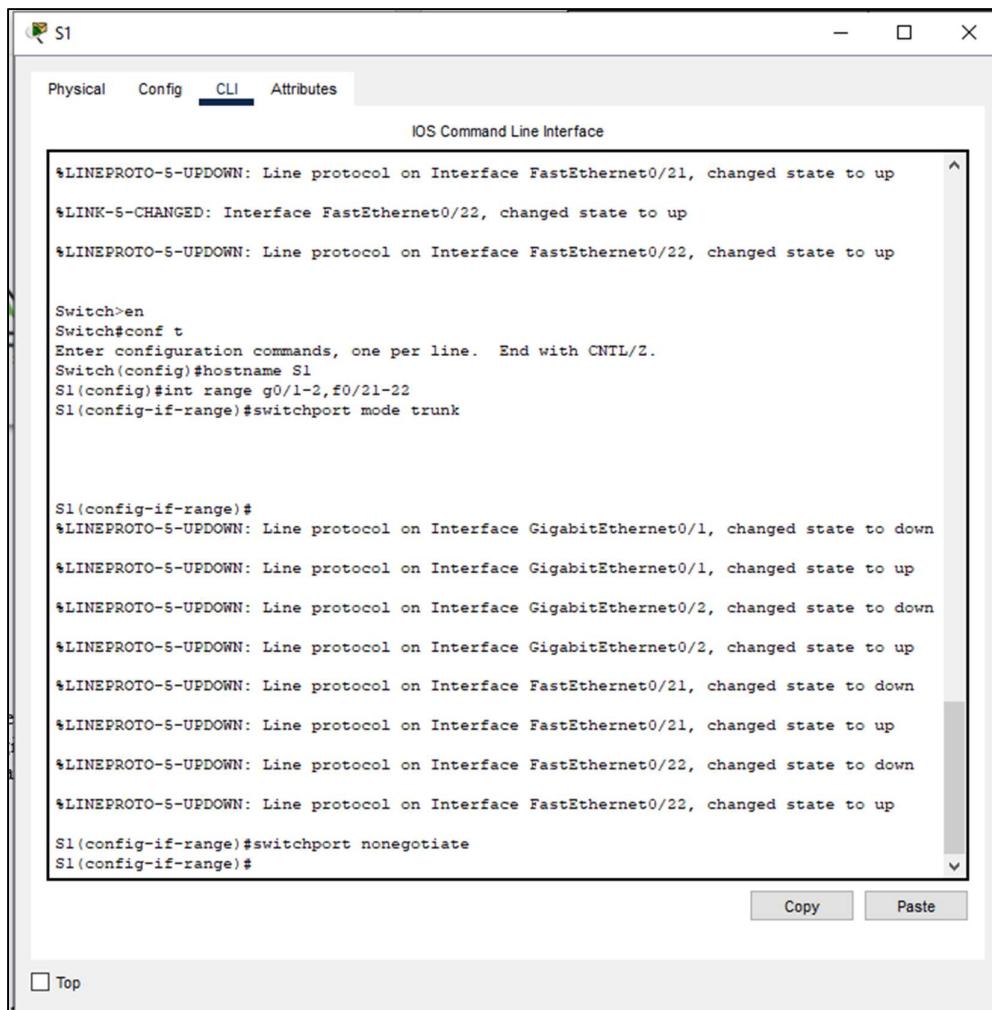
Three switches have just been installed. There are redundant uplinks between the switches. As configured, only one of these links can be used; otherwise, a bridging loop might occur. However, using only one link utilizes only half of the available bandwidth. EtherChannel allows up to eight redundant links to be bundled together into one logical link. In this lab, you will configure Port Aggregation Protocol (PAgP), a Cisco EtherChannel protocol, and Link Aggregation Control Protocol (LACP), an IEEE 802.3ad open standard version of EtherChannel. Before beginning the configuration, review the EtherChannel Configuration Guidelines and Restrictions listed at the end of this activity.

## Port Channel Table

Channel Group	Ports	Protocol
1	S1 F0/21, F0/22 S3 F0/21, F0/22	PAgP
2	S1 G0/1, G0/2 S2 G0/1, G0/2	LACP
3	S2 F0/23, F0/24 S3 F0/23, F0/24	Negotiated LACP

### Part 1: Configure Basic Switch Settings

- a) Assign each switch a hostname according to the topology diagram.
- b) Before beginning the link aggregation between switches, verify the existing configuration of the ports that connect the switches to ensure that the ports will successfully join the EtherChannels. Commands that provide information about the state of the switch ports include:



```

S1
Physical Config CLI Attributes
IOS Command Line Interface

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/21, changed state to up
%LINK-5-CHANGED: Interface FastEthernet0/22, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/22, changed state to up

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname S1
S1(config)#int range g0/1-2,f0/21-22
S1(config-if-range)#switchport mode trunk

S1(config-if-range)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/21, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/21, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/22, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/22, changed state to up

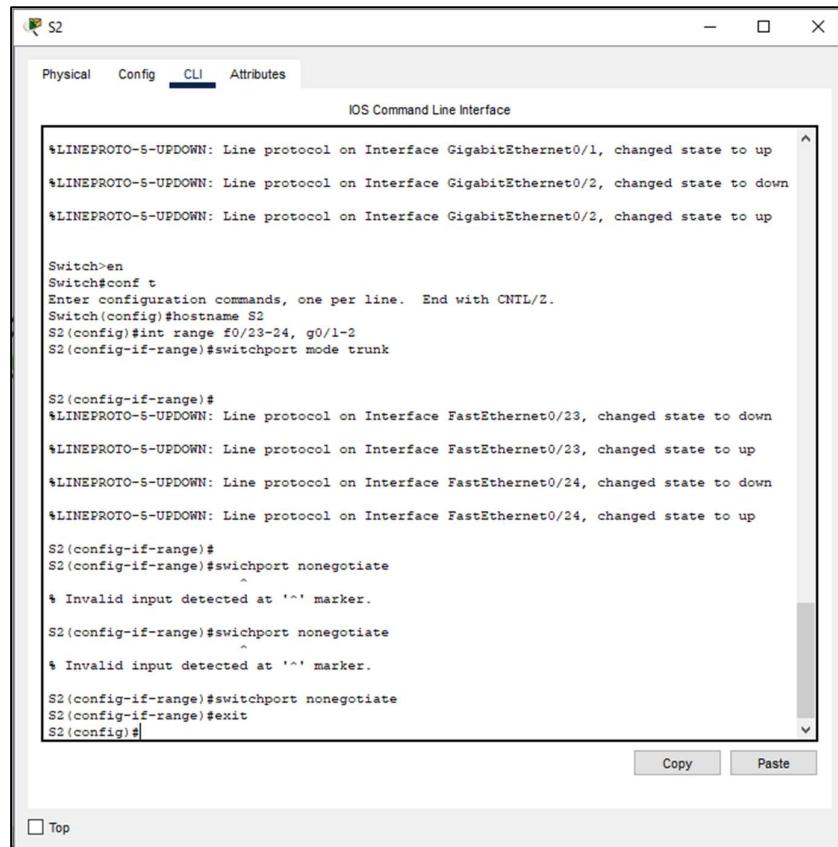
S1(config-if-range)#switchport nonegotiate
S1(config-if-range)#

