جامعة بيرزيت

BIRZEIT UNIVERSITY

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ENCS4130-Computer network laboratory

Report #2

Experiment 7&8 : Switching and VLANs

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Section: 7

Date: 21/11/2024

Place: Masri503

Abstract:

This experiments focuses on building practical skills in configuring and managing Cisco network devices using the Cisco IOS command-line interface (CLI) and simulators. The goal is to learn how to set up Cisco switches, work with switch simulators, and divide router interfaces into sub-interfaces. Additionally, the experiments involves splitting switches and multi-layer switches into multiple virtual ones to create and manage Virtual Local Area Networks (VLANs). By the end of the experiments, We will gain hands-on experience in configuring network devices, a solid understanding of VLANs, and the ability to simulate and troubleshoot real-world networking scenarios. This knowledge is essential for anyone looking to deepen their expertise in modern network management.

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Acronyms and Abbreviations:

→ CLI : Command line interface

→ SVI : Switch Virtual Interface

→ VLAN : Virtual Local Area Network

→ LAN : Local Area Network

→ IEEE: Institute of Electrical and Electronics Engineers

→ WAN: Wide Area Network

→ MLS : Multi-layer Switch

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1. Theory

Switching plays a vital role in computer networks, covering concepts like VLANs, multilayer switching, trunks, and how switches operate at different layers. In the first part of this experiment, we explored the basics of switching and VLANs, focusing on the "Router on a Stick" method to implement VLANs. Then, in this second part, we’re diving deeper into VLANs by introducing the "Switch Virtual Interface" (SVI) concept, using advanced multi-layer (Layer 3) switches. Together, these experiments provide a hands-on introduction to VLAN configurations and their practical uses in real-world networking.

1.1 How does a switch work

Network switches are important devices that help structure the network by splitting the large network into smaller manageable networks called subnets or LAN segments. The switch enables this process by forwarding data packets to their corresponding locations by looking up the MAC address of the receiver and determining the correct output of the data.

Switches have multiple ports, so when data comes into one of them, the switch looks at the destination address and performs some checks before sending the data to the correct device. They can perform these operations with different communication modes such as one-to-one (unicast), one-to-many (multicasting), and one-to-all (broadcasting) making them critical components in enhancing the performance of the computer network.

Whenever any device intends to transmit data to another host, the packet first arrives to the switch. The switch inspects the header of the packet to look for the MAC address of the recipient and determines the correct port for the transmission of data to the intended device.

The switch connects the two devices only for the duration of communication and disconnects them afterwards. It also facilitates clear communication by allowing each device to send and receive data simultaneously over the entire bandwidth available, thus preventing any possible collisions [1].

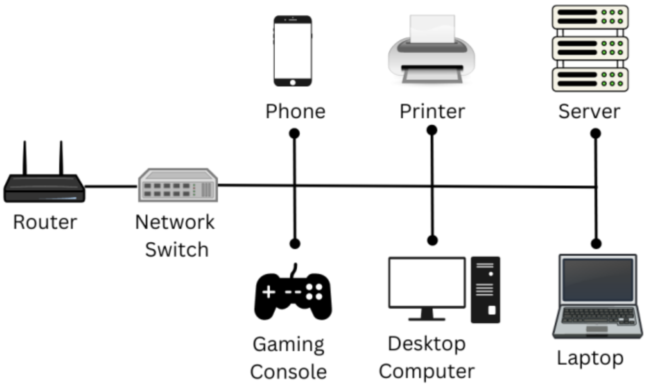


Figure 1- 1: Network Switch [2]

1.2 IEEE 802.1Q VLAN

IEEE 802.1Q, commonly referred to as Dot1Q, is a protocol that enables Virtual Local Area Networks (VLANs) onto Ethernet systems. Specifically, it describes how VLAN identifiers are inserted into the Ethernet frames and how bridges and switches process such frames. There is also an extension for this standard, which concerns the ability to prioritize traffic called IEEE 802.1p, and it also describes the Generic Attribute Registration Protocol.

In networks that utilize VLANs as envisaged in the IEEE 802.1Q standard, the frames are appended with the details of the VLAN to which the frame belongs. As a frame enters this region of the network, a VLAN ID is assigned to the frame. A single frame can only be in one VLAN, and in the case where a frame is not marked, then it is taken to be the native VLAN.

This standard is the brainchild of the group of people who were in found many improvements between years and decades so important them like IEEE 802.1ad, IEEE 802.1ak, and so on IEEE 802.1s. The update 802.1Q-2014 used also contents from the standard IEEE 802.1D-2004 [3] .

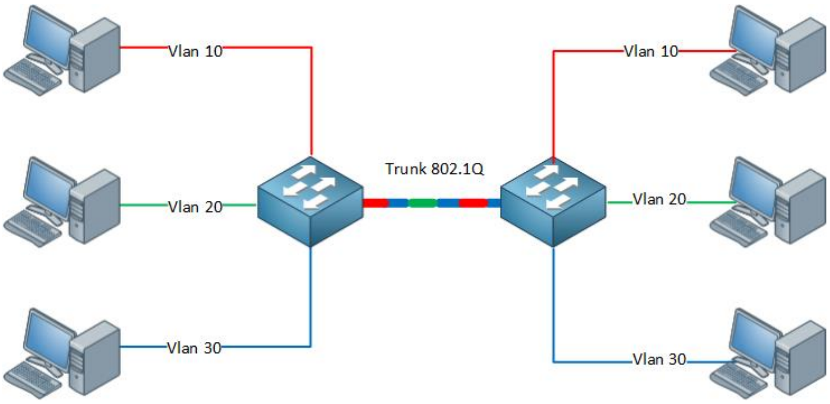


Figure 1- 2: 802.1Q Encapsulation Explained [4]

1.2.1 Tagging

Port tagging is a method designed for the recognition and delineation of particular traffic flows within a network by its associated VLAN. Network elements are able to differentiate between the Ethernet frames belonging to various VLAN's through tags attached to these frames and hence can implement settings and policies relevant. This helps especially in verticals like enterprise data network or data center wherein a number of VLANs operate on the same physical connectivity. Each network does not have to be provided with a separate cabling system and switches, port tagging is able to achieve the same goals and lower the expenses instead.

There are many pros to port tagging. Enabling segmentation of traffic – that is one of the most important functions offered. Rather than appreciate a single large area, it allows one to manage the space with ease by segmenting the use, thus maximizing the control of traffic and in turn the efficiency at which the system operates. In addition, security is reinforced, as it enables the establishment of secured broadcast domains between two virtual local area networks (VLANs), an efficient approach for networks operating with classified data. Do port tagging offers easer management; it enables the implementation of the same policies for different VLANs and therefore makes implementing access control, quality of service or IP address management easier. In turn it serves the purpose of efficient usage of wasteful resources by eliminating excessive use of bandwidth thus improving overall performance especially in networks with much traffic.

Still, there are problems associated with port tagging. There may be cases whereby it can cause incompatibility issues or configuration problems, but these can be prevented through proper design and installation. This will, however, ensure that the network remains functional and proper security measures are put in place [5] .

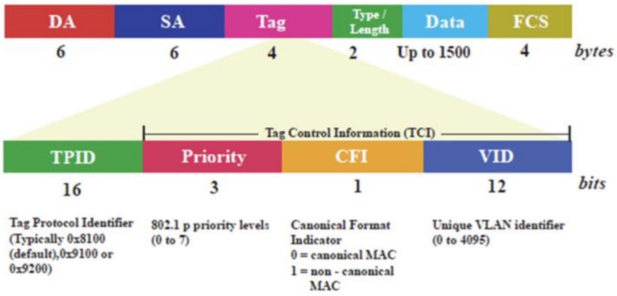

DA
SA
Tag
Type / Length
Data
FCS
6
6
4
2
Up to 1500
4
bytes
Tag Control Information (TCI)
TPID
Priority
CFI
VID
16
3
1
12
bits
Tag Protocol Identifier (Typically 0x8100 (default),0x9100 or 0x9200)
802.1 p priority levels (0 to 7)
Canonical Format Indicator
0 = canonical MAC
1 = non - canonical MAC
Unique VLAN identifier (0 to 4095)

Figure 1- 3: IEEE 802 frame structure [6]

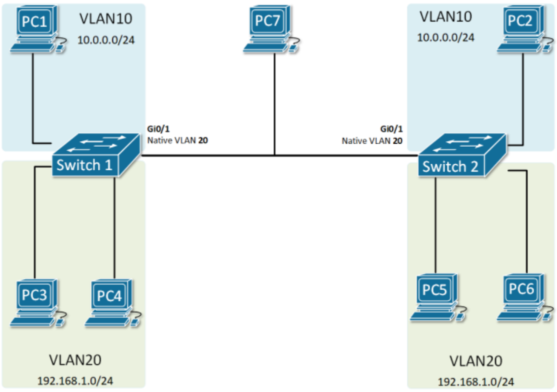


Figure 1- 4: Trunk VLAN [7]

1.3 VLAN Numbering

For every Virtual Device Context , VLANs are assigned numbers that range between 1 and 4094. When initially configure a switch as a Layer 2 switch, all its ports belong to the default VLAN, that is VLAN 1 by default. This VLAN was given some default values and we cannot add remove or suppress this VLAN.

To add a new VLAN, it simply by assign a number to it. we can also delete VLANs or put them in a suspended state. On the other hand, when create a VLAN with a number that already exists the device will enter VLAN submode but no additional VLAN will be created.

VLANs created newly will not come into effect unless we allocate Layer 2 ports to them. Therefore, by default, all ports are assumed to be under VLAN 1 [8] .

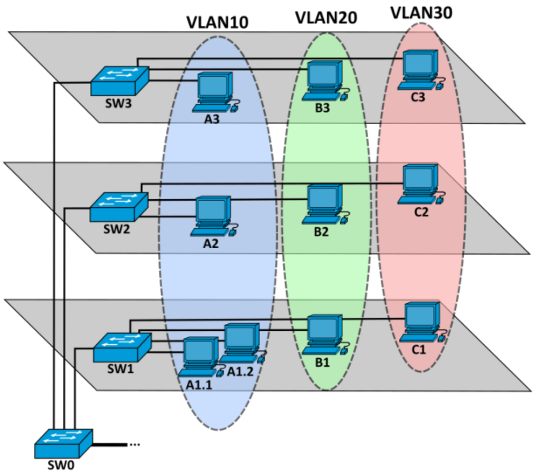


Figure 1- 5:The general concept of VLANs [9]

1.3.1 Creating a VLAN

We can create a specific VLAN on a switch using the following command:

```
Switch(config)# VLAN <VLAN-NUMBER>
```

Then we can check that this VLAN is configures using the following command:

```
Switch# show VLAN
```

1.4 Trunk and access ports

In the field of computer networking, the phrases access port and trunk port are regularly used which brings about a great deal of confusion and misunderstanding as they have different purposes. These terms are however used across various other network devices apart from Cisco. A port of access can be said to connect to only one particular VLAN while on the other hand a trunk port can connect to many VLANs at any given time. Upon close inspection, however, one can understand the fundamental differences between the two [10].

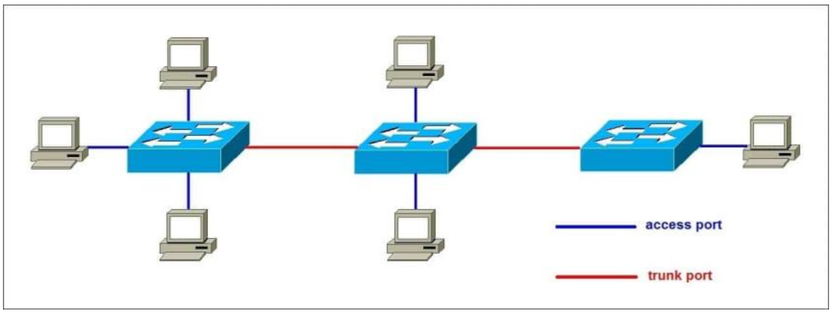


Figure 1- 6: Access and trunk ports [11]

1.4.1 Trunk Ports

A trunk port is utilized for connections between switches/ routers and allows the information of various VLANs to travel across the link simultaneously. It employs tags to ensure that the information is sent out to its appropriate destination which increases bandwidth and lowers latency. As a layer 2 device within the OSI model, trunk ports use the encapsulation method defined by IEEE 802.1Q to carry the traffic. The key advantages of trunk ports include providing higher bandwidth and lower latency as well as allowing the carrying of various VLANs traffic over one single link. The only downside is that It may be more challenging to implement than an access port [10] .

Configuring a trunk cable on switch is simple. We must access the needed port and perform the following command:

```
Switch(config -if)# switchport mode trunk
```

When one end of a link is configured as a trunk, the other end changes automatically to trunk mode.

1.4.2 Access Ports

An access port connects virtual machines to a switch or VLAN, handling data within just one VLAN. This setup avoids signal problems because the frames stay within the same VLAN, but it might not be the best fit for more complex networks. However, it can be improved by using it as a host port for better efficiency. The main benefits of access ports are that they send and receive untagged frames, and there are no signal issues as long as the traffic stays in one VLAN. Additionally, using a host port can speed up the time it takes for the port to start forwarding packets. The downside is that access ports can only carry traffic for a single VLAN, and only end stations can be set as host ports[10].

To Assigning an interface to an existing VLAN. We must access the needed port and perform the following command:

```
Switch(config -if)# switchport access VLAN <VLAN-NUMBER<
```

This command assigns the interface to VLAN with the VLAN-NUMBER.

we can also assign a group of interfaces to a VLAN. To do that, we can use the following command that creates a range of interfaces, and then we can assign them to any VLAN using the access command.

```
Switch(config)#interface range <TYPE> <SLOT>/<START-PORT> - <ENDPORT<
```

For example:

```
Switch(config)#interface range fastethernet0/1 – 20
```

Then assign them to a specific VLAN using the access command.

1.5 Sub interface on Routers

A sub-interface is defined as a virtual interface made by dividing one physical interface into several interfaces logically. A sub-interface on a Cisco router utilizes the underlying physical interface to transmit and receive packets. sub-interface are beneficial in many situations. For instance, in the case of a router with only one physical interface, but needs to connect to two different IP networks in order to route the traffic to the second router, numerous sub-interface can be configured on that single physical interface. Each sub-interface is assigned an IP address from a different subnet allowing the router to route traffic across those subnets. sub-interface are widely implemented in scenarios such as inter-VLAN routing in a Router-on-a-Stick configuration and in Non-Broadcast Multiple Access (NBMA) Wide Area Networks (WAN) that employ frame relay or ATM technologies [12] .

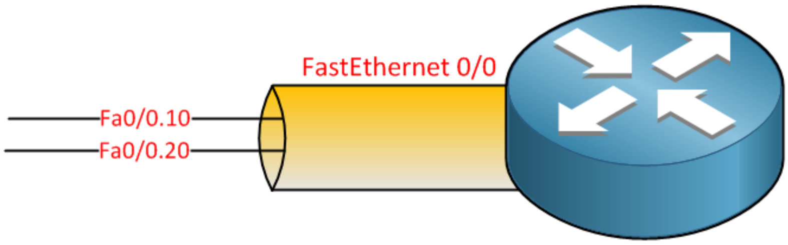


Figure 1- 7: Sub interface on Routers [13]

1.5.1 Initializing a sub interface

The command Router(config)# interface <TYPE> <SLOT>/<PORT>.<SUB-INTERFACE-NUMBER> is used to define a subinterface on the primary interface. Here, the type, slot, and port refer to the same values displayed on the router’s interface, while the subinterface number represents the virtual interface created within the primary interface.

1.5.2 Initializing IP address for a sub interface

The commands Router(config-subif)# encapsulation dot1Q <VLAN-ID> and Router(config-subif)# ip address <IP-ADDRESS> <SUBNET-MASK> are used to assign an IP address to a subinterface. The encapsulation command configures the subinterface according to the IEEE 802.1Q standard, while the IP address command assigns an IP address and subnet mask to that subinterface.