```

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□ Top

- c) Configure all ports that are required for the EtherChannels as static trunk ports.



```

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname S2
S2(config)#int range f0/1-2, g0/1-2
S2(config-if-range)#switchport mode trunk

S2(config-if-range)#
*S1NEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to up
*S1NEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to down
*S1NEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to up

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname S2
S2(config)#int range f0/23-24, g0/1-2
S2(config-if-range)#switchport mode trunk

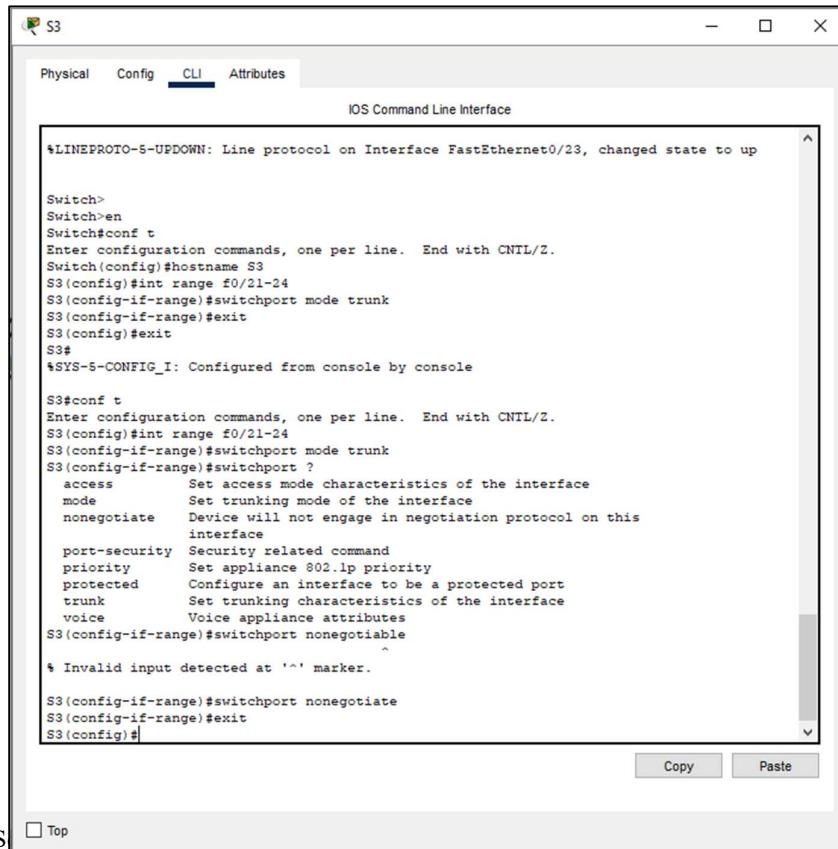
S2(config-if-range)#
*S1NEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to down
*S1NEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to up
*S1NEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to down
*S1NEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to up

S2(config-if-range)#
S2(config-if-range)#switchport nonegotiate
^
* Invalid input detected at '^' marker.

S2(config-if-range)#
^
* Invalid input detected at '^' marker.

S2(config-if-range)#switchport nonegotiate
S2(config-if-range)#exit
S2(config)#

```



```

Switch>
Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname S3
S3(config)#int range f0/21-24
S3(config-if-range)#switchport mode trunk
S3(config-if-range)#exit
S3(config)#
*SYS-5-CONFIG_I: Configured from console by console

S3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S3(config)#int range f0/21-24
S3(config-if-range)#switchport mode trunk
S3(config-if-range)#
access      Set access mode characteristics of the interface
mode       Set trunking mode of the interface
nonegotiate Device will not engage in negotiation protocol on this
              interface
port-security Security related command
priority    Set appliance 802.1p priority
protected   Configure an interface to be a protected port
trunk      Set trunking characteristics of the interface
voice      Voice appliance attributes
S3(config-if-range)#switchport nonegotiable
^
* Invalid input detected at '^' marker.

S3(config-if-range)#
S3(config-if-range)#
S3(config)#

```

**Note:** If the ports are configured with DTP dynamic auto mode, and you do not set the mode of the ports to trunk, the links do not form trunks and remain access ports. The default mode on a 2960 switch is for DTP to be enabled and set to dynamic auto. DTP can be disabled on interfaces with the **switchport nonegotiate** command.

## Part 2: Configure an EtherChannel with Cisco PAgP

**Note:** When configuring EtherChannels, it is recommended to shut down the physical ports being grouped on both devices before configuring them into channel groups. Otherwise, EtherChannel Misconfig Guard may place these ports into an err-disabled state. The ports and port channels can be re-enabled after EtherChannel is configured.

### **Step 1: Configure Port Channel 1.**

- a) The first EtherChannel that is created for this activity aggregates ports F0/21 and F0/22 between **S1** and **S3**. Configure the ports on both switches as static trunk ports.
  - b) Use the **show interfaces trunk** command to ensure that you have an active trunk link for those two links and that the native VLAN on both links is the same.

- c) On S1 and S3, add ports F0/21 and F0/22 to Port Channel 1 with the **channel-group 1 mode desirable** command. The **mode desirable** option enables the switch to actively negotiate to form a PAgP link. Note: Interfaces must be **shutdown** before adding them to the channel group.

The screenshot shows a Cisco IOS Command Line Interface (CLI) window titled "S1". The window has tabs for "Physical", "Config", "CLI" (which is selected), and "Attributes". The main area displays the following configuration commands:

```
* Invalid input detected at ^ or <space>.
S1>en
S1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S1(config)#interface range f0/21-22
S1(config-if-range)#shutdown

S1(config-if-range)#
%LINK-5-CHANGED: Interface FastEthernet0/21, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/21, changed state to down
%LINK-5-CHANGED: Interface FastEthernet0/22, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/22, changed state to down

S1(config-if-range)#
S1(config-if-range)#channel-group 1 mode desirable
S1(config-if-range)#
Creating a port-channel interface Port-channel 1

S1(config-if-range)#no shutdown

S1(config-if-range)#
%LINK-5-CHANGED: Interface FastEthernet0/21, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/21, changed state to up
%LINK-5-CHANGED: Interface FastEthernet0/22, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/22, changed state to up

S1(config-if-range)#exit
S1(config)#


```

At the bottom of the window, there are "Copy" and "Paste" buttons. Below the window, there is a "Top" button.

```

S3>en
S3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S3(config)#int range f0/21-233
interface range not validated - command rejected
S3(config)#int range f0/21-22
S3(config-if-range)#shutdown

S3(config-if-range)#
%LINK-5-CHANGED: Interface FastEthernet0/21, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/21, changed state to down
%LINK-5-CHANGED: Interface FastEthernet0/22, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/22, changed state to down
S3(config-if-range)#channel-group 1 mode desirable
S3(config-if-range)#
Creating a port-channel interface Port-channel 1

S3(config-if-range)#
S3(config-if-range)#
S3(config-if-range)#no shutdown

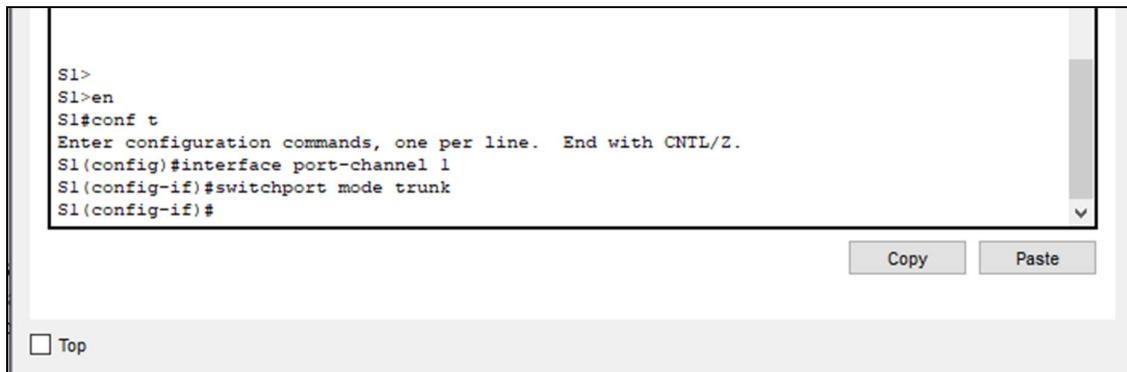
S3(config-if-range)#
%LINK-5-CHANGED: Interface FastEthernet0/21, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/21, changed state to up
%LINK-5-CHANGED: Interface FastEthernet0/22, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/22, changed state to up
%LINK-5-CHANGED: Interface Port-channel1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up
S3(config-if-range)#
S3(config-if-range)#

```

Top

The message “**Creating a port-channel interface Port-channel 1**” should appear on both switches when the channel-group is configured. This interface designation will appear as Po1 in the command output.

- d) Configure the logical interface to become a trunk by first entering the **interface portchannel number** command and then the **switchport mode trunk** command.  
Add this configuration to both switches.