1.6 Third layer switch

A Layer 3 switch is a piece of network hardware that encompasses the functions of a switch and a router in one unit. It is capable of operating on both Layer 2 (Data Link) and Layer 3 (Network) of the OSI reference model which thus enables it to route traffic between different VLANs. It is capable of performing such tasks as routing by incorporating additional routing protocols such as RIP, OSPF, and EIGRP with the objective of making network management easier and therefore eliminating the need for routers in all cases. The smart routing capabilities ensure that there is an increase in the general output of the network together with a reduction in the need for physical devices and connections which often result in high latency and difficulty in configuring VLANs [14] .

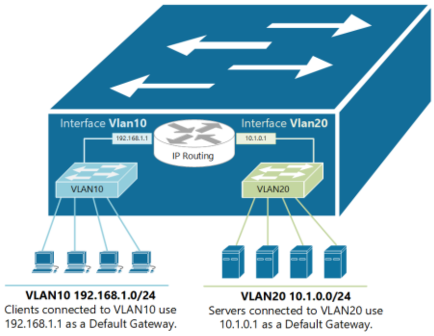

Interface Vlan10
192.168.1.1
IP Routing
Interface Vlan20
10.1.0.1
VLAN10
VLAN20
VLAN10 192.168.1.0/24
Clients connected to VLAN10 use 192.168.1.1 as a Default Gateway.
VLAN20 10.1.0.0/24
Servers connected to VLAN20 use 10.1.0.1 as a Default Gateway.

Figure 1- 8: Third Layer switch [15]

1.6.1 Features of a layer 3 switch

A Layer 3 switch functions on the Layer 2 and Layer 3 of the OSI model, most of the time providing 24 or 48 Ethernet. It permits intra. And helps to improve the overall performance of the interconnection and the management of the network because of the simple switching technique used and routing protocols. Such type of switches are used to efficiently connect multiple equipment's within a large data network [14] .

1.6.2 Benefits of a layer 3 switch

Layer 3 switches enable inter-VLAN routing, enhance the fault-tolerance mechanism and ease the management of security controls. In addition, they help decrease broadcast traffic, ease the use of VLANs in practice, and eliminate the need for extra routers. Because they contain separate routing tables, the switches create a more efficient flow of traffic, facilitate high-speed growth, and reduce the latency of the network by reducing the number of routers needed to send the packets. These characteristics make it possible for them to function efficiently and effectively in a network that does not compromise its scalability [14].

1.6.2 Disadvantages of layer 3 switch

Due to their higher cost and complexity of management as compared to layer 2 switches, layer 3 switches are primarily designed for larger enterprise networks. One of their disadvantages is lack of WAN capabilities, thus, routers are still necessary for purposes of connecting to other traffic. They are not as fast as layer 2 switches; however, their capacity is also limited because a VLAN is often associated with one switch making the use of several switches well-planned. Such situations pose challenges especially in multiprovider networks. Layer 3 switches might not be appropriate for smaller organizations as a result of these difficulties [14].

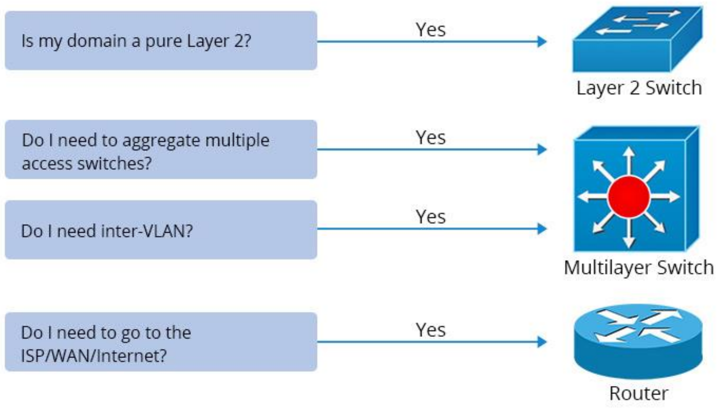

Is my domain a pure Layer 2?
Yes
Layer 2 Switch
Do I need to aggregate multiple access switches?
Yes
Do I need inter-VLAN?
Yes
Multilayer Switch
Do I need to go to the ISP/WAN/Internet?
Yes
Router

Figure 1- 9: Layer 2 vs Layer 3 Switch [16]

1.7 Configuring Third Layer Switch

1.7.1 Switch to Router link

In order for a third layer switch port to work as a router port, we have to use the following command:

```
Switch(config-if)#no switchport
Switch(config-if)# ip address
```

This command enables the interface to work as a router interface. It takes an IP address and Subnet mask.

1.7.2 Enable routing

This can be done using the following command:

```
Switch(config)# ip routing
```

1.7.3 Switch Virtual Interfaces

This can be done as follows:

```
Switch(config)#interface vlan <VLAN-NUMBER<
Switch(config-if)# ip address <IP-ADDRESS> <SUBNET-MASK>
```

After this, a new VLAN interface will be created with the IP address assigned to it.

2. Procedure And Data Analysis For Experiment 7

2.1 Building the Topology

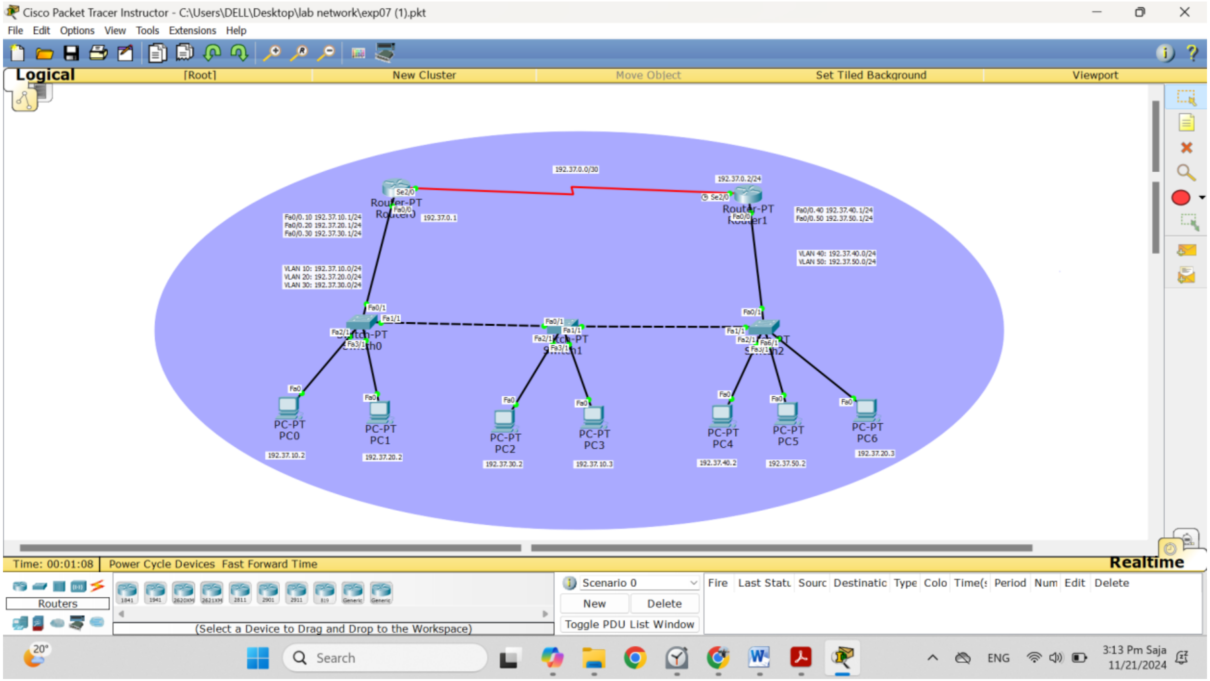
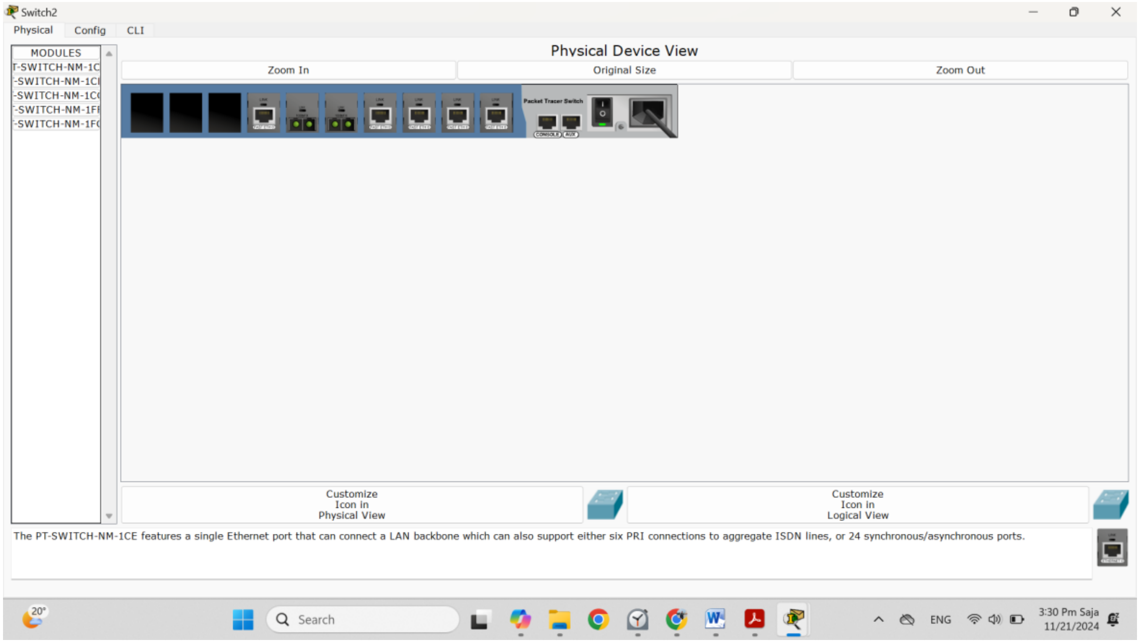


Figure 2- 1: The Toplogy

To set up the network topology in Figure 2-1 , two Cisco routers and three Cisco switches are required for interconnectivity. Six PCs will act as end devices for testing and communication. Several CAT5 straight-wired cables will be used to connect devices within the network, and a serial cable with male and female connectors will enable communication between the two routers. This equipment is essential for building and configuring the desired network environment effectively.

For switch 2, I add an extra interface physically using PT-SWITCH-NM-1CFE Module, as shown in the Figure below:



The PT-SWITCH-NM-1CE features a single Ethernet port that can connect a LAN backbone which can also support either six PRI connections to aggregate ISDN lines, or 24 synchronous/asynchronous ports.

Figure 2- 2: Adding interface to Switch 2

This is the IP address for the topology requirements:

Table 2- 1: Networks IPS

Area	Network	Device	Interface	IP	Subnet Mask	Wildcard Mask	VLAN ID
0	192.37.0.0/30	Router 1	Se2/0	192.37.0.2	255.255.255.252	0.0.0.3	1
0	192.37.0.0/30	Router 0	Se2/0	192.37.0.1	255.255.255.252	0.0.0.3	1
0	192.37.10.0/24	Router 1	Fa0/0.10	192.37.10.1	255.255.255.0	0.0.0.255	10
0	192.37.10.0/24	PC0	Fa0	192.37.10.2	255.255.255.0	0.0.0.255	10
0	192.37.10.0/24	PC3	Fa0	192.37.10.3	255.255.255.0	0.0.0.255	10
0	192.37.20.0/24	Router 0	Fa0/0.20	192.37.20.1	255.255.255.0	0.0.0.255	20
0	192.37.20.0/24	PC1	Fa0	192.37.20.2	255.255.255.0	0.0.0.255	20
0	192.37.20.0/24	PC6	Fa0	192.37.20.3	255.255.255.0	0.0.0.255	20

0	192.37.30.0/24	Router 0	Fa0/0.30	192.37.30.1	255.255.255.0	0.0.0.255	30
0	192.37.30.0/24	PC2	Fa0	192.37.30.2	255.255.255.0	0.0.0.255	30
0	192.37.40.0/24	Router 1	Fa0/0.40	192.37.40.1	255.255.255.0	0.0.0.255	40
0	192.37.40.0/24	PC4	Fa0	192.37.40.2	255.255.255.0	0.0.0.255	40
0	192.37.50.0/24	Router 1	Fa0/0.50	192.37.50.1	255.255.255.0	0.0.0.255	50
0	192.37.50.0/24	PC5	Fa0	192.37.50.2	255.255.255.0	0.0.0.255	50

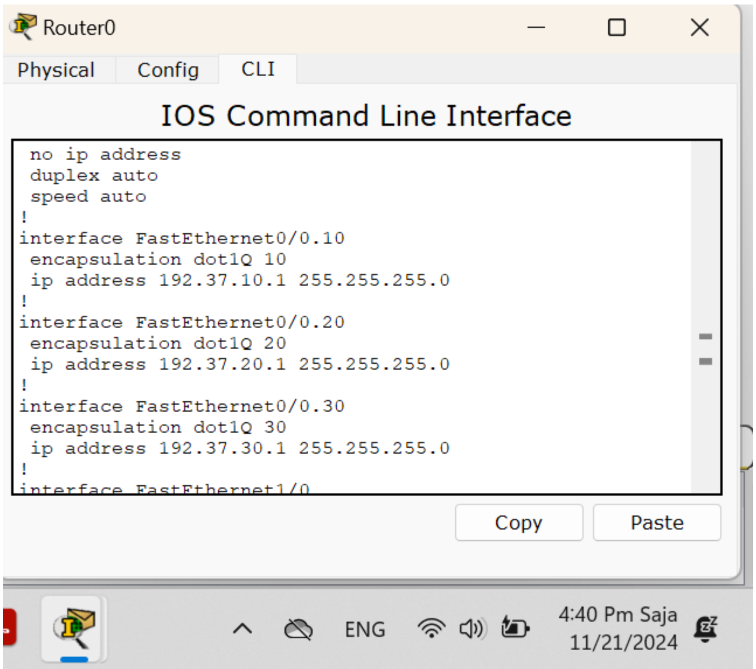
2.1 Configuring Routers

2.1.1 Configuring Routers Sub Interfaces

When using the Router on a Stick method to configure VLANs, a separate subinterface must be created for each VLAN on the switch. Each subinterface serves as the default gateway for its corresponding VLAN, enabling proper routing and communication between VLANs.