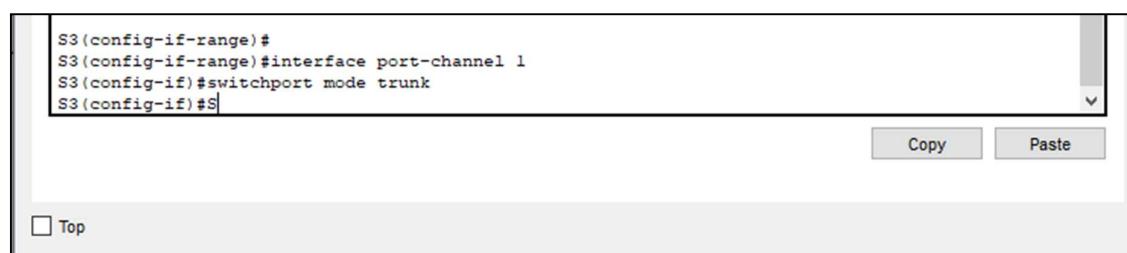
```

S1>
S1>en
S1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S1(config)#interface port-channel 1
S1(config-if)#switchport mode trunk
S1(config-if)#

```

**Copy**    **Paste**

**Top**



```

S3(config-if-range)#
S3(config-if-range)#interface port-channel 1
S3(config-if)#switchport mode trunk
S3(config-if)#

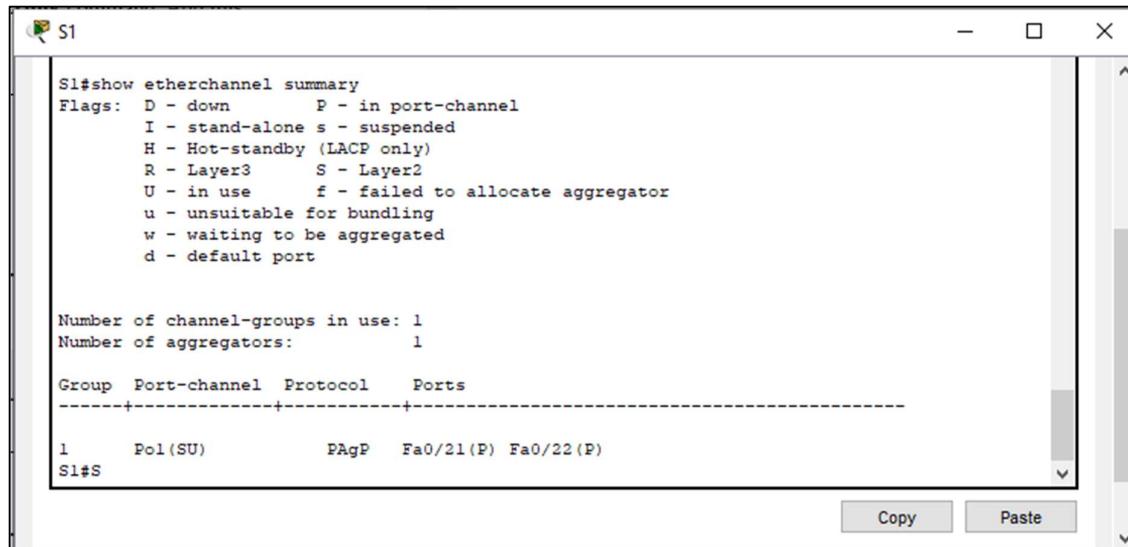
```

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**Top**

### Step 2: Verify Port Channel 1 status.

- a) Issue the **show EtherChannel summary** command on S1 and S3 to verify that EtherChannel is working on both switches. This command displays the type of EtherChannel, the ports utilized, and the port states. Command output is shown for S1.



```

S1#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)        PAgP      Fa0/21(P) Fa0/22(P)
S1#S

```

**Copy**    **Paste**

- b) If the EtherChannel does not come up, shut down the physical interfaces on both ends of the EtherChannel and then bring them back up again. The **show interfaces trunk** and **show spanning-tree** commands should show the port channel as one logical link.

### **Part 3: Configure an 802.3ad LACP EtherChannel**

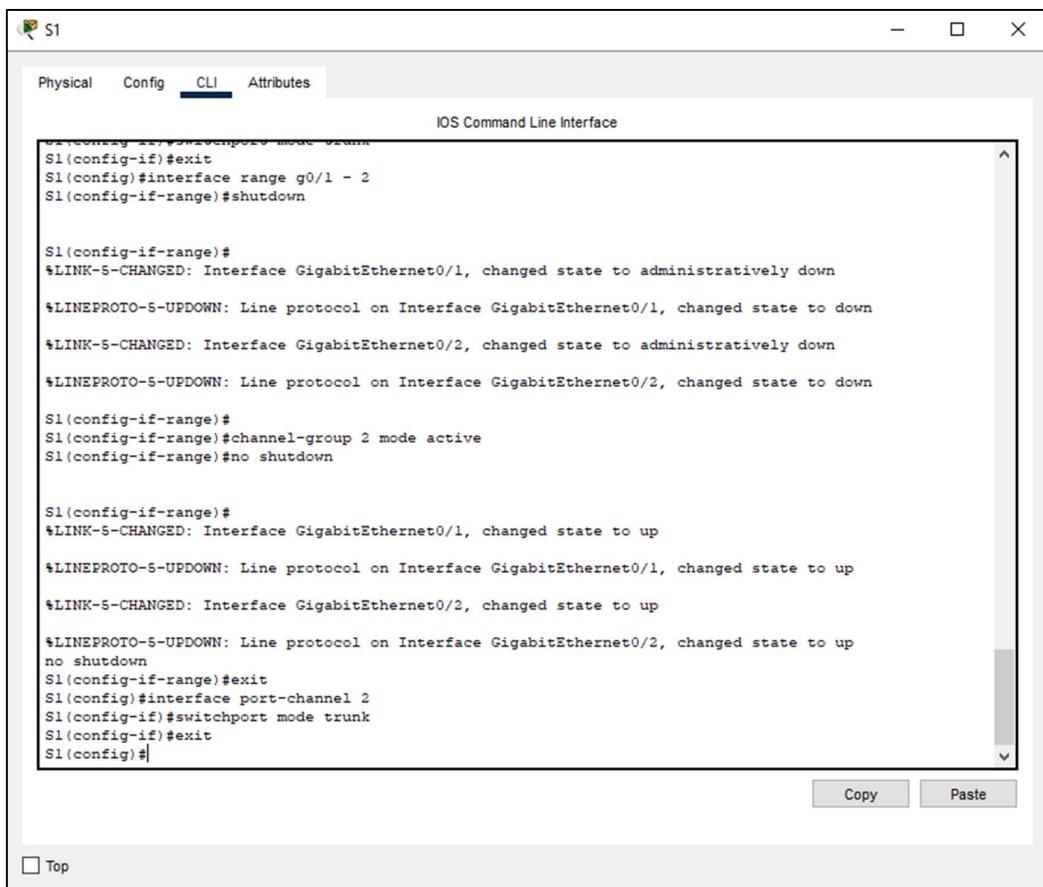
#### **Step 1: Configure Port Channel 2.**

- a) In 2000, the IEEE released 802.3ad, which is an open standard version of EtherChannel. It is commonly referred to as LACP. Using the previous commands, configure the link between S1 and S2, using ports G0/1 and G0/2, as an LACP EtherChannel. You must use a different port channel number on S1 than 1, because you already used that in the previous step.

To configure port channel 2 as LACP, use the interface configuration mode channelgroup 2 mode active command. Active mode indicates that the switch actively tries to negotiate that link as LACP, as opposed to PAgP. The configuration of S1 is shown below.

#### **Step 2: Verify Port Channel 2 status.**

Use the **show** commands from Part 1 Step 2 to verify the status of the Port Channel. Look for the protocol used by each port.



```

S1(config-if)#exit
S1(config)#interface range g0/1 - 2
S1(config-if-range)#shutdown

S1(config-if-range)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to down
%LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to down

S1(config-if-range)#
S1(config-if-range)#channel-group 2 mode active
S1(config-if-range)#no shutdown

S1(config-if-range)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to up
%LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to up
no shutdown
S1(config-if-range)#exit
S1(config)#interface port-channel 2
S1(config-if)#switchport mode trunk
S1(config-if)#exit
S1(config)#

```

The screenshot shows the Cisco IOS Command Line Interface (CLI) window titled "S1". The window has tabs for "Physical", "Config", "CLI" (which is selected), and "Attributes". Below the tabs is the text "IOS Command Line Interface". The main area contains the CLI session output. At the bottom right are "Copy" and "Paste" buttons, and at the bottom left is a "Top" button.

S2>  
S2>en  
S2#conf t  
Enter configuration commands, one per line. End with CNTL/Z.  
S2(config)#interface portchannel 2  
^  
% Invalid input detected at '^' marker.  
  
S2(config)#interface port-channel 2  
S2(config-if)#switchport mode trunk  
S2(config-if)#exit  
S2(config)#

Top

S1#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: 2  
Number of aggregators: 2

Group	Port-channel	Protocol	Ports
1	Po1(SU)	PAgP	Fa0/21(P) Fa0/22(P)
2	Po2(SD)	LACP	Gig0/1(I) Gig0/2(I)

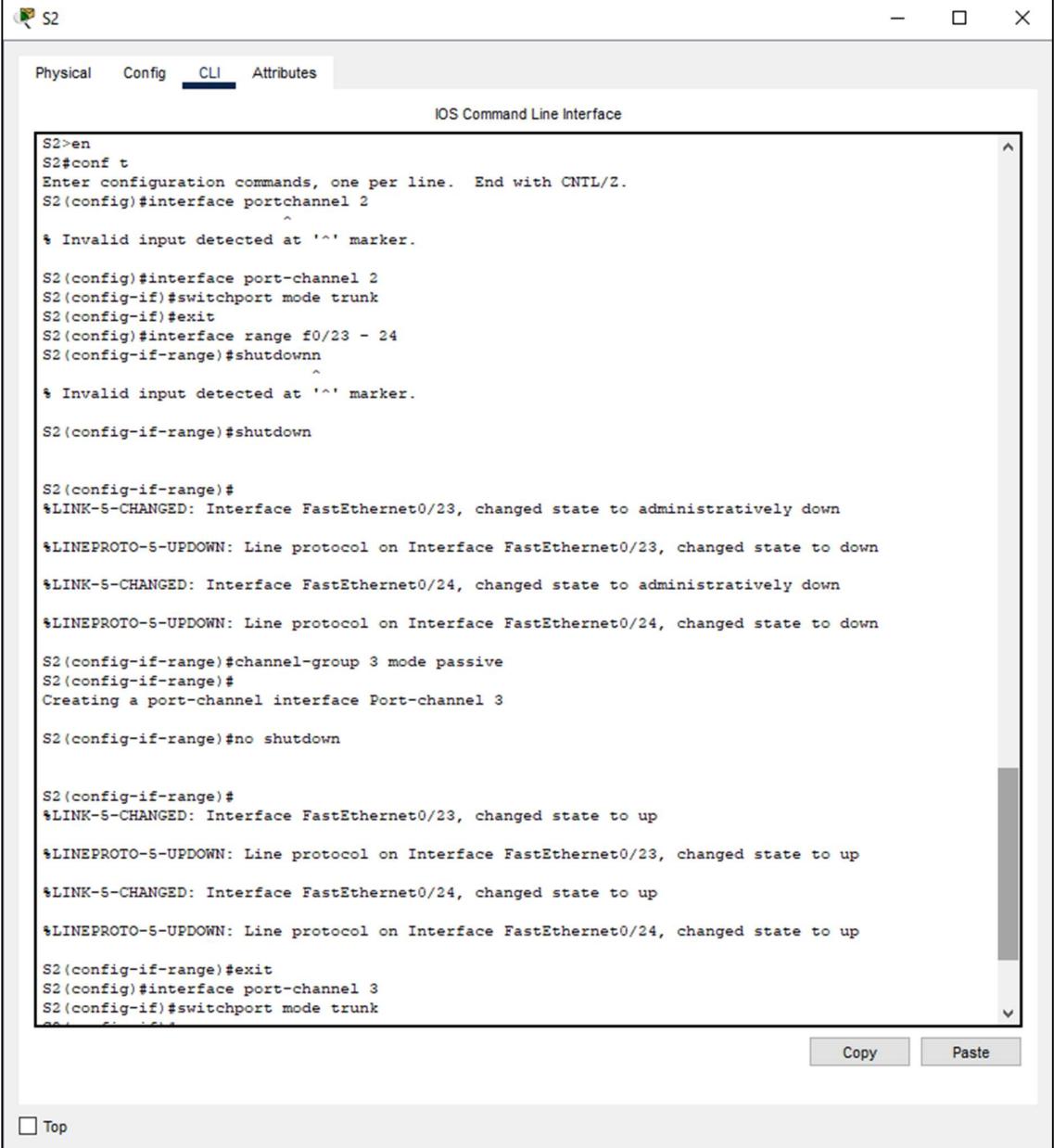
S1#

Top

## Part 4: Configure a Redundant EtherChannel Link.

### Step 1: Configure Port Channel 3

There are various options for the **channel-group number mode** command:



The screenshot shows a Cisco IOS CLI window titled "S2". The tab bar at the top has "Physical", "Config", "CLI" (which is selected), and "Attributes". Below the tabs is the text "IOS Command Line Interface". The main area contains the following configuration commands:

```

S2>en
S2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S2(config)#interface portchannel 2
      ^
% Invalid input detected at '^' marker.

S2(config)#interface port-channel 2
S2(config-if)#switchport mode trunk
S2(config-if)#exit
S2(config)#interface range f0/23 - 24
S2(config-if-range)#shutdownn
      ^
% Invalid input detected at '^' marker.

S2(config-if-range)#shutdown

S2(config-if-range)#
%LINK-5-CHANGED: Interface FastEthernet0/23, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to down
%LINK-5-CHANGED: Interface FastEthernet0/24, changed state to administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to down

S2(config-if-range)#channel-group 3 mode passive
S2(config-if-range)#
Creating a port-channel interface Port-channel 3

S2(config-if-range)#no shutdown

S2(config-if-range)#
%LINK-5-CHANGED: Interface FastEthernet0/23, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to up
%LINK-5-CHANGED: Interface FastEthernet0/24, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to up

S2(config-if-range)#exit
S2(config)#interface port-channel 3
S2(config-if)#switchport mode trunk
      ^
%LINK-5-CHANGED: Interface Port-channel 3, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel 3, changed state to up

```

At the bottom right of the CLI window are "Copy" and "Paste" buttons. At the bottom left is a "Top" button.

- a) On switch **S2**, add ports F0/23 and F0/24 to Port Channel 3 with the **channel-group 3 mode passive** command. The **passive** option indicates that you want the switch to use LA only if another LACP device is detected. Statically configure Port Channel 3 as a trunk interface.

```

S2(config-if)#interface range f0/23-24
S2(config-if-range)#shutdown

S2(config-if-range)#
*S2(config-if-range)#
*LINK-5-CHANGED: Interface FastEthernet0/23, changed state to administratively down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to down
*LINK-5-CHANGED: Interface FastEthernet0/24, changed state to administratively down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to down
S2(config-if-range)#channel-group 3 mode passive
S2(config-if-range)#no shutdown

S2(config-if-range)#
*LINK-5-CHANGED: Interface FastEthernet0/23, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/24, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to up
S2(config-if-range)#exit
S2(config)#interface port-channel 3
S2(config-if)#switchport mode trunk
S2(config-if)#

```

- b) On **S3**, add ports F0/23 and F0/24 to Port Channel 3 with the **channel-group 3 mode active** command. The **active** option indicates that you want the switch to use LACP unconditionally. Statically configure Port Channel 3 as a trunk interface.

**Step 2:** Verify Port Channel 3 status.

- a) Use the **show** commands from Part 1 Step 2 to verify the status of Port Channel 3.  
Look for the protocol used by each port.

```

$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to up
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to up

S2(config-if)#
S2(config-if)#exit
S2(config)#end
S2#
*SYS-5-CONFIG_I: Configured from console by console

S2#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: 2
Number of aggregators: 2

Group  Port-channel  Protocol    Ports
-----+-----+-----+
2      Po2 (SD)      -
3      Po3 (SD)      LACP        Fa0/23(I)  Fa0/24(I)
S2#

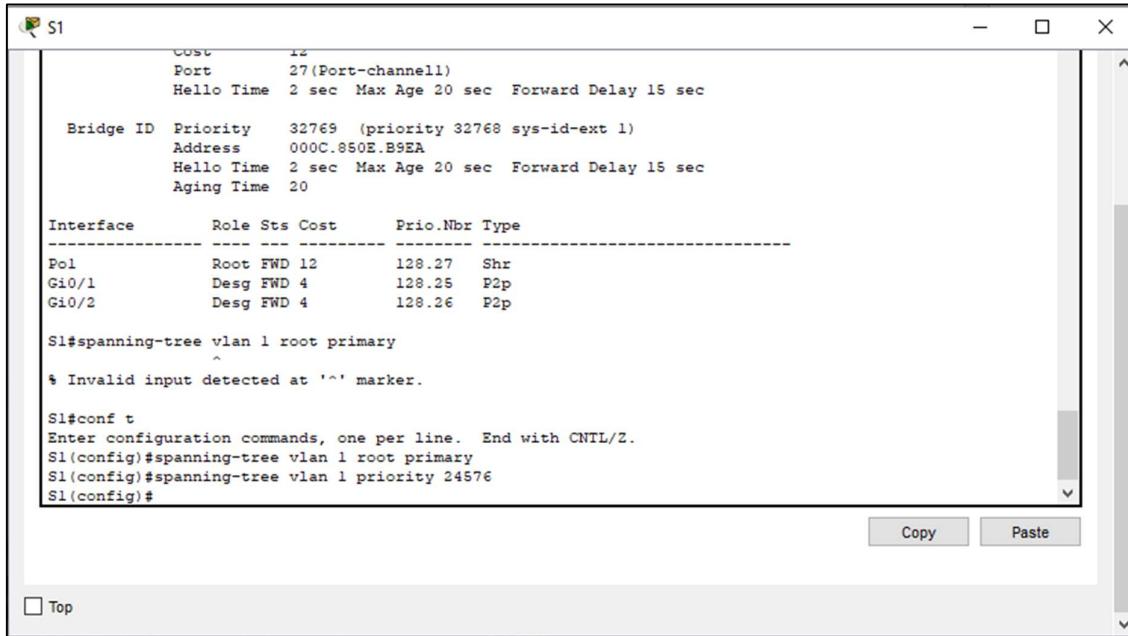
```