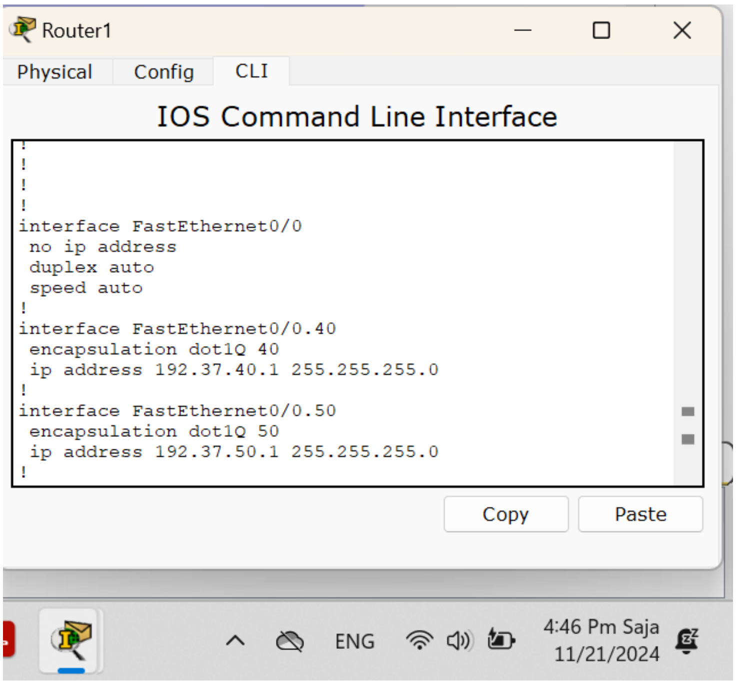
The commands used for configuring a sub interface are:

```
Router(config)# interface <TYPE> <SLOT>/<PORT>.<SUB-INTERFACE-NUMBER>
Router(config-subif)#encapsulation dot1Q <VLAN-ID>
Router(config-subif)#ip address <IP-ADDRESS> <SUBNET-MASK>
```



```
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/0.10
 encapsulation dot1Q 10
 ip address 192.37.10.1 255.255.255.0
!
interface FastEthernet0/0.20
 encapsulation dot1Q 20
 ip address 192.37.20.1 255.255.255.0
!
interface FastEthernet0/0.30
 encapsulation dot1Q 30
 ip address 192.37.30.1 255.255.255.0
!
interface FastEthernet1/0
```

Figure 2- 3: Sub interface Fa0/0 in router0

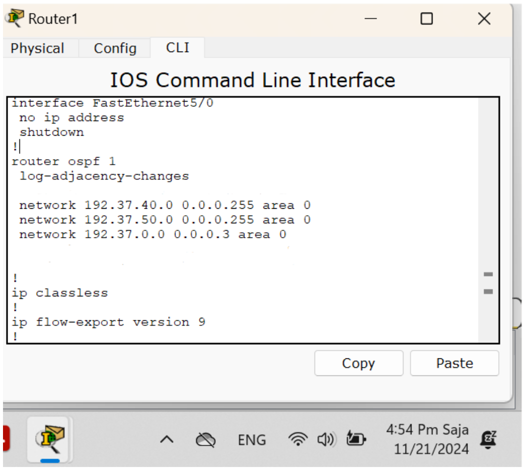


```
!
!
!
!
interface FastEthernet0/0
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/0.40
 encapsulation dot1Q 40
 ip address 192.37.40.1 255.255.255.0
!
interface FastEthernet0/0.50
 encapsulation dot1Q 50
 ip address 192.37.50.1 255.255.255.0
!
```

Figure 2- 4: Sub interface Fa0/0 in router1

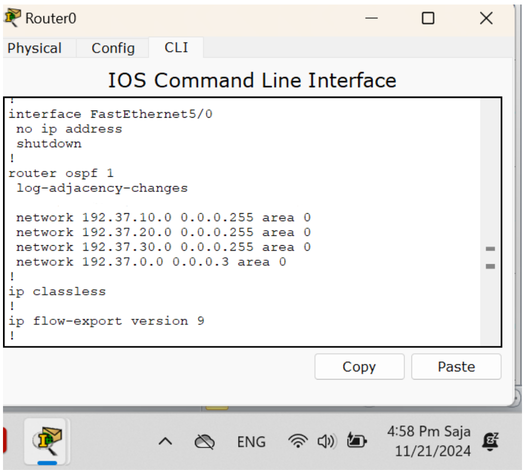
2.1.2 Configuring OSPF Routing

I configure OSPF routing protocol for both routers 0 and 1



```
interface FastEthernet5/0
 no ip address
 shutdown
!
router ospf 1
 log-adjacency-changes

 network 192.37.40.0 0.0.0.255 area 0
 network 192.37.50.0 0.0.0.255 area 0
 network 192.37.0.0 0.0.0.3 area 0


!
ip classless
!
ip flow-export version 9
!
```

Figure 2- 5: Configuring OSPF in Router 1



```
!
interface FastEthernet5/0
 no ip address
 shutdown
!
router ospf 1
 log-adjacency-changes

 network 192.37.10.0 0.0.0.255 area 0
 network 192.37.20.0 0.0.0.255 area 0
 network 192.37.30.0 0.0.0.255 area 0
 network 192.37.0.0 0.0.0.3 area 0
!
ip classless
!
ip flow-export version 9
!
```

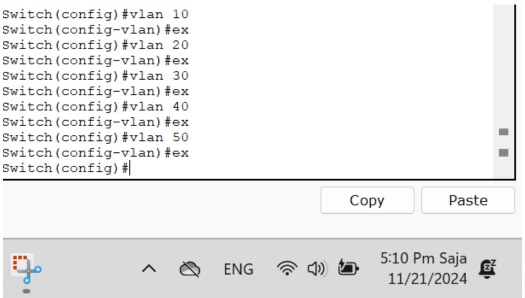
Figure 2- 6: Configuring OSPF in Router 0

2.1.3 Configuring Switches

2.1.3.1 Creating a VLAN

We can create a specific VLAN on a switch using the following command: Switch(config)# VLAN <VLAN- Number>

and in each switch we create this command for all VLAN in the toplogy



```
Switch(config)#vlan 10
Switch(config-vlan)#ex
Switch(config)#vlan 20
Switch(config-vlan)#ex
Switch(config)#vlan 30
Switch(config-vlan)#ex
Switch(config)#vlan 40
Switch(config-vlan)#ex
Switch(config)#vlan 50
Switch(config-vlan)#ex
Switch(config)#
```

Figure 2- 7 : Creating VLAN in each switch

Now all VLANS is configured inside each switch

2.1.3.2 Configuring Switch Access and Trunks

Assigning an interface to an existing VLAN we must access the needed port and perform the access command:

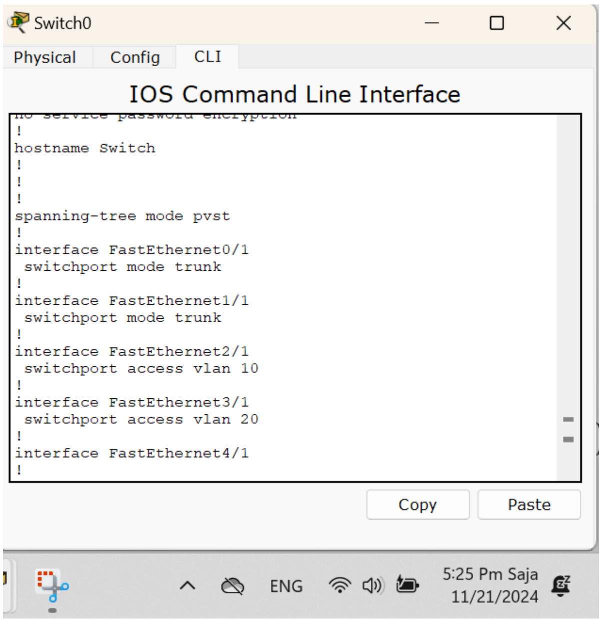
```
Switch(config-if)# switchport access VLAN <VLAN – Number>
```

Assigning an interface to be a trunk is simple. we must access the needed port and perform the following command:

```
Switch(config -if)# switchport mode trunk
```

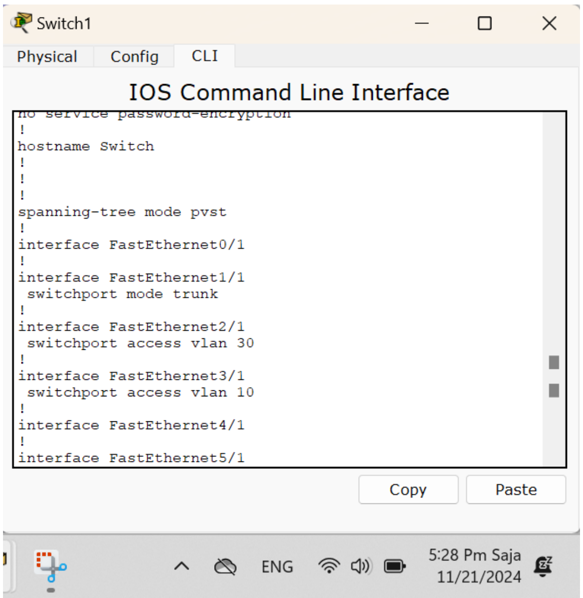
Table 2- 2 : Switches Ports

Switch	Port	Kind	VLAN
Switch 0	Fa0/1	Trunk	---
Switch 0	Fa1/1	Trunk	---
Switch 0	Fa2/1	Access	10
Switch 0	Fa3/1	Access	20
Switch 1	Fa0/1	Trunk	---
Switch 1	Fa1/1	Trunk	---
Switch 1	Fa2/1	Access	30
Switch 1	Fa3/1	Access	10
Switch 2	Fa0/1	Trunk	---
Switch 2	Fa1/1	Trunk	---
Switch 2	Fa2/1	Access	40
Switch 2	Fa3/1	Access	50
Switch 2	Fa6/1	Access	20



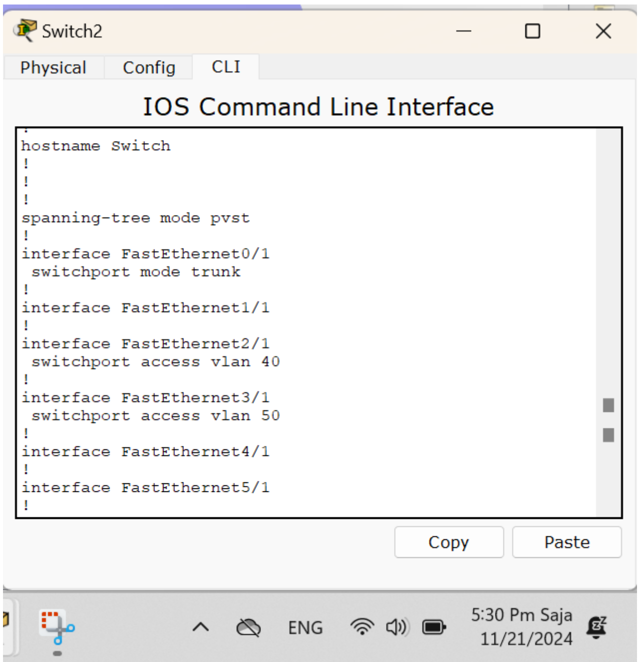
```
no service password-encryption
!
hostname Switch
!
!
!
spanning-tree mode pvst
!
interface FastEthernet0/1
 switchport mode trunk
!
interface FastEthernet1/1
 switchport mode trunk
!
interface FastEthernet2/1
 switchport access vlan 10
!
interface FastEthernet3/1
 switchport access vlan 20
!
interface FastEthernet4/1
!
```

Figure 2- 8: Configuring Switch Access and Trunks for switch 0



```
no service password-encryption
!
hostname Switch
!
!
!
spanning-tree mode pvst
!
interface FastEthernet0/1
!
interface FastEthernet1/1
 switchport mode trunk
!
interface FastEthernet2/1
 switchport access vlan 30
!
interface FastEthernet3/1
 switchport access vlan 10
!
interface FastEthernet4/1
!
interface FastEthernet5/1
```

Figure 2- 9: Configuring Switch Access and Trunks for switch 1



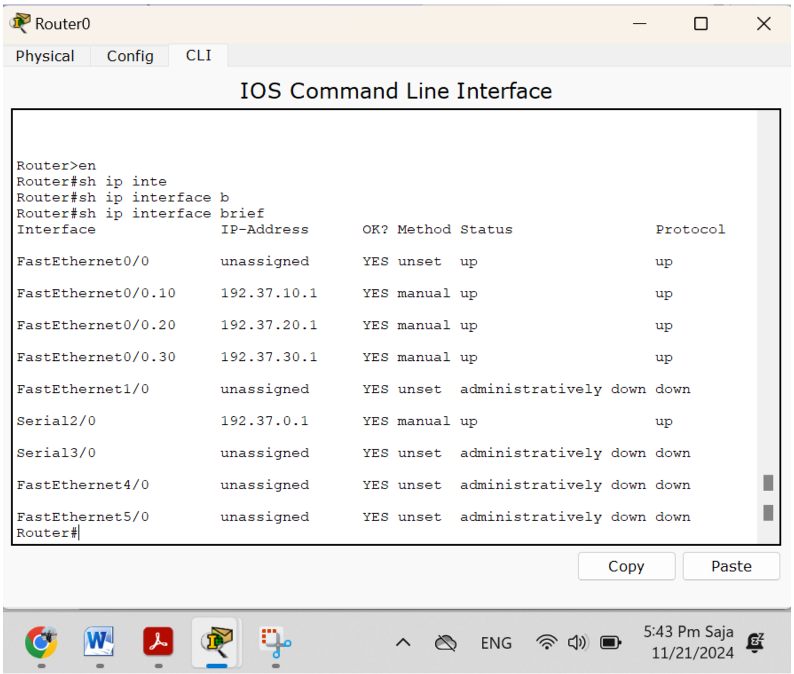
```
!
hostname Switch
!
!
!
spanning-tree mode pvst
!
interface FastEthernet0/1
 switchport mode trunk
!
interface FastEthernet1/1
!
interface FastEthernet2/1
 switchport access vlan 40
!
interface FastEthernet3/1
 switchport access vlan 50
!
interface FastEthernet4/1
!
interface FastEthernet5/1
!
```

Figure 2- 10: Configuring Switch Access and Trunks for switch 2

3. Results For Experiment 7

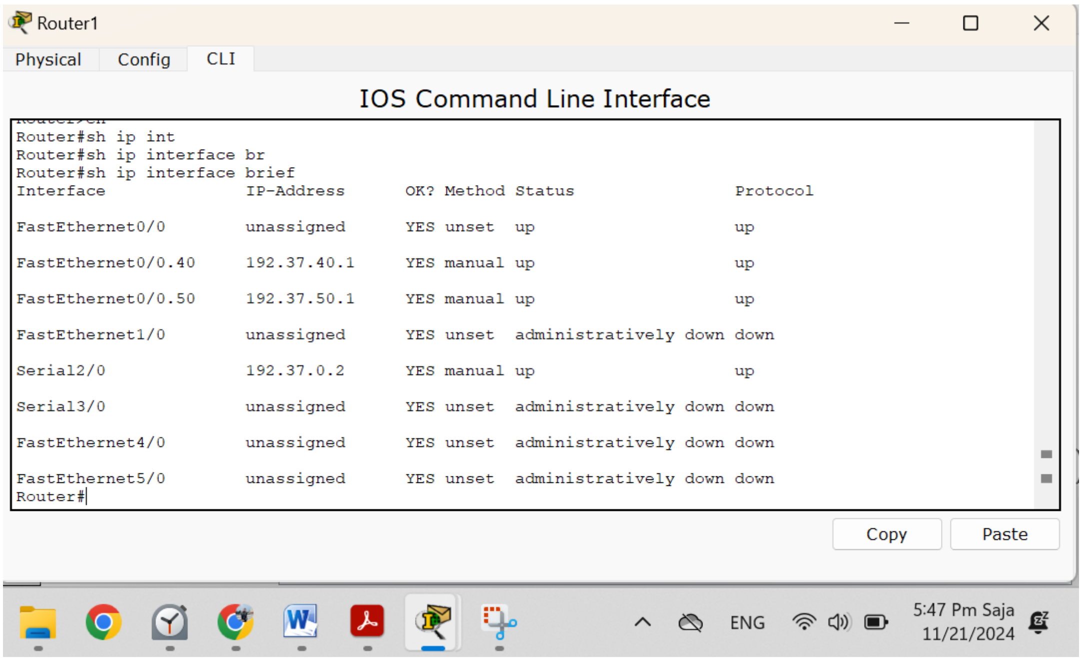
3.1 Router Interfaces:

The configured interfaces are verified by using the command "show ip interface brief" .



```
Router>en
Router#sh ip inte
Router#sh ip interface b
Router#sh ip interface brief
Interface              IP-Address      OK? Method Status                Protocol

FastEthernet0/0        unassigned      YES unset  up                    up

FastEthernet0/0.10     192.37.10.1     YES manual up                    up

FastEthernet0/0.20     192.37.20.1     YES manual up                    up

FastEthernet0/0.30     192.37.30.1     YES manual up                    up

FastEthernet1/0        unassigned      YES unset  administratively down down

Serial2/0              192.37.0.1      YES manual up                    up

Serial3/0              unassigned      YES unset  administratively down down

FastEthernet4/0        unassigned      YES unset  administratively down down

FastEthernet5/0        unassigned      YES unset  administratively down down
Router#
```

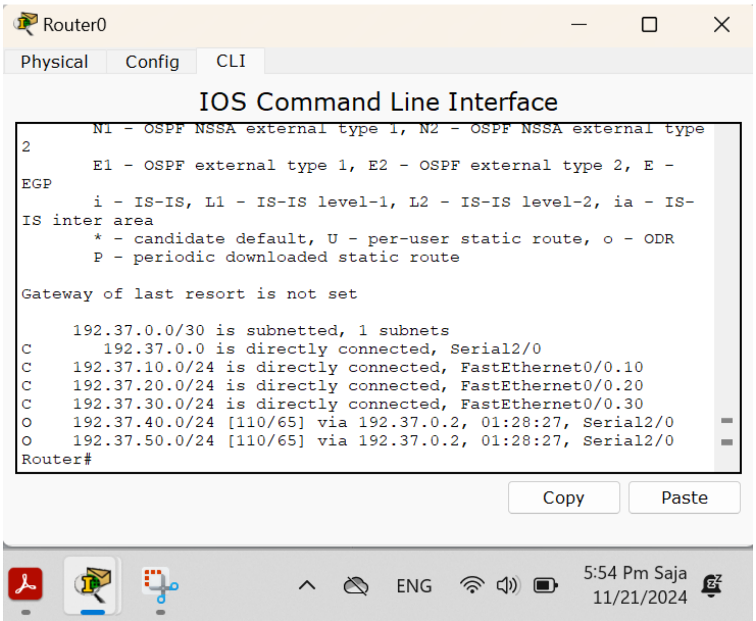
Figure 3- 1 : Router 0 interface configuration



```
Router#sh ip int
Router#sh ip interface br
Router#sh ip interface brief
Interface              IP-Address      OK? Method Status                Protocol

FastEthernet0/0        unassigned      YES unset  up                    up

FastEthernet0/0.40     192.37.40.1     YES manual up                    up

FastEthernet0/0.50     192.37.50.1     YES manual up                    up

FastEthernet1/0        unassigned      YES unset  administratively down down

Serial2/0              192.37.0.2      YES manual up                    up

Serial3/0              unassigned      YES unset  administratively down down

FastEthernet4/0        unassigned      YES unset  administratively down down

FastEthernet5/0        unassigned      YES unset  administratively down down
Router#
```

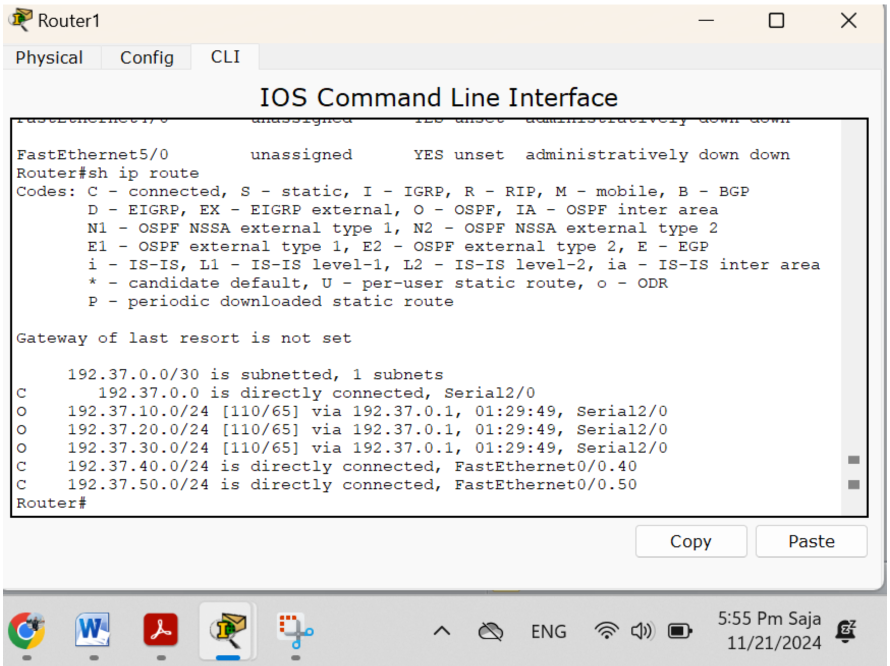
Figure 3- 2: Router 1 interface configuration

3.2 Router OSPF:



```
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type
2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E -
EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-
IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     192.37.0.0/30 is subnetted, 1 subnets
C       192.37.0.0 is directly connected, Serial2/0
C    192.37.10.0/24 is directly connected, FastEthernet0/0.10
C    192.37.20.0/24 is directly connected, FastEthernet0/0.20
C    192.37.30.0/24 is directly connected, FastEthernet0/0.30
O    192.37.40.0/24 [110/65] via 192.37.0.2, 01:28:27, Serial2/0
O    192.37.50.0/24 [110/65] via 192.37.0.2, 01:28:27, Serial2/0
Router#
```

Figure 3- 3: Router 0 ip route

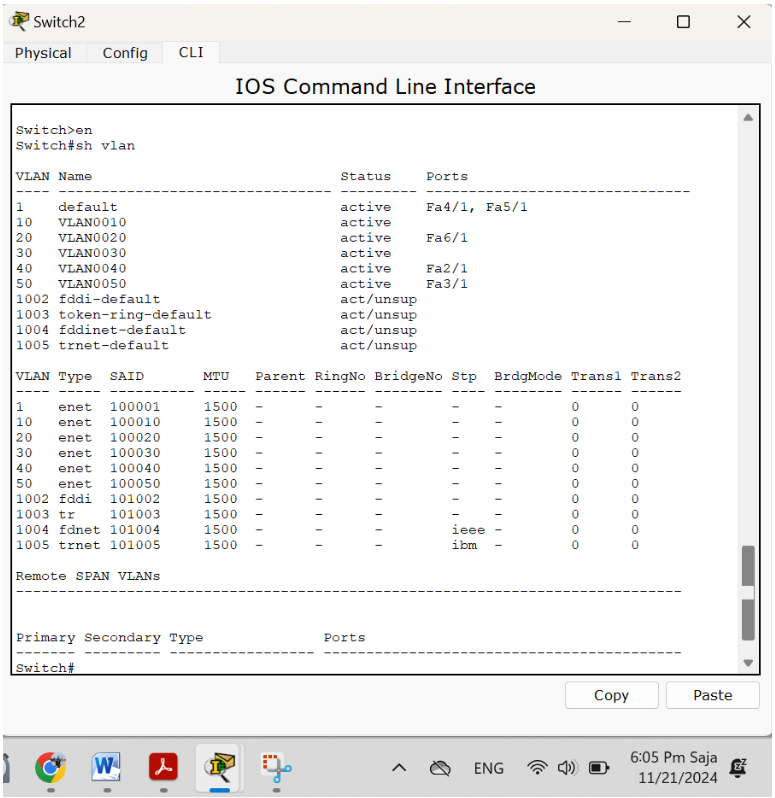


```
FastEthernet4/0        unassigned      YES unset  administratively down down
FastEthernet5/0        unassigned      YES unset  administratively down down
Router#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     192.37.0.0/30 is subnetted, 1 subnets
C       192.37.0.0 is directly connected, Serial2/0
O    192.37.10.0/24 [110/65] via 192.37.0.1, 01:29:49, Serial2/0
O    192.37.20.0/24 [110/65] via 192.37.0.1, 01:29:49, Serial2/0
O    192.37.30.0/24 [110/65] via 192.37.0.1, 01:29:49, Serial2/0
C    192.37.40.0/24 is directly connected, FastEthernet0/0.40
C    192.37.50.0/24 is directly connected, FastEthernet0/0.50
Router#
```

Figure 3- 4: Router 1 ip route

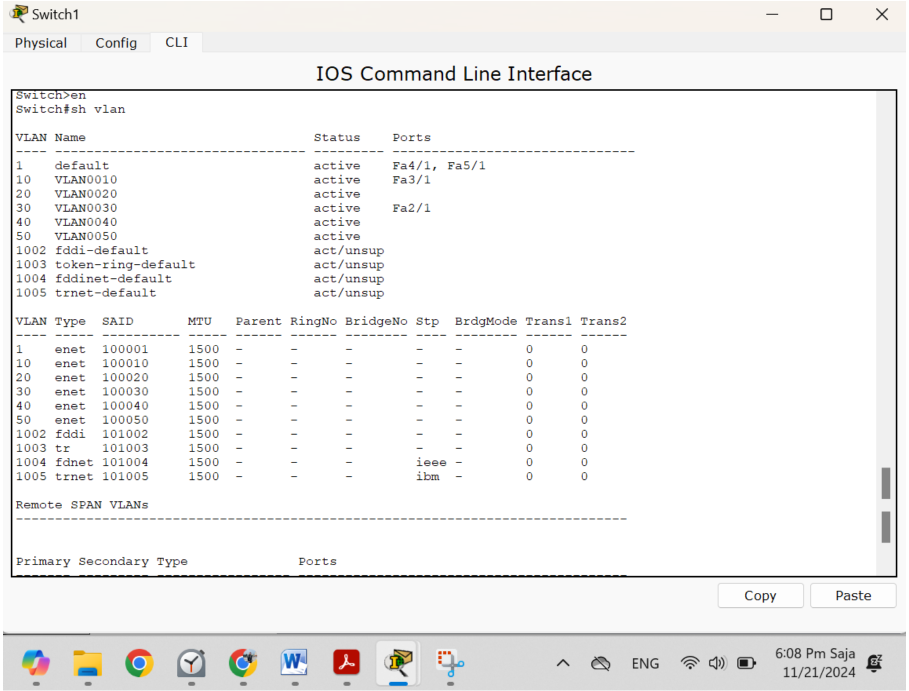
3.3 Switches VLANs

The configured VLANs done by the "show vlan" command which is used in Cisco networking devices, such as switches, to display information about the VLANs configured on the switch. This command provides details about the VLAN IDs, names, and associated ports.



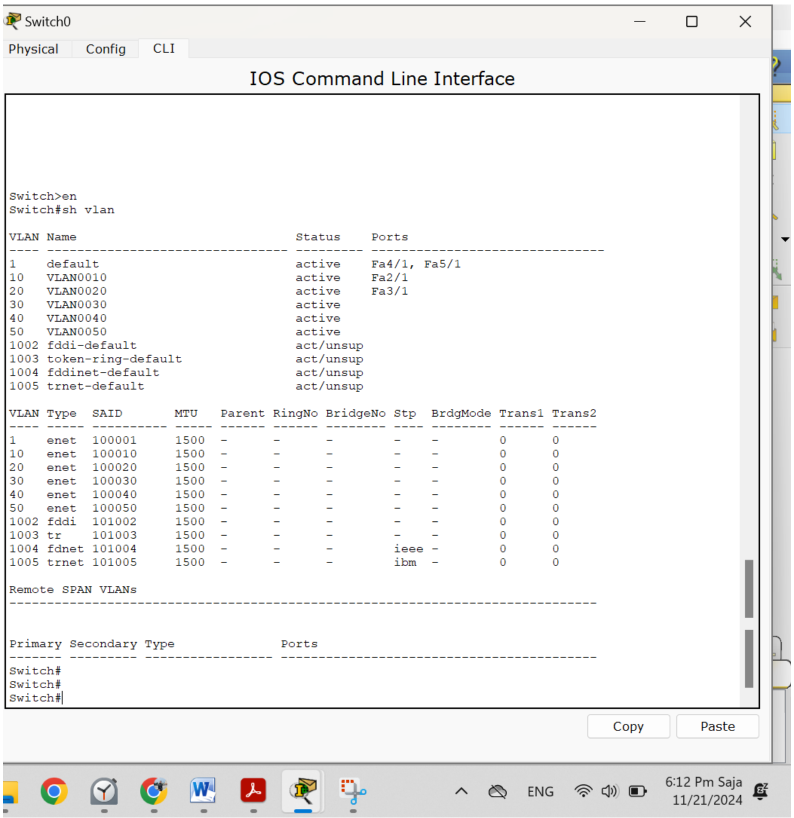
```
Switch>en
Switch#sh vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa4/1, Fa5/1
10   VLAN0010                         active    
20   VLAN0020                         active    Fa6/1
30   VLAN0030                         active    
40   VLAN0040                         active    Fa2/1
50   VLAN0050                         active    Fa3/1
1002 fddi-default                     act/unsup 
1003 token-ring-default               act/unsup 
1004 fddinet-default                  act/unsup 
1005 trnet-default                    act/unsup 

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        0      0
10   enet  100010     1500  -      -      -        -    -        0      0
20   enet  100020     1500  -      -      -        -    -        0      0
30   enet  100030     1500  -      -      -        -    -        0      0
40   enet  100040     1500  -      -      -        -    -        0      0
50   enet  100050     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        0      0
1003 tr    101003     1500  -      -      -        -    -        0      0
1004 fdnet 101004     1500  -      -      -        ieee -        0      0
1005 trnet 101005     1500  -      -      -        ibm  -        0      0

Remote SPAN VLANs
------------------------------------------------------------------------------


Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------
Switch#
```

Figure 3- 5: VLAN configrution for switch 2



```
Switch>en
Switch#sh vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa4/1, Fa5/1
10   VLAN0010                         active    Fa3/1
20   VLAN0020                         active    
30   VLAN0030                         active    Fa2/1
40   VLAN0040                         active    
50   VLAN0050                         active    
1002 fddi-default                     act/unsup 
1003 token-ring-default               act/unsup 
1004 fddinet-default                  act/unsup 
1005 trnet-default                    act/unsup 

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        0      0
10   enet  100010     1500  -      -      -        -    -        0      0
20   enet  100020     1500  -      -      -        -    -        0      0
30   enet  100030     1500  -      -      -        -    -        0      0
40   enet  100040     1500  -      -      -        -    -        0      0
50   enet  100050     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        0      0
1003 tr    101003     1500  -      -      -        -    -        0      0
1004 fdnet 101004     1500  -      -      -        ieee -        0      0
1005 trnet 101005     1500  -      -      -        ibm  -        0      0

Remote SPAN VLANs
------------------------------------------------------------------------------


Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------
```

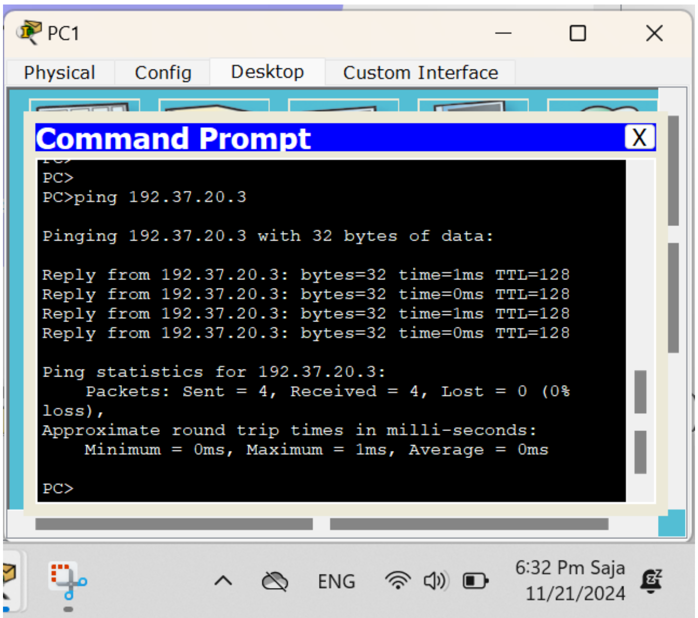
Figure 3- 6: VLAN configrution for switch 1



```
Switch>en
Switch#sh vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa4/1, Fa5/1
10   VLAN0010                         active    Fa2/1
20   VLAN0020                         active    Fa3/1
30   VLAN0030                         active
40   VLAN0040                         active
50   VLAN0050                         active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        0      0
10   enet  100010     1500  -      -      -        -    -        0      0
20   enet  100020     1500  -      -      -        -    -        0      0
30   enet  100030     1500  -      -      -        -    -        0      0
40   enet  100040     1500  -      -      -        -    -        0      0
50   enet  100050     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        0      0
1003 tr    101003     1500  -      -      -        -    -        0      0
1004 fdnet 101004     1500  -      -      -        ieee -        0      0
1005 trnet 101005     1500  -      -      -        ibm  -        0      0

Remote SPAN VLANs
------------------------------------------------------------------------------


Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------
Switch#
Switch#
Switch#
```

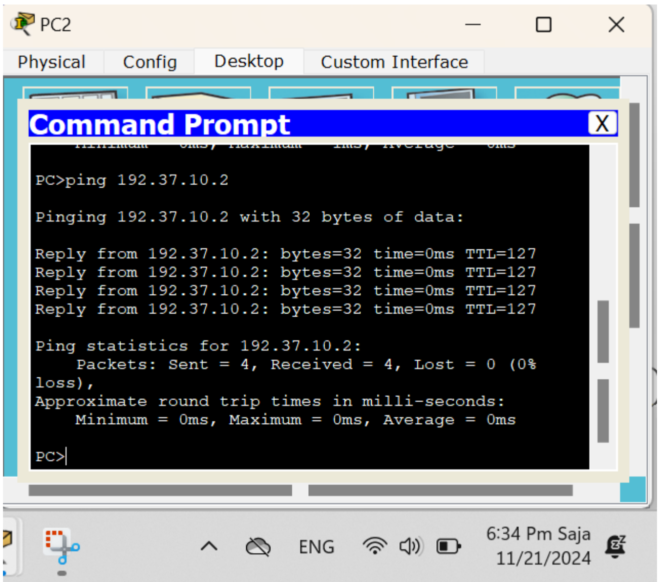
Figure 3- 7:VLAN configrution for switch 0

3.4 Test Connection for Topology



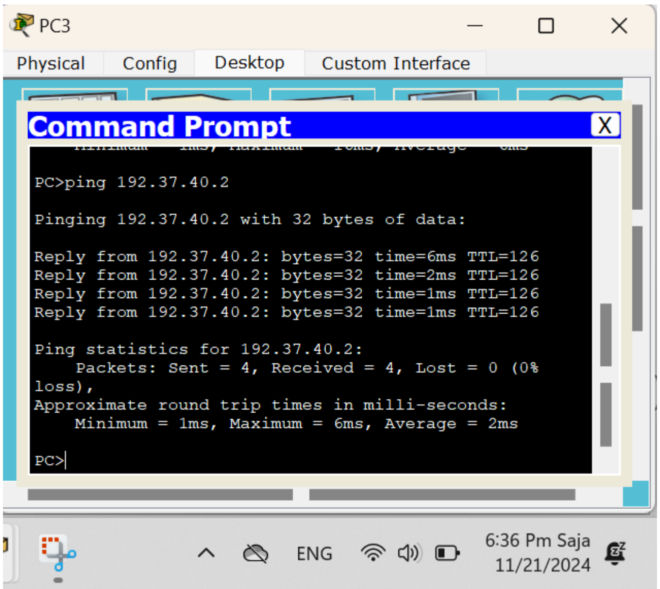
```
PC>
PC>ping 192.37.20.3

Pinging 192.37.20.3 with 32 bytes of data:

Reply from 192.37.20.3: bytes=32 time=1ms TTL=128
Reply from 192.37.20.3: bytes=32 time=0ms TTL=128
Reply from 192.37.20.3: bytes=32 time=1ms TTL=128
Reply from 192.37.20.3: bytes=32 time=0ms TTL=128

Ping statistics for 192.37.20.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0%
loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

PC>
```

Figure 3- 8: Ping between PC1 and PC6



```
PC>ping 192.37.10.2

Pinging 192.37.10.2 with 32 bytes of data:

Reply from 192.37.10.2: bytes=32 time=0ms TTL=127
Reply from 192.37.10.2: bytes=32 time=0ms TTL=127
Reply from 192.37.10.2: bytes=32 time=0ms TTL=127
Reply from 192.37.10.2: bytes=32 time=0ms TTL=127

Ping statistics for 192.37.10.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0%
loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

PC>
```

Figure 3- 9: Ping between PC2 and PC0

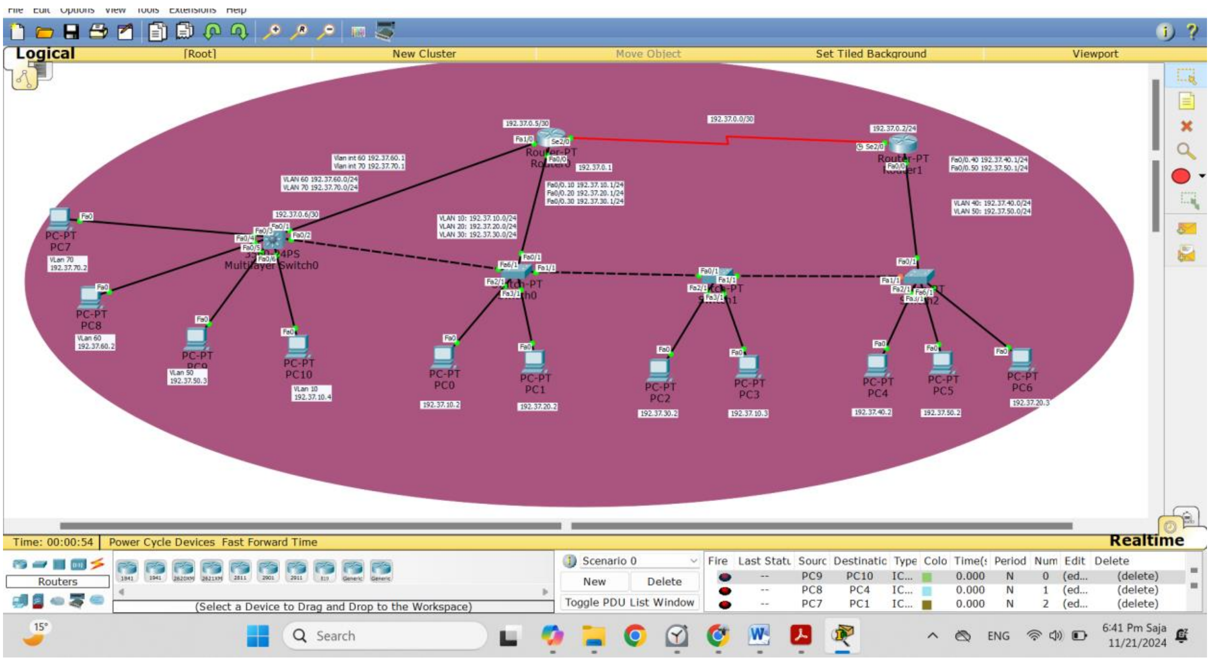


```
PC>ping 192.37.40.2

Pinging 192.37.40.2 with 32 bytes of data:

Reply from 192.37.40.2: bytes=32 time=6ms TTL=126
Reply from 192.37.40.2: bytes=32 time=2ms TTL=126
Reply from 192.37.40.2: bytes=32 time=1ms TTL=126
Reply from 192.37.40.2: bytes=32 time=1ms TTL=126

Ping statistics for 192.37.40.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0%
loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 6ms, Average = 2ms

PC>
```

Figure 3- 10: Ping between PC3 and PC4

4. Procedure And Data Analysis For Experiment 8

4.1 Building the Topology

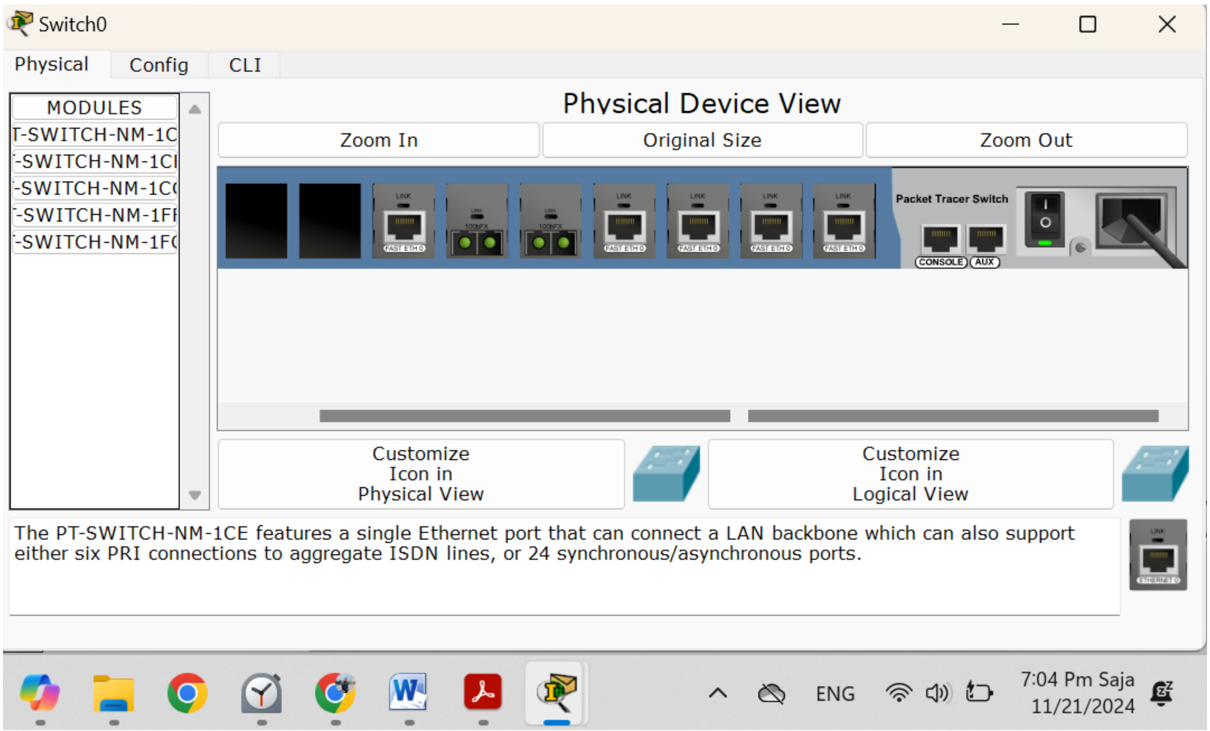


Fire	Last Statu	Sourc	Destinatic	Type	Colo	Time(s	Period	Num	Edit	Delete
●	--	PC9	PC10	IC...	🟩	0.000	N	0	(ed...	(delete)
●	--	PC8	PC4	IC...	🟦	0.000	N	1	(ed...	(delete)
●	--	PC7	PC1	IC...	🟫	0.000	N	2	(ed...	(delete)

Figure 4- 1: The Toplogy

In this experiment, we expanded on the previous setup by incorporating a Cisco 3560-24PS multi-layer switch. This addition enhances the network's capabilities by allowing for advanced features such as VLAN routing and improved traffic management, completing the configuration and providing a more robust and scalable network topology.

For switch 0, I add an extra interface physically using PT-SWITCH-NM-1CFE Module, as shown in the Figure below:



The PT-SWITCH-NM-1CE features a single Ethernet port that can connect a LAN backbone which can also support either six PRI connections to aggregate ISDN lines, or 24 synchronous/asynchronous ports.

Figure 4- 2: Adding interface to Switch 0

This is the IP address for the topology requirements:

Table 4- 1 : Newly Added Networks IPs

Area	Network	Device	Interface	IP	Subnet Mask	Wildcard Mask	VLAN ID
0	192.37.0.4/30	Router0	Fa1/0	192.37.0.5	255.255.255.252	0.0.0.3	1
0	192.37.0.4/30	MLS0	Fa0/1	192.37.0.6	255.255.255.252	0.0.0.3	1
0	192.37.10.0/24	PC10	Fa0	192.37.10.4	255.255.255.0	0.0.0.255	10
0	192.37.50.0/24	PC9	Fa0	192.37.50.5	255.255.255.0	0.0.0.255	50
0	192.37.60.0/24	MLS0	VLAN60	192.37.60.1	255.255.255.0	0.0.0.255	60
0	192.37.60.0/24	PC8	Fa0	192.37.60.2	255.255.255.0	0.0.0.255	60
0	192.37.70.0/24	MLS0	VLAN70	192.37.70.1	255.255.255.0	0.0.0.255	70
0	192.37.70.0/24	PC7	Fa0	192.37.70.2	255.255.255.0	0.0.0.255	70

4.2 Configuration

4.2.1 Multi-Layer Switch to Router link

We add an IP address to the switch port connected to the router, so firstly we change the switch port to a router port and then add an IP address, we did that by use the following command:

```
Switch(config-if)#no switchport
Switch(config-if)#ip address <IP-ADDRESS> <SUBNET-MASK>
```

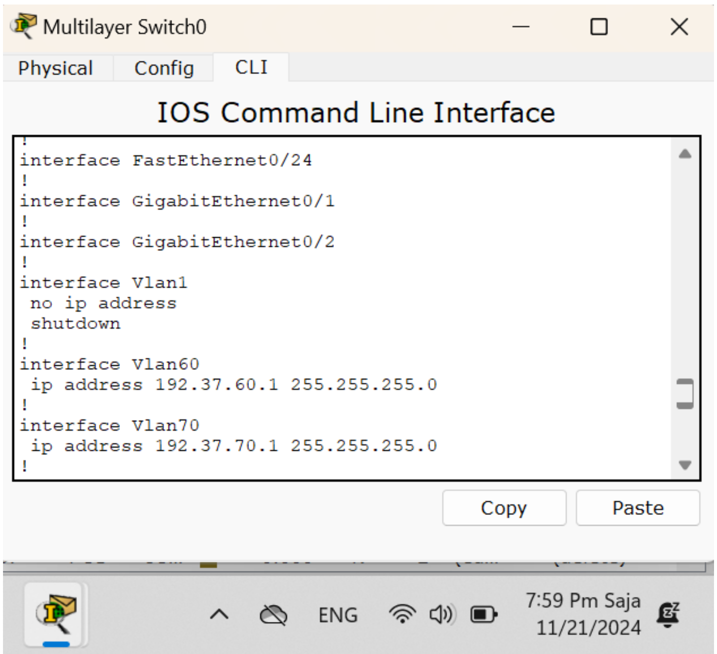
To add IP address 192.X.0.6/30 to port Fa0/1 on the multi-layer switch we use the commands below:

```
Switch(config)#interface fa0/1
Switch(config-if)#no switchport
Switch(config-if)#ip address 192.X.0.6 255.255.255.252
```

4.2.2 Multi-Layer Switch Configuring VLAN Interfaces IPs (Switch Virtual Interfaces)

We use the following commands to configure switch virtual interfaces on the switch to act as default gateways for the new VLANs

```
Switch(config)#interface vlan <VLAN-NUMBER>
Switch(config-if)# ip address <IP-ADDRESS> <SUBNET-MASK>
```

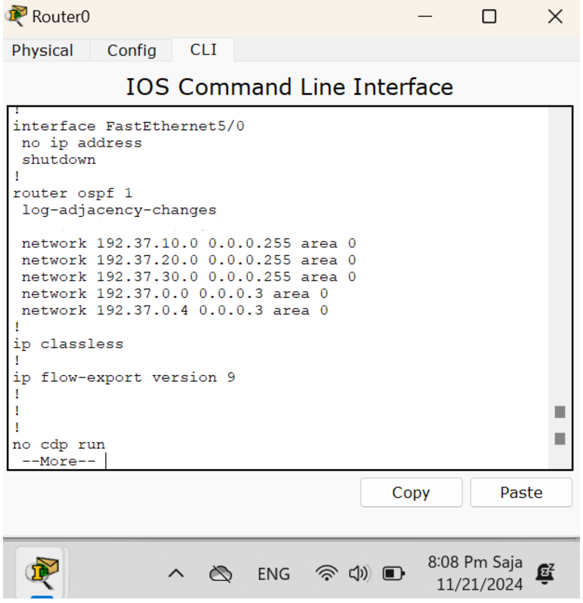


```
!
interface FastEthernet0/24
!
interface GigabitEthernet0/1
!
interface GigabitEthernet0/2
!
interface Vlan1
 no ip address
 shutdown
!
interface Vlan60
 ip address 192.37.60.1 255.255.255.0
!
interface Vlan70
 ip address 192.37.70.1 255.255.255.0
!
```

Figure 4- 3: configure an IP address for VLAN 60 and VLAN 70 in MLS0

4.2.3 Enable routing on Multi-Layer Switch and configuring OSPF

We configure The OSPF routing protocol for both routers 0 and the Multi-layer switch.