Top

**Copy**    **Paste**

- b) Creating EtherChannel links does not prevent Spanning Tree from detecting switching loops. **View the spanning tree status of the active ports on S1.**

Port Channel 2 is not operative because the Spanning Tree Protocol placed some ports into blocking mode. Unfortunately, those ports were the Gigabit ports. In this topology, you can restore these ports by configuring S1 to be primary root for VLAN 1. You could also set the priority to **24576**.



```

S1
      COST      12
      Port      27(Port-channel1)
      Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

      Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
      Address 000C.850E.B9EA
      Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
      Aging Time 20

      Interface Role Sts Cost      Prio.Nbr Type
      -----
      Po1       Root FWD 12      128.27  Shr
      Gi0/1    Desg FWD 4       128.25  P2p
      Gi0/2    Desg FWD 4       128.26  P2p

      S1#spanning-tree vlan 1 root primary
      ^
      * Invalid input detected at '^' marker.

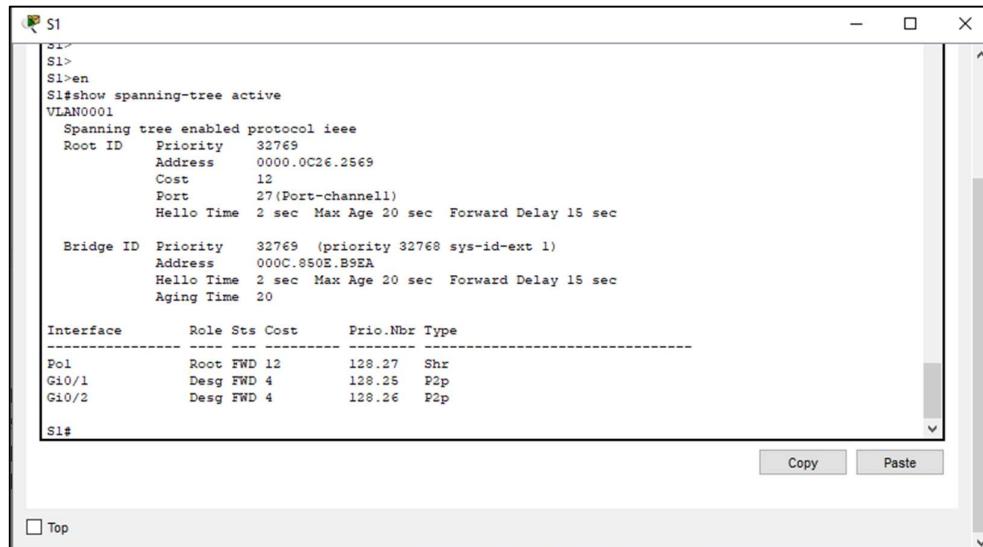
      S1#conf t
      Enter configuration commands, one per line. End with CNTL/Z.
      S1(config)#spanning-tree vlan 1 root primary
      S1(config)#spanning-tree vlan 1 priority 24576
      S1(config)#

```

Top

**Copy**    **Paste**

You may have to wait for STP to recalculate the tree topology. Press fast-forward if necessary. Use the **show spanning-tree active** command to verify that the Gigabit ports are now in the forwarding state.



```

S1>
S1>en
S1>show spanning-tree active
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID  Priority  32769
            Address  0000.0C26.2569
            Cost      12
            Port      27(Port-channel1)
            Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority  32769 (priority 32768 sys-id-ext 1)
  Address  000C.850E.B9EA
  Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
  Aging Time 20

  Interface Role Sts Cost      Prio.Nbr Type
  -----
  Po1       Root FWD 12      128.27  Shr
  Gi0/1    Desg FWD 4       128.25  P2p
  Gi0/2    Desg FWD 4       128.26  P2p

S1#

```

Top

## **EtherChannel Configuration Guidelines and Restrictions.**

EtherChannel has some specific guidelines that must be followed in order to avoid configuration problems.

- 1) All Ethernet interfaces support EtherChannel up to a maximum of eight interfaces with no requirement that the interfaces be on the same interface module.
- 2) All interfaces within an EtherChannel must operate at the same speed and duplex.
- 3) EtherChannel links can function as either single VLAN access ports or as trunk links between switches.
- 4) All interfaces in a Layer 2 EtherChannel must be members of the same VLAN or be configured as trunks.
- 5) If configured as trunk links, Layer 2 EtherChannel must have the same native VLAN and have the same VLANs allowed on both switches connected to the trunk.
- 6) When configuring EtherChannel links, all interfaces should be shut down prior to beginning the EtherChannel configuration. When the configuration is complete, the links can be re-enabled.
- 7) After configuring the EtherChannel, verify that all interfaces are in the up/up state.
- 8) It is possible to configure an EtherChannel as static, or for it to use either PAgP or LACP to negotiate the EtherChannel connection. The determination of how an EtherChannel is set up is the value of the **channel-group number mode** command. Valid values are:

**Active** LACP is enabled unconditionally

**Passive** LACP is enabled only if another PAgP-capable device is connected.

**Desirable** PAgP is enabled unconditionally.

**Auto** PAgP is enabled only if another PAgP-capable device is connected.

**on** EtherChannel is enabled, but without either LACP or PAgP.

- 9) LAN ports can form an EtherChannel using PAgP if the modes are compatible. Compatible PAgP modes are:

**desirable => desirable**

**desirable => auto**

If both interfaces are in auto mode, an EtherChannel cannot form.

10) LAN ports can form an EtherChannel using LACP if the modes are compatible.

Compatible LACP modes are:

**active => active**

**active => passive**

If both interfaces are in passive mode, an EtherChannel cannot form using LACP.

11) Channel-group numbers are local to the individual switch. Although this activity uses the same Channel-group number on either end of the EtherChannel connection, it is not a requirement. Channelgroup 1 (interface po1) on one switch can form an EtherChannel with Channel-group 5 (interface po5) on another switch.