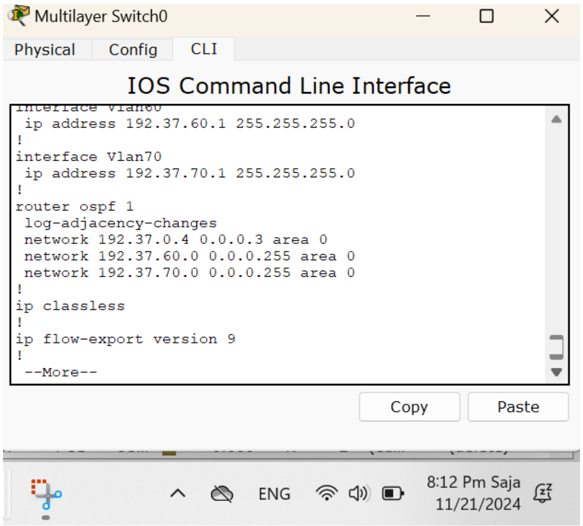


```
!
interface FastEthernet5/0
 no ip address
 shutdown
!
router ospf 1
 log-adjacency-changes

 network 192.37.10.0 0.0.0.255 area 0
 network 192.37.20.0 0.0.0.255 area 0
 network 192.37.30.0 0.0.0.255 area 0
 network 192.37.0.0 0.0.0.3 area 0
 network 192.37.0.4 0.0.0.3 area 0
!
ip classless
!
ip flow-export version 9
!
!
!
no cdp run
 --More--
```

Figure 4- 4: OSPF Configruation for router 0

By default, the routing is disabled on the third layer switch, in order to enable it we use the following command:

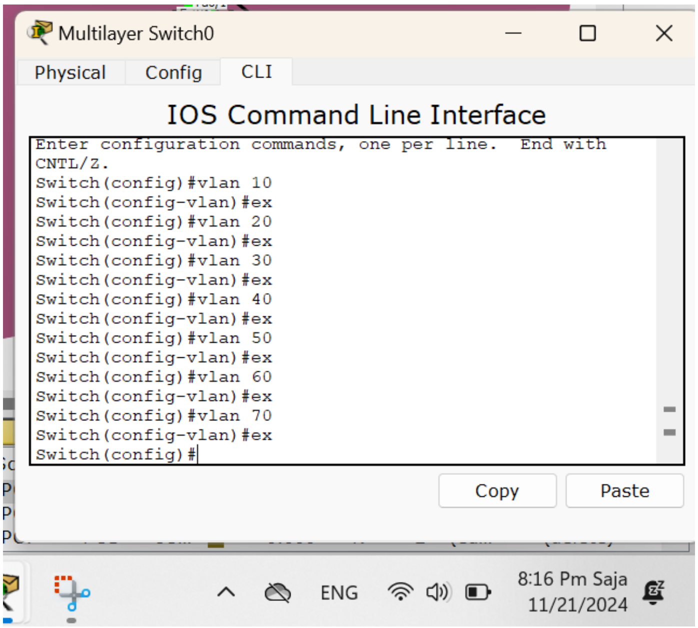
Switch(config)# ip routing



```
interface Vlan60
 ip address 192.37.60.1 255.255.255.0
!
interface Vlan70
 ip address 192.37.70.1 255.255.255.0
!
router ospf 1
 log-adjacency-changes
 network 192.37.0.4 0.0.0.3 area 0
 network 192.37.60.0 0.0.0.255 area 0
 network 192.37.70.0 0.0.0.255 area 0
!
ip classless
!
ip flow-export version 9
!
 --More--
```

Figure 4- 5: OSPF Configruation for MLS 0

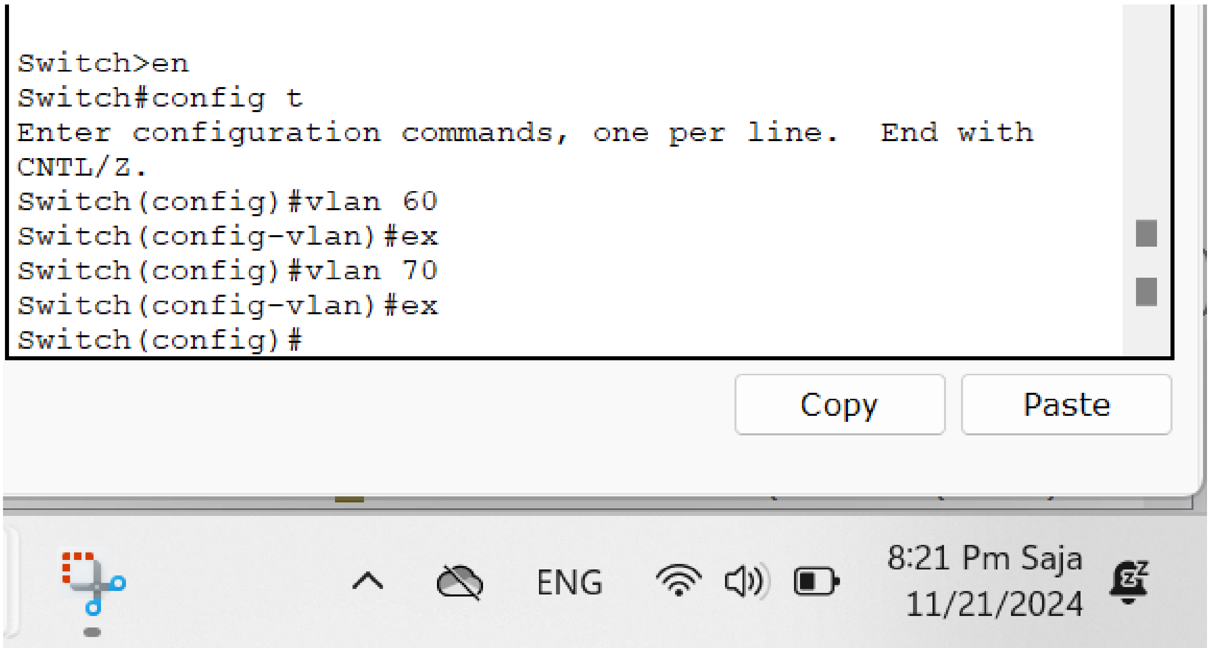
4.2.4 Configuring VLANs on



```
Enter configuration commands, one per line.  End with
CNTL/Z.
Switch(config)#vlan 10
Switch(config-vlan)#ex
Switch(config)#vlan 20
Switch(config-vlan)#ex
Switch(config)#vlan 30
Switch(config-vlan)#ex
Switch(config)#vlan 40
Switch(config-vlan)#ex
Switch(config)#vlan 50
Switch(config-vlan)#ex
Switch(config)#vlan 60
Switch(config-vlan)#ex
Switch(config)#vlan 70
Switch(config-vlan)#ex
Switch(config)#
```

Figure 4- 6: Configure VLANs on MLS 0

Now all VLANs are configured inside MLS0

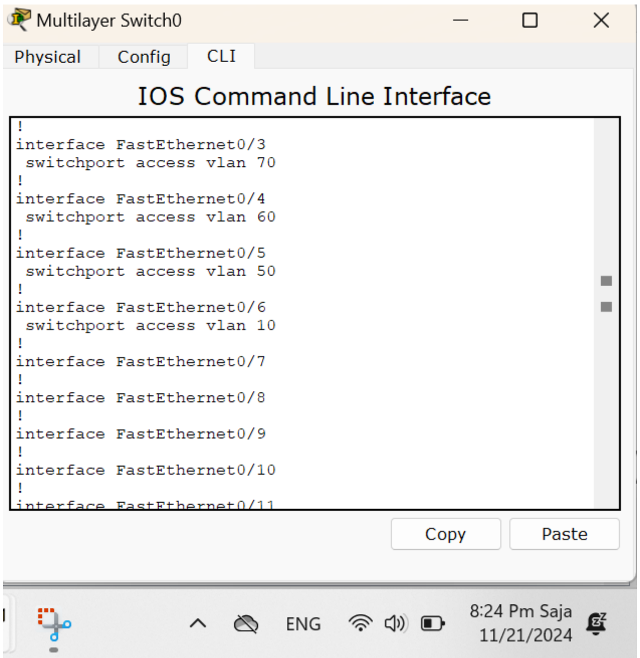


```
Switch>en
Switch#config t
Enter configuration commands, one per line.  End with
CNTL/Z.
Switch(config)#vlan 60
Switch(config-vlan)#ex
Switch(config)#vlan 70
Switch(config-vlan)#ex
Switch(config)#
```

Figure 4- 7 : Configure VLANs 60 and 70 on switch0 , switch1 and switch2

Now all VLANs are configured inside all switchs

4.2.5 Configuring Access Ports on Multi-Layer Switch



```
!
interface FastEthernet0/3
 switchport access vlan 70
!
interface FastEthernet0/4
 switchport access vlan 60
!
interface FastEthernet0/5
 switchport access vlan 50
!
interface FastEthernet0/6
 switchport access vlan 10
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
```

Figure 4- 8 : Configuring Access Ports on Multi-Layer Switch

Configuring access ports on a multi-layer switch is the same as configuring them on a normal switch.

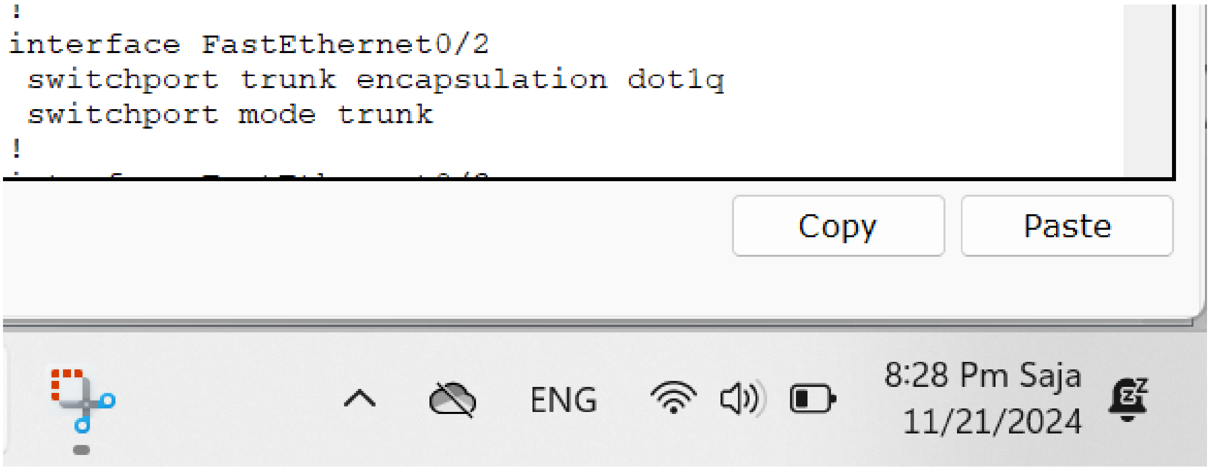
4.2.6 Configuring Trunk on Multi-Layer Switch

To configure a trunk on a third layer switch, we encapsulate that switch, to do this on interface Fa0/2 we use the following commands:

Switch(config)#interface Fa0/2

Switch(config-if)#switchport trunk encapsulation dot1q

Switch(config-if)#switchport mode trunk

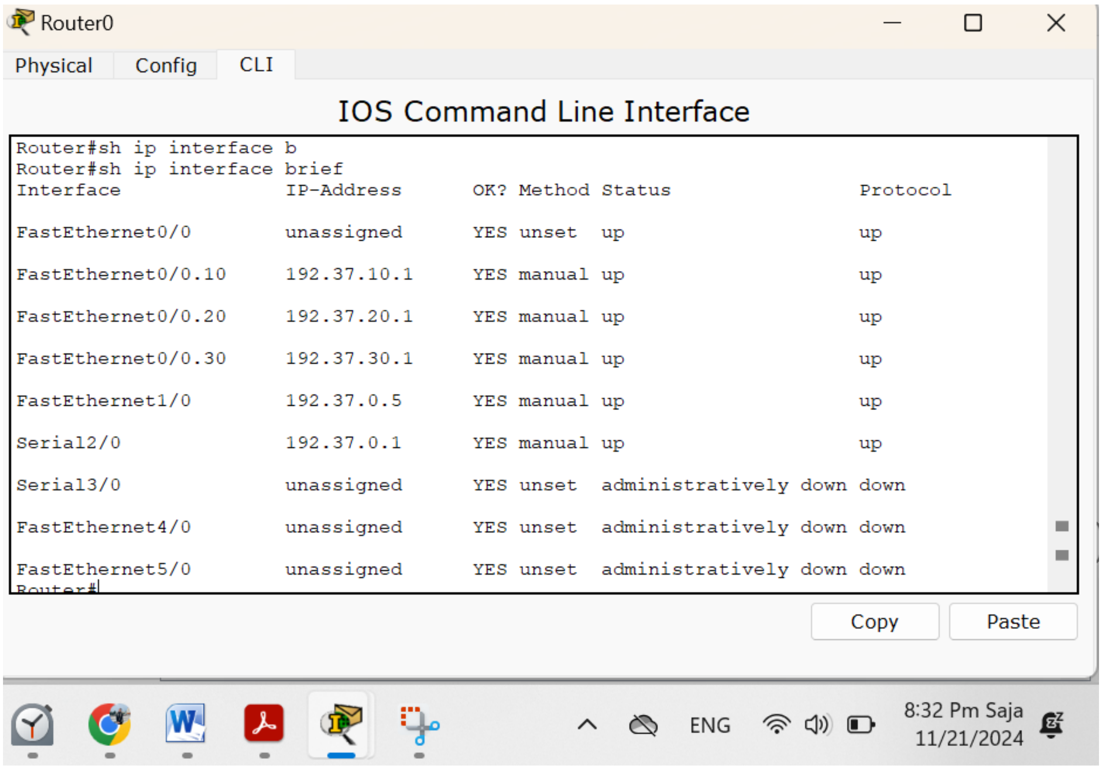


```
!
interface FastEthernet0/2
 switchport trunk encapsulation dot1q
 switchport mode trunk
!
```

Figure 4- 9: Configuring Trunk on Multi-Layer Switch

5. Results For Experiment 8

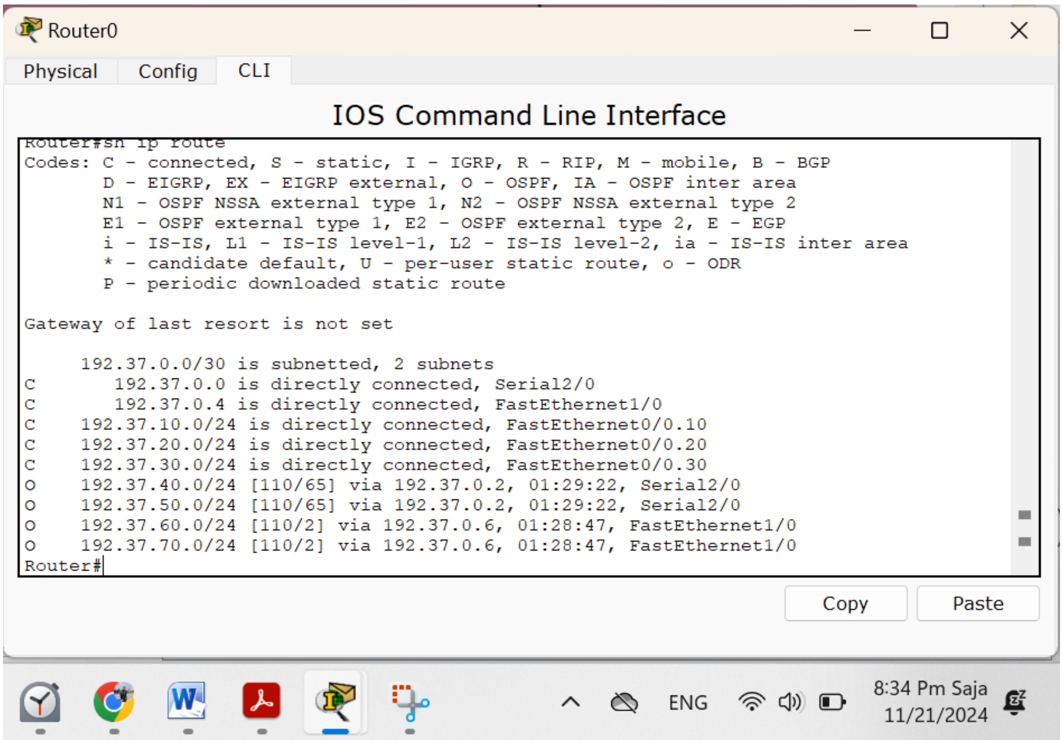
5.1 Router0 Interfaces:



```
Router#sh ip interface b
Router#sh ip interface brief
Interface              IP-Address      OK? Method Status                Protocol

FastEthernet0/0        unassigned      YES unset  up                    up

FastEthernet0/0.10     192.37.10.1     YES manual up                    up

FastEthernet0/0.20     192.37.20.1     YES manual up                    up

FastEthernet0/0.30     192.37.30.1     YES manual up                    up

FastEthernet1/0        192.37.0.5      YES manual up                    up

Serial2/0              192.37.0.1      YES manual up                    up

Serial3/0              unassigned      YES unset  administratively down down

FastEthernet4/0        unassigned      YES unset  administratively down down

FastEthernet5/0        unassigned      YES unset  administratively down down
Router#
```

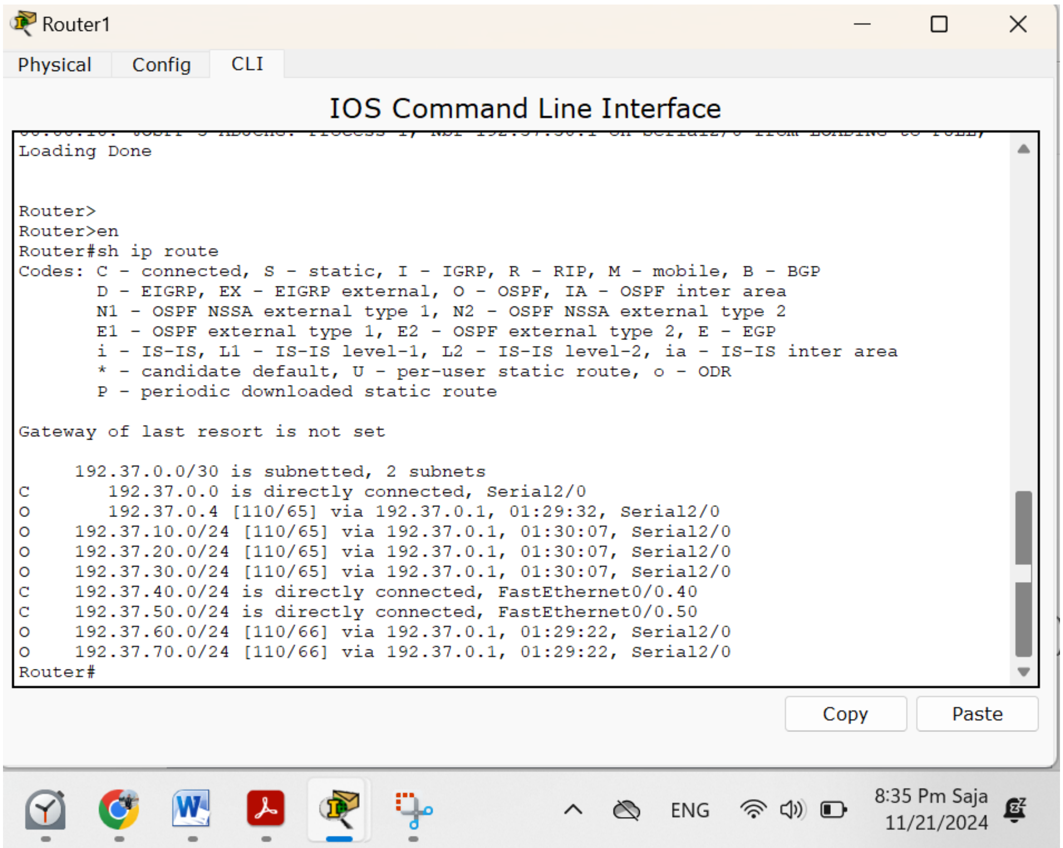
Figure 5 - 1: Router 0 interfaces

5.2 Router and MLS routing table:



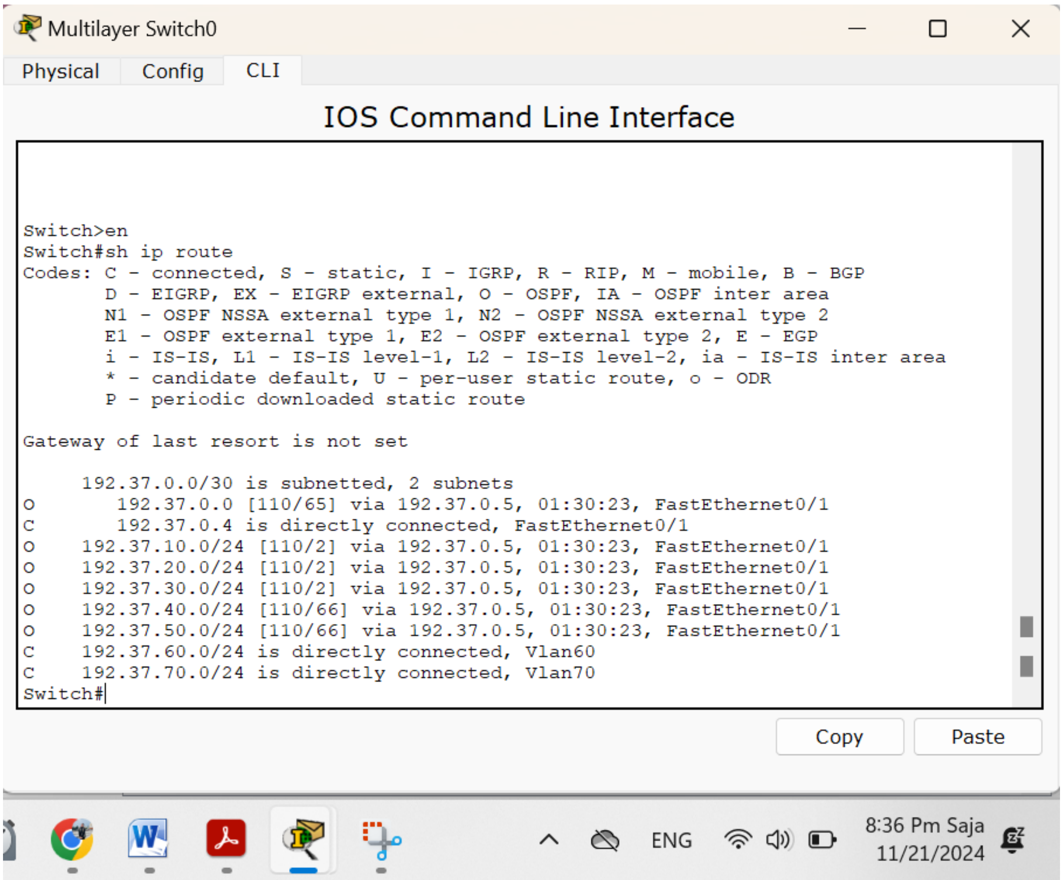
```
Router#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     192.37.0.0/30 is subnetted, 2 subnets
C       192.37.0.0 is directly connected, Serial2/0
C       192.37.0.4 is directly connected, FastEthernet1/0
C    192.37.10.0/24 is directly connected, FastEthernet0/0.10
C    192.37.20.0/24 is directly connected, FastEthernet0/0.20
C    192.37.30.0/24 is directly connected, FastEthernet0/0.30
O    192.37.40.0/24 [110/65] via 192.37.0.2, 01:29:22, Serial2/0
O    192.37.50.0/24 [110/65] via 192.37.0.2, 01:29:22, Serial2/0
O    192.37.60.0/24 [110/2] via 192.37.0.6, 01:28:47, FastEthernet1/0
O    192.37.70.0/24 [110/2] via 192.37.0.6, 01:28:47, FastEthernet1/0
Router#
```

Figure 5 - 2: IP route for router 0



```
Loading Done


Router>
Router>en
Router#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     192.37.0.0/30 is subnetted, 2 subnets
C       192.37.0.0 is directly connected, Serial2/0
O       192.37.0.4 [110/65] via 192.37.0.1, 01:29:32, Serial2/0
O    192.37.10.0/24 [110/65] via 192.37.0.1, 01:30:07, Serial2/0
O    192.37.20.0/24 [110/65] via 192.37.0.1, 01:30:07, Serial2/0
O    192.37.30.0/24 [110/65] via 192.37.0.1, 01:30:07, Serial2/0
C    192.37.40.0/24 is directly connected, FastEthernet0/0.40
C    192.37.50.0/24 is directly connected, FastEthernet0/0.50
O    192.37.60.0/24 [110/66] via 192.37.0.1, 01:29:22, Serial2/0
O    192.37.70.0/24 [110/66] via 192.37.0.1, 01:29:22, Serial2/0
Router#
```

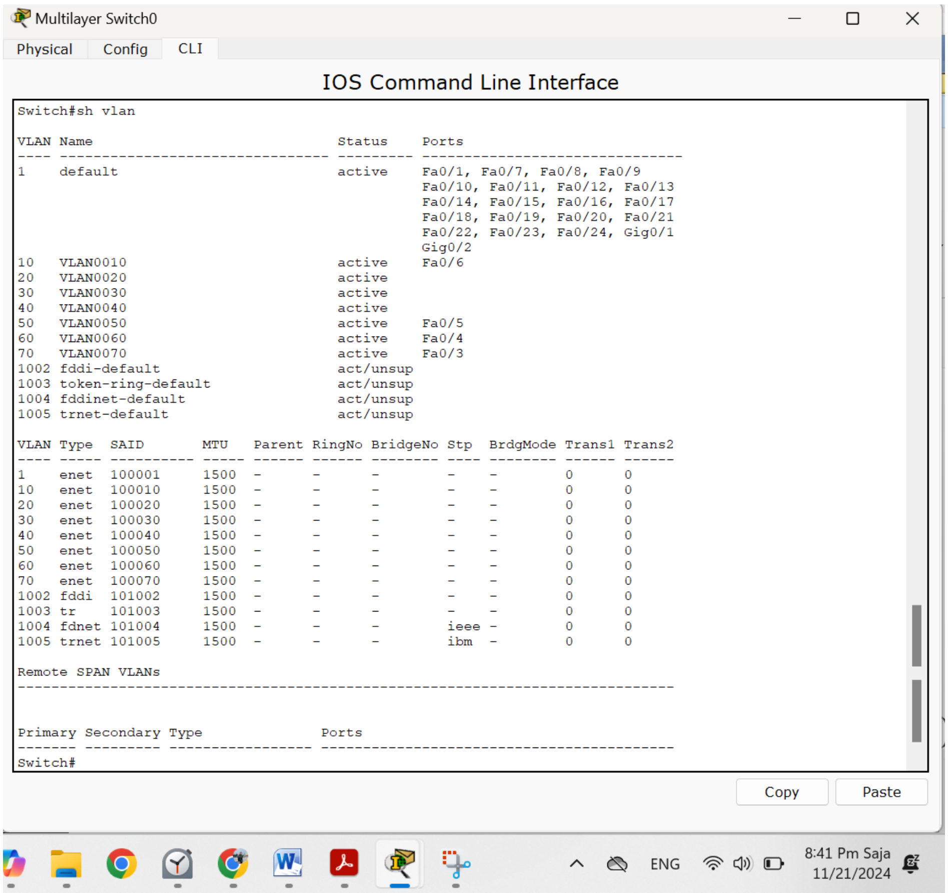
Figure 5 - 3 : IP route for router 1



```
Switch>en
Switch#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     192.37.0.0/30 is subnetted, 2 subnets
O       192.37.0.0 [110/65] via 192.37.0.5, 01:30:23, FastEthernet0/1
C       192.37.0.4 is directly connected, FastEthernet0/1
O    192.37.10.0/24 [110/2] via 192.37.0.5, 01:30:23, FastEthernet0/1
O    192.37.20.0/24 [110/2] via 192.37.0.5, 01:30:23, FastEthernet0/1
O    192.37.30.0/24 [110/2] via 192.37.0.5, 01:30:23, FastEthernet0/1
O    192.37.40.0/24 [110/66] via 192.37.0.5, 01:30:23, FastEthernet0/1
O    192.37.50.0/24 [110/66] via 192.37.0.5, 01:30:23, FastEthernet0/1
C    192.37.60.0/24 is directly connected, Vlan60
C    192.37.70.0/24 is directly connected, Vlan70
Switch#
```