## PRACTICAL-08

### Aim:

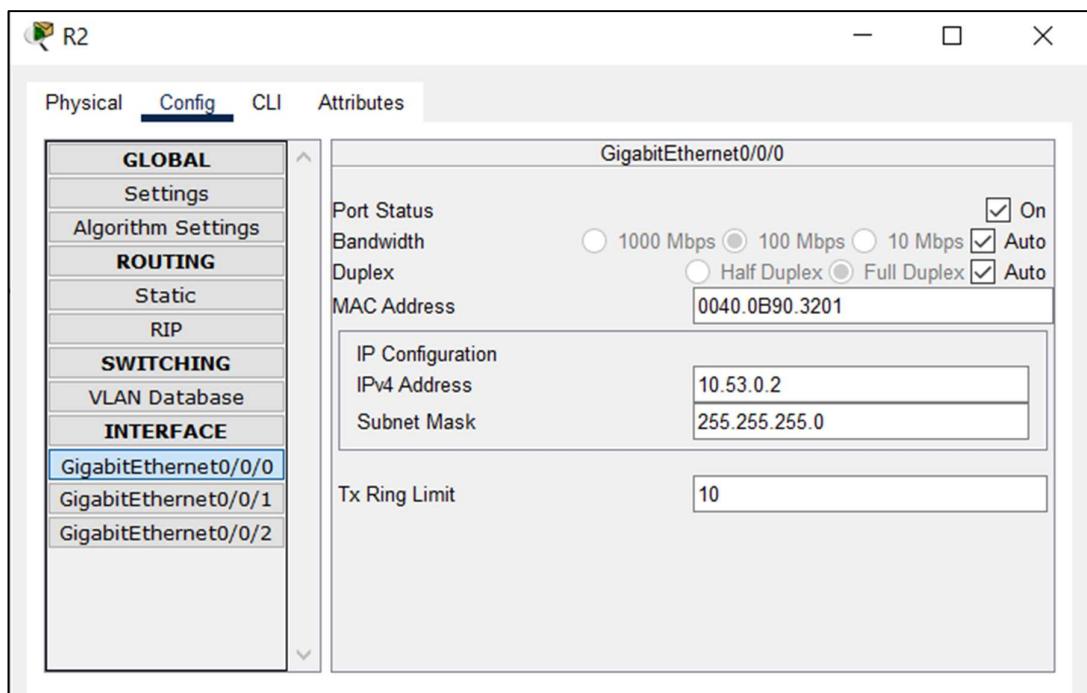
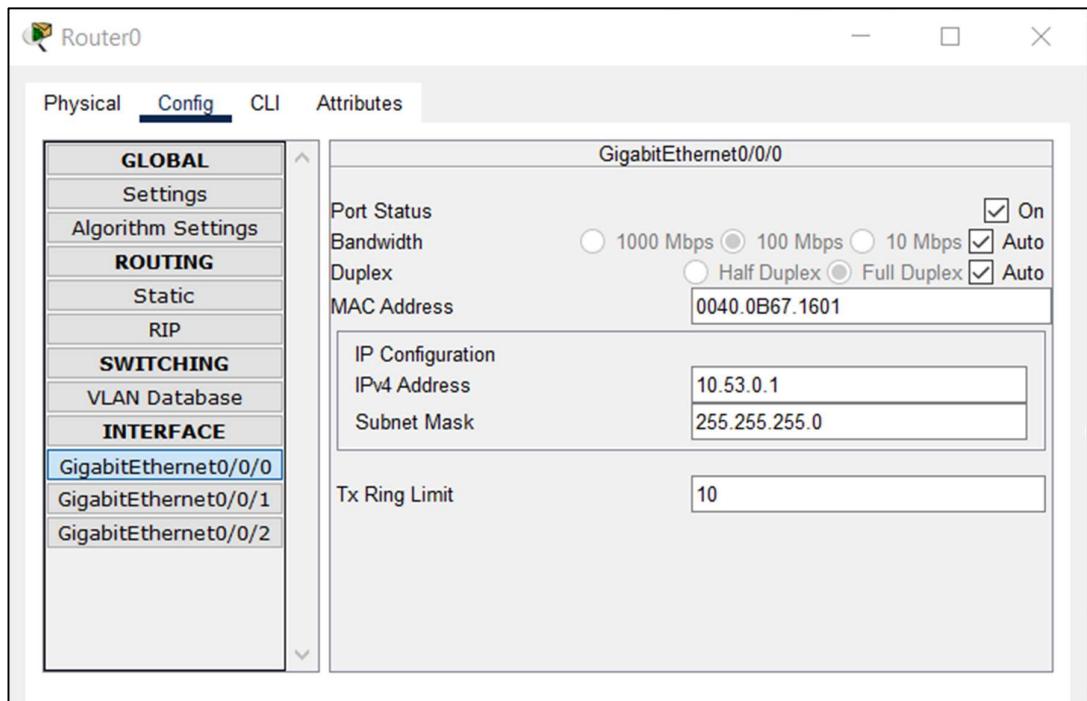
- A) Configure Single-Area OSPFv2

### Theory:

The OSPF (Open Shortest Path First) protocol is one of a family of IP Routing protocols for the Internet, used to distribute IP routing information throughout a single Autonomous System (AS) in an IP network.

A single area OSPF design is a network in which all router in same area

<b>Topology</b>			
<b>Addressing Table</b>			
Device	Interface	IP Address	Subnet Mask
R1	G0/0/1	10.53.0.1	255.255.255.0
	Loopback1	172.16.1.1	255.255.255.0
R2	G0/0/1	10.53.0.2	255.255.255.0
	Loopback1	192.168.1.1	255.255.255.0



```
R1(config)#  
R1(config)#int g0/0/0  
R1(config-if)#ip add 10.53.0.1 255.255.255.0  
R1(config-if)#no shut
```

```
R1(config)#int lo1  
  
R1(config-if)#  
%LINK-5-CHANGED: Interface Loopback1, changed state to up  
  
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1,  
up  
  
R1(config-if)#  
R1(config-if)#ip add 172.16.1.1 255.255.255.0
```

```
R1(config-router)#do sh ip ospf  
Routing Process "ospf 56" with ID 1.1.1.1  
Supports only single TOS(TOS0) routes  
Supports opaque LSA  
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs  
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs  
Number of external LSA 0. Checksum Sum 0x00000000  
Number of opaque AS LSA 0. Checksum Sum 0x00000000  
Number of DCbitless external and opaque AS LSA 0  
Number of DoNotAge external and opaque AS LSA 0  
Number of areas in this router is 1. 1 normal 0 stub 0 nssa  
External flood list length 0  
Area BACKBONE(0)  
    Number of interfaces in this area is 2  
    Area has no authentication  
    SPF algorithm executed 3 times  
    Area ranges are  
        Number of LSA 3. Checksum Sum 0x014c15  
        Number of opaque link LSA 0. Checksum Sum 0x00000000  
        Number of DCbitless LSA 0  
        Number of indication LSA 0  
        Number of DoNotAge LSA 0  
    Flood list length 0
```

```
R1(config)#router ospf 56
R1(config-router)#router-
R1(config-router)#router-id 1.1.1.1
R1(config-router)#network 10.53.0.0 0.0.0.255 area 0
R1(config-router)#network 172.16.1.0 0.0.0.255 area 0
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.2	1	FULL/BDR	00:00:39	10.53.0.2	
GigabitEthernet0/0/0					

```
R2(config)#do sh ip ospf
Routing Process "ospf 56" with ID 2.2.2.2
Supports only single TOS(TOS0) routes
Supports opaque LSA
SPF schedule delay 5 secs, Hold time between two SPF 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
External flood list length 0
  Area BACKBONE(0)
    Number of interfaces in this area is 1
    Area has no authentication
    SPF algorithm executed 2 times
    Area ranges are
```

```
R2(config)#router ospf 56
R2(config-router)#router
R2(config-router)#router-id 2.2.2.2
R2(config-router)#network 10.53.0.0 0.0.0.255 area 0
R2(config-router)#network 172.0.0 0.0.0.255 area 0
00:08:20: %OSPF-5-ADJCHG: Process 56, Nbr 1.1.1.1 on Gigab
froaaaa
^
* Invalid input detected at '^' marker.

R2(config-router)#network 192.168.0.0 0.0.0.255 area 0
```

```
R2(config)#do sh ip ospf ne
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
1.1.1.1	1	FULL/DR	00:00:31	10.53.0.1	GigabitEthernet0/0/0

### Conclusion:

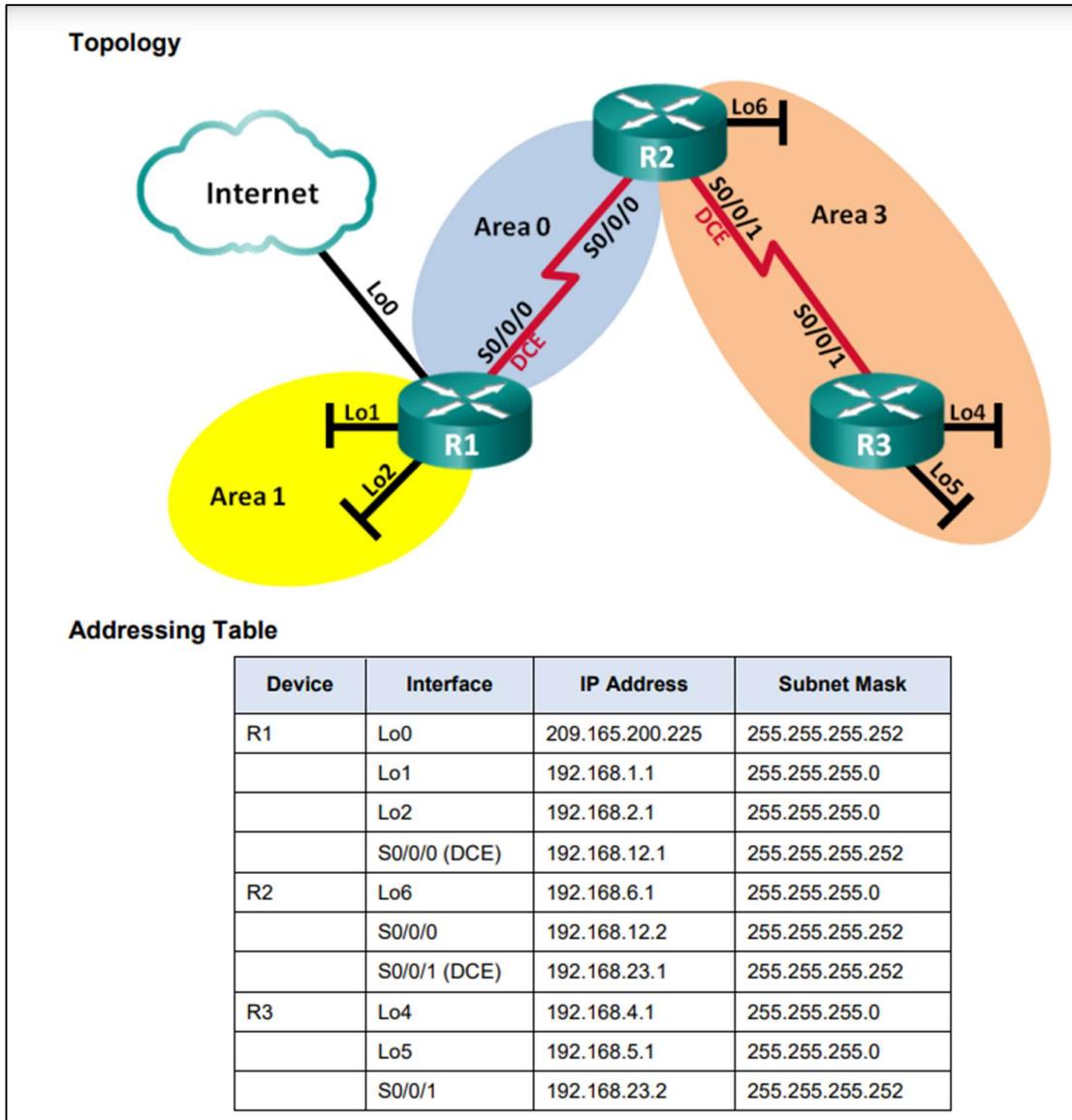
The Above Practical Configure Single-Area OSPFv2 is configured Successfully.

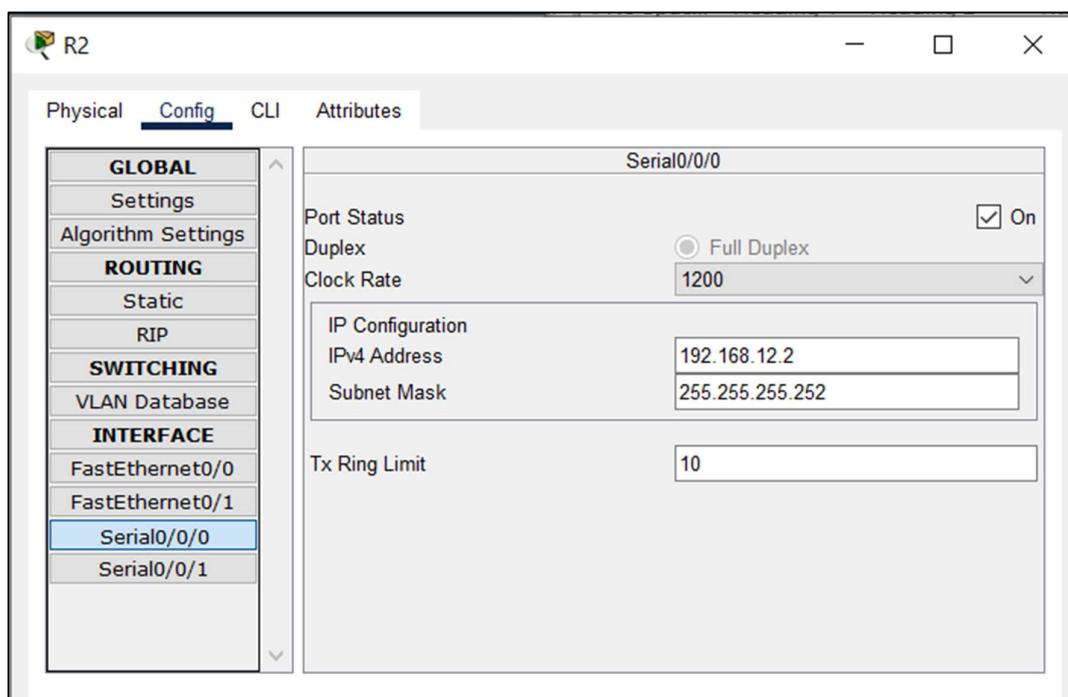
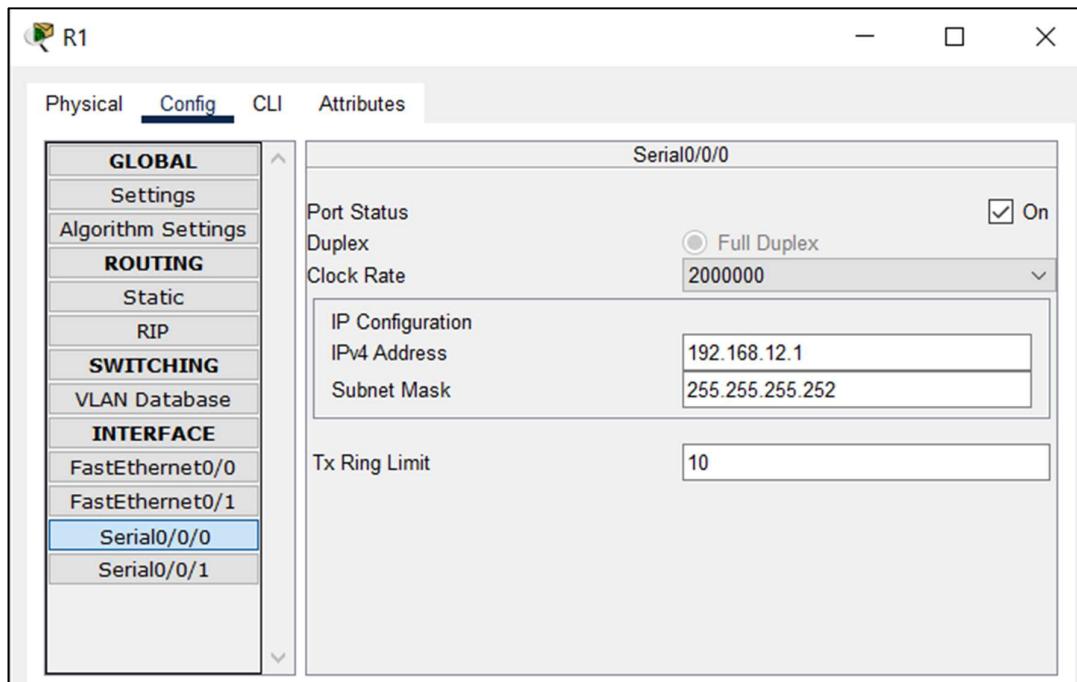
**Aim:**

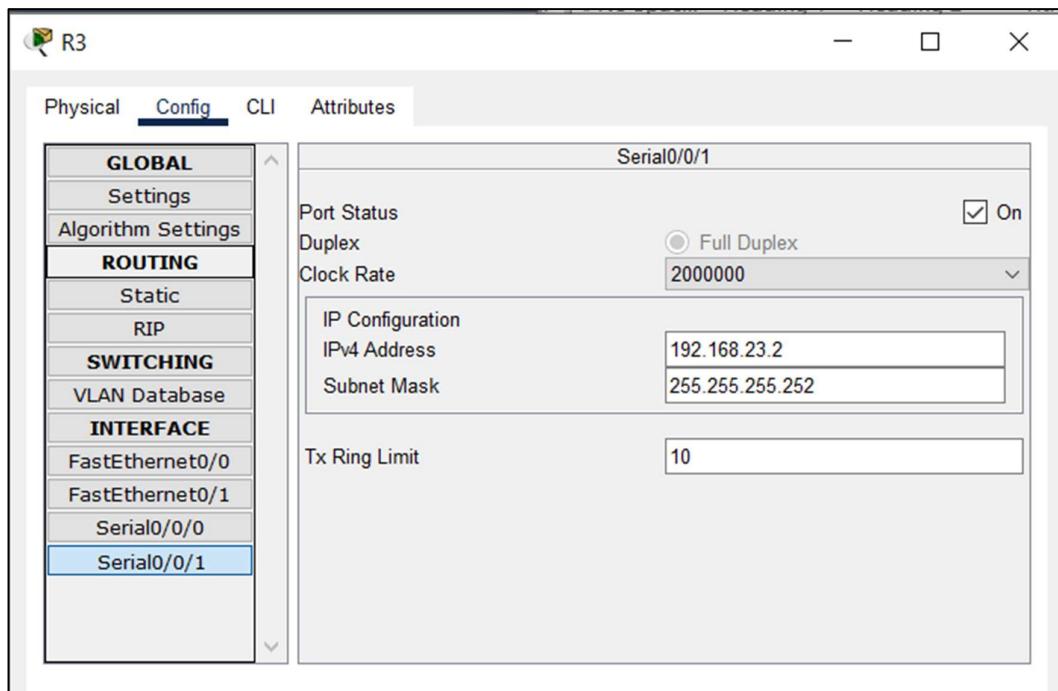
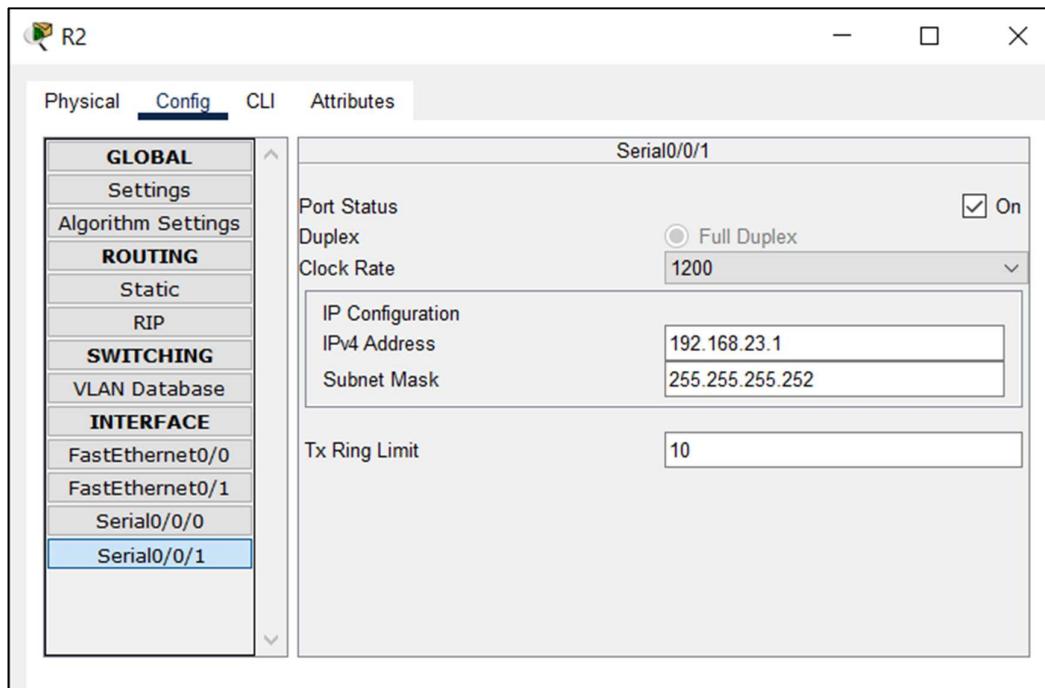
B) Configuring multi-area OSPFv2

**Theory:**

A single physical Link (Router Interface) can belong to multiple OSPF area.







```
R1(config)#int lo0
R1(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
R1(config-if)#
R1(config-if)#ip add 209.165.200.225 255.255.255.252
R1(config-if)#int lo1

R1(config-if)#
%LINK-5-CHANGED: Interface Loopback1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1,
R1(config-if)#ip add 192.168.1.1 255.255.255.0
R1(config-if)#int lo2

R1(config-if)#
%LINK-5-CHANGED: Interface Loopback2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2,
R1(config-if)#ip add 192.168.2.1 255.255.255.0
R1(config-if)#int s0/0/0
R1(config-if)#ip add 192.168.12.1 255.255.255.252
R1(config-if)#no shut
```

```
R1(config)#router ospf 1
R1(config-router)#rou
R1(config-router)#router-id 1.1.1.1
R1(config-router)#netw
R1(config-router)#network 192.168.1.0 0.0.0.255 area 1
R1(config-router)#network 192.168.2.0 0.0.0.255 area 1
R1(config-router)#network 192.168.12.0 0.0.0.3 area 0
R1(config-router)#pass
R1(config-router)#passive-interface lo1
R1(config-router)#passive-interface lo2
R1(config-router)#ip
R1(config-router)#ip rou
R1(config-router)#ip rou
R1(config-router)#ip rou
R1(config-router)#ip rou?
% Unrecognized command
R1(config-router)#exit
R1(config)#ip route
R1(config)#ip route 0.0.0.0 0.0.0.0 lo0
R1(config)#rout
R1(config)#router ospf 1
R1(config-router)#de
R1(config-router)#default-information o
R1(config-router)#default-information originate
```

```

Router(config)#hostname R2
R2(config)#int lo6

R2(config-if)#
%LINK-5-CHANGED: Interface Loopback6, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback6, changed state to up

R2(config-if)#ip add 192.168.6.1 255.255.255.0
R2(config-if)#int se0/0/0
R2(config-if)#ip add 192.168.12.2 255.255.255.252
R2(config-if)#no shut

R2(config-if)#
%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up

R2(config-if)#
R2(config-if)#
R2(config-if)#int se0/0/1
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed sdscd
^
% Invalid input detected at '^' marker.

R2(config-if)#
R2(config-if)#int se0/0/1
R2(config-if)#ip add 192.168.23.1 255.255.255.252
R2(config-if)#no shut

```

```

R2(config)#route ospf 1
R2(config-router)#ro
R2(config-router)#router-id 2.2.2.2
R2(config-router)#net
R2(config-router)#network 192.168.6.0 0.0.0.255 area 3
R2(config-router)#network 192.168.12.0 0.0.0.3 area 0
R2(config-router)#network 192.168.23.0 0.0.0.3 area 0
00:13:43: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on Serial0/0/0 wsxaxws
^
% Invalid input detected at '^' marker.

R2(config-router)#network 192.168.23.0 0.0.0.3 area 1
R2(config-router)#network 192.168.23.0 0.0.0.3 area 3
R2(config-router)#
00:14:04: %OSPF-6-AREACHG: 192.168.23.0/0 changed from area 1 to area 3
pas
R2(config-router)#passive-interface lo6
R2(config-router)#
00:17:24: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on Serial0/0/1 from LOADING to FULL, Loading Done

```

```
R2(config-router)#do sh ip ospf
Routing Process "ospf 1" with ID 2.2.2.2
Supports only single TOS(TOS0) routes
Supports opaque LSA
It is an area border router
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
Number of external LSA 1. Checksum Sum 0x00fecf
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 3. 3 normal 0 stub 0 nssa
External flood list length 0
  Area 3
    Number of interfaces in this area is 2
    Area has no authentication
    SPF algorithm executed 6 times
    Area ranges are
    Number of LSA 6. Checksum Sum 0x02913b
    Number of opaque link LSA 0. Checksum Sum 0x000000
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0
  Area BACKBONE(0)
```

```
R2(config-router)#do sh ip ospf ne
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
3.3.3.3	0	FULL/ -	00:00:33	192.168.23.2	Serial0/0/1
1.1.1.1	0	FULL/ -	00:00:36	192.168.12.1	Serial0/0/0

```
R3] (config)#hostname R3
R3(config)#int lo4

R3(config-if)#
%LINK-5-CHANGED: Interface Loopback4, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback4, changed state to up

R3(config-if)#ip add 192.168.4.1 255.255.255.0
R3(config-if)#int lo5

R3(config-if)#
%LINK-5-CHANGED: Interface Loopback5, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback5, changed state to up

R3(config-if)#ip add 192.168.5.1 255.255.255.0
R3(config-if)#int se0/0/1
R3(config-if)#ip add 192.168.23.2 255.255.255.252
R3(config-if)#no shut
```

```
R3(config)#router ospf 1
R3(config-router)#ro
R3(config-router)#router-id 3.3.3.3
R3(config-router)#ne
R3(config-router)#ne
R3(config-router)#net
R3(config-router)#network 192.168.4.0.0 0.0.0.255 area 3
^
% Invalid input detected at '^' marker.

R3(config-router)#network 192.168.4.0 0.0.0.255 area 3
R3(config-router)#networki
R3(config-router)#network 192.168.5.0 0.0.0.255 area 3
R3(config-router)#network 192.168.23.0 0.0.0.3 area 3
R3(config-router)#
00:17:23: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on Serial0/0/1
p
R3(config-router)#passive-interface lo 4
R3(config-router)#pa
R3(config-router)#passive-interface lo 5
n
```

```
R3(config)#do sh ip ospf
Routing Process "ospf 1" with ID 3.3.3.3
Supports only single TOS(TOS0) routes
Supports opaque LSA
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
Number of external LSA 1. Checksum Sum 0x00fecf
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
External flood list length 0
  Area 3
    Number of interfaces in this area is 3
    Area has no authentication
    SPF algorithm executed 3 times
    Area ranges are
      Number of LSA 6. Checksum Sum 0x02913b
      Number of opaque link LSA 0. Checksum Sum 0x000000
      Number of DCbitless LSA 0
      Number of indication LSA 0
      Number of DoNotAge LSA 0
      Flood list length 0

R3(config)#do sh ip ospf ne

Neighbor ID      Pri   State        Dead Time     Address          Interface
2.2.2.2           0     FULL/       00:00:37    192.168.23.1   Serial0/0/1
```

### **Conclusion:**

The Above Practical Configure Multi-area OSPFv2 is configured Successfully.