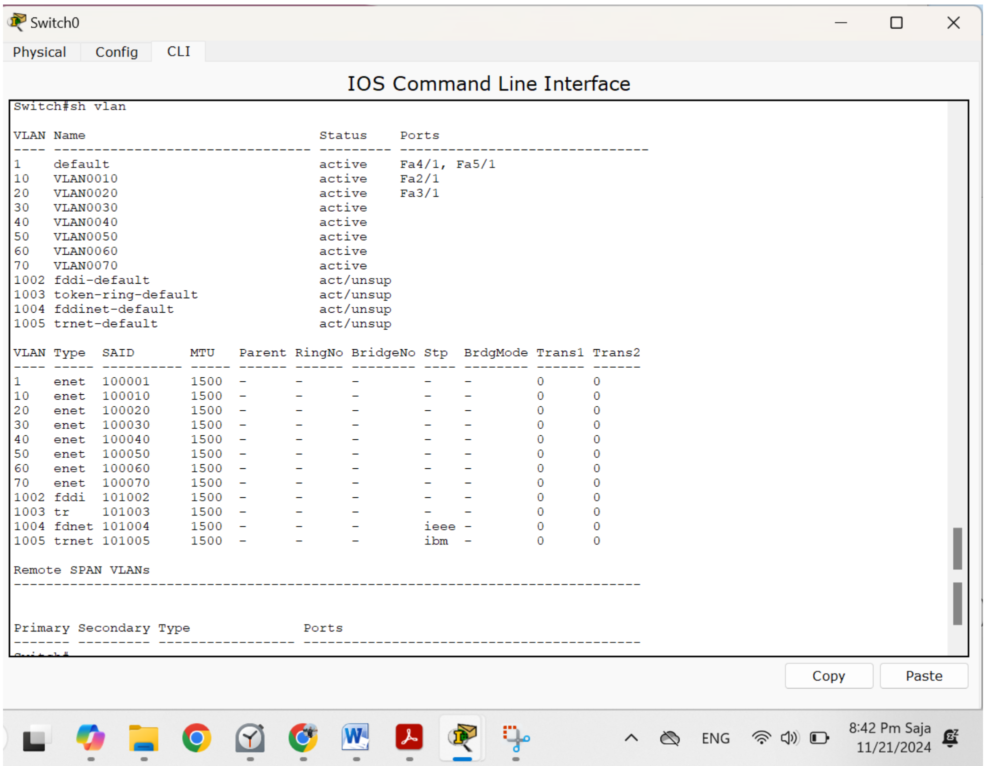
Figure 5 - 4: IP route for MLS0

5.3 Switches VLANs



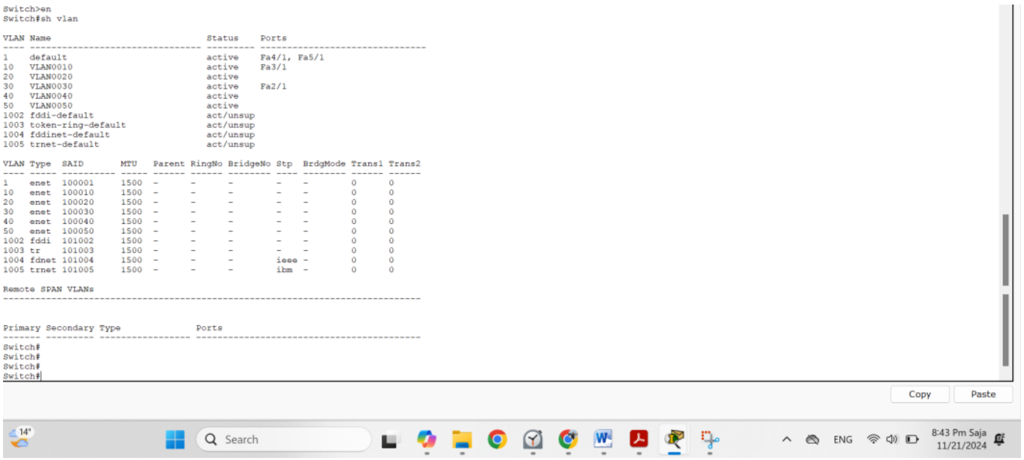
```
Switch#sh vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/1, 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   VLAN0010                         active    Fa0/6
20   VLAN0020                         active
30   VLAN0030                         active
40   VLAN0040                         active
50   VLAN0050                         active    Fa0/5
60   VLAN0060                         active    Fa0/4
70   VLAN0070                         active    Fa0/3
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        0      0
10   enet  100010     1500  -      -      -        -    -        0      0
20   enet  100020     1500  -      -      -        -    -        0      0
30   enet  100030     1500  -      -      -        -    -        0      0
40   enet  100040     1500  -      -      -        -    -        0      0
50   enet  100050     1500  -      -      -        -    -        0      0
60   enet  100060     1500  -      -      -        -    -        0      0
70   enet  100070     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        0      0
1003 tr    101003     1500  -      -      -        -    -        0      0
1004 fdnet 101004     1500  -      -      -        ieee -        0      0
1005 trnet 101005     1500  -      -      -        ibm  -        0      0

Remote SPAN VLANs
------------------------------------------------------------------------------


Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------
Switch#
```

Figure 5 - 5: VLANS for MLS 0



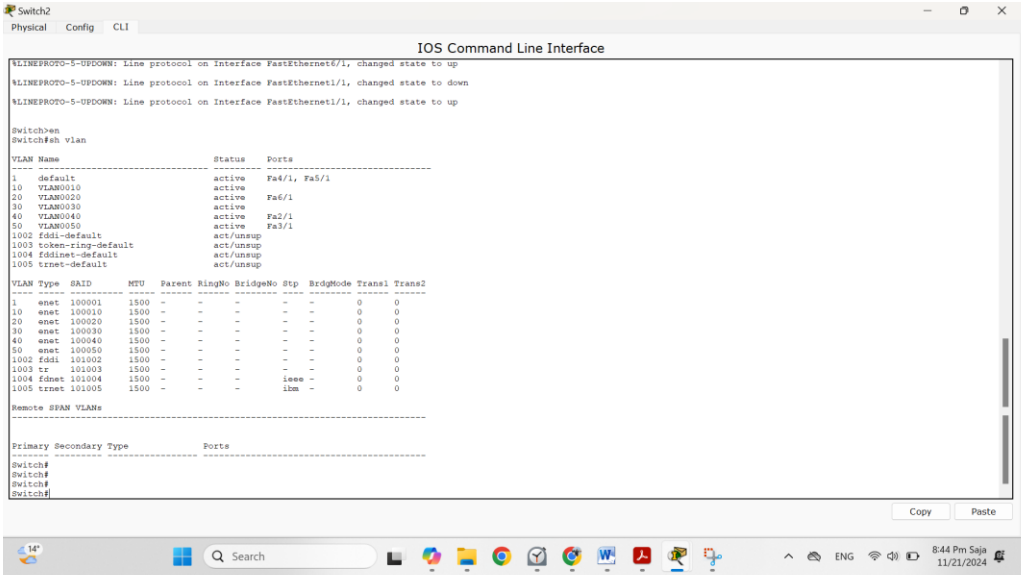
```
Switch#sh vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa4/1, Fa5/1
10   VLAN0010                         active    Fa2/1
20   VLAN0020                         active    Fa3/1
30   VLAN0030                         active
40   VLAN0040                         active
50   VLAN0050                         active
60   VLAN0060                         active
70   VLAN0070                         active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        0      0
10   enet  100010     1500  -      -      -        -    -        0      0
20   enet  100020     1500  -      -      -        -    -        0      0
30   enet  100030     1500  -      -      -        -    -        0      0
40   enet  100040     1500  -      -      -        -    -        0      0
50   enet  100050     1500  -      -      -        -    -        0      0
60   enet  100060     1500  -      -      -        -    -        0      0
70   enet  100070     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        0      0
1003 tr    101003     1500  -      -      -        -    -        0      0
1004 fdnet 101004     1500  -      -      -        ieee -        0      0
1005 trnet 101005     1500  -      -      -        ibm  -        0      0

Remote SPAN VLANs
------------------------------------------------------------------------------


Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------
Switch#
```

Figure 5 - 6: VLANS for switch0



```
Switch>en
Switch#sh vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa4/1, Fa5/1
10   VLAN0010                         active    Fa3/1
20   VLAN0020                         active
30   VLAN0030                         active    Fa2/1
40   VLAN0040                         active
50   VLAN0050                         active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        0      0
10   enet  100010     1500  -      -      -        -    -        0      0
20   enet  100020     1500  -      -      -        -    -        0      0
30   enet  100030     1500  -      -      -        -    -        0      0
40   enet  100040     1500  -      -      -        -    -        0      0
50   enet  100050     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        0      0
1003 tr    101003     1500  -      -      -        -    -        0      0
1004 fdnet 101004     1500  -      -      -        ieee -        0      0
1005 trnet 101005     1500  -      -      -        ibm  -        0      0

Remote SPAN VLANs
------------------------------------------------------------------------------


Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------
Switch#
Switch#
Switch#
Switch#
```

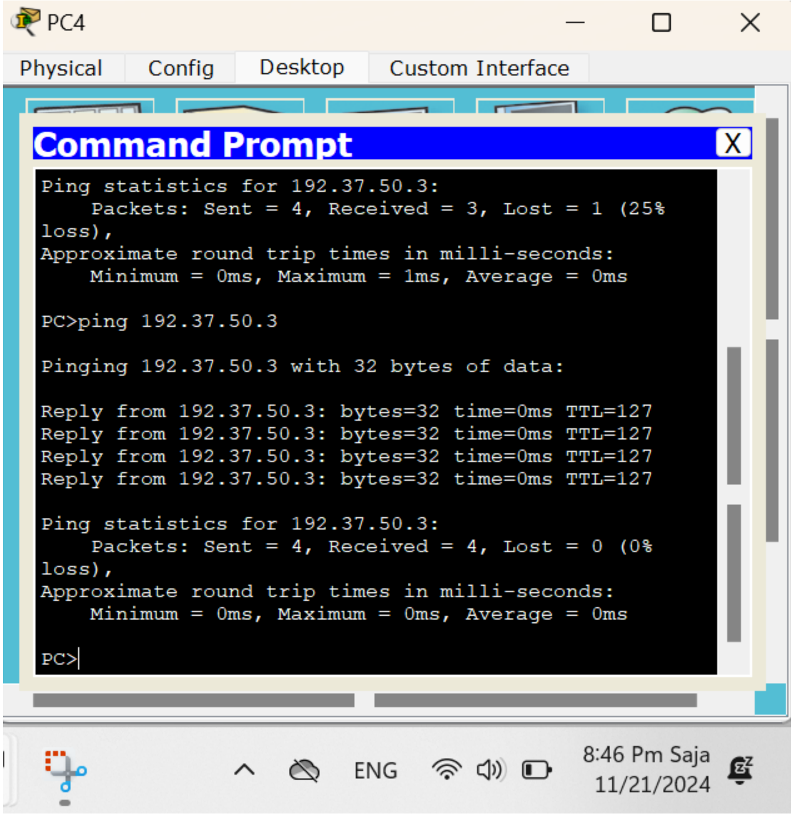
Figure 5 - 7 : VLANS for switch1



```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet6/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/1, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/1, changed state to up


Switch>en
Switch#sh vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa4/1, Fa5/1
10   VLAN0010                         active
20   VLAN0020                         active    Fa6/1
30   VLAN0030                         active
40   VLAN0040                         active    Fa2/1
50   VLAN0050                         active    Fa3/1
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        0      0
10   enet  100010     1500  -      -      -        -    -        0      0
20   enet  100020     1500  -      -      -        -    -        0      0
30   enet  100030     1500  -      -      -        -    -        0      0
40   enet  100040     1500  -      -      -        -    -        0      0
50   enet  100050     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        0      0
1003 tr    101003     1500  -      -      -        -    -        0      0
1004 fdnet 101004     1500  -      -      -        ieee -        0      0
1005 trnet 101005     1500  -      -      -        ibm  -        0      0

Remote SPAN VLANs
------------------------------------------------------------------------------


Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------
Switch#
Switch#
Switch#
Switch#
```

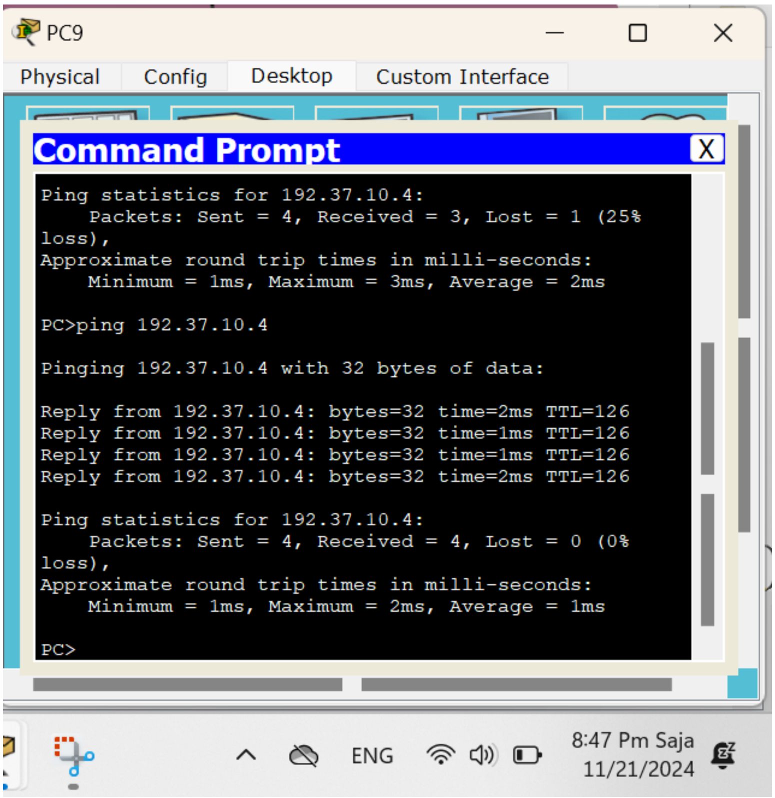
Figure 5 - 8 : VLANS for switch2

5.4 Test Connection for Topology



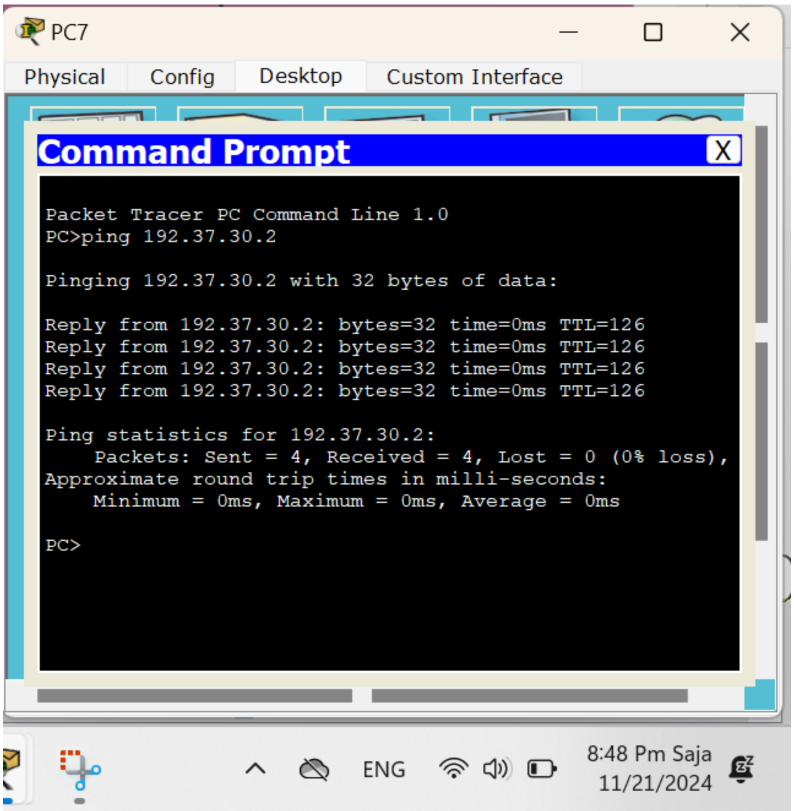
```
Ping statistics for 192.37.50.3:
    Packets: Sent = 4, Received = 3, Lost = 1 (25%
loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

PC>ping 192.37.50.3

Pinging 192.37.50.3 with 32 bytes of data:

Reply from 192.37.50.3: bytes=32 time=0ms TTL=127
Reply from 192.37.50.3: bytes=32 time=0ms TTL=127
Reply from 192.37.50.3: bytes=32 time=0ms TTL=127
Reply from 192.37.50.3: bytes=32 time=0ms TTL=127

Ping statistics for 192.37.50.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0%
loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

PC>
```

Figure 5 - 9 : Ping from PC4 to PC9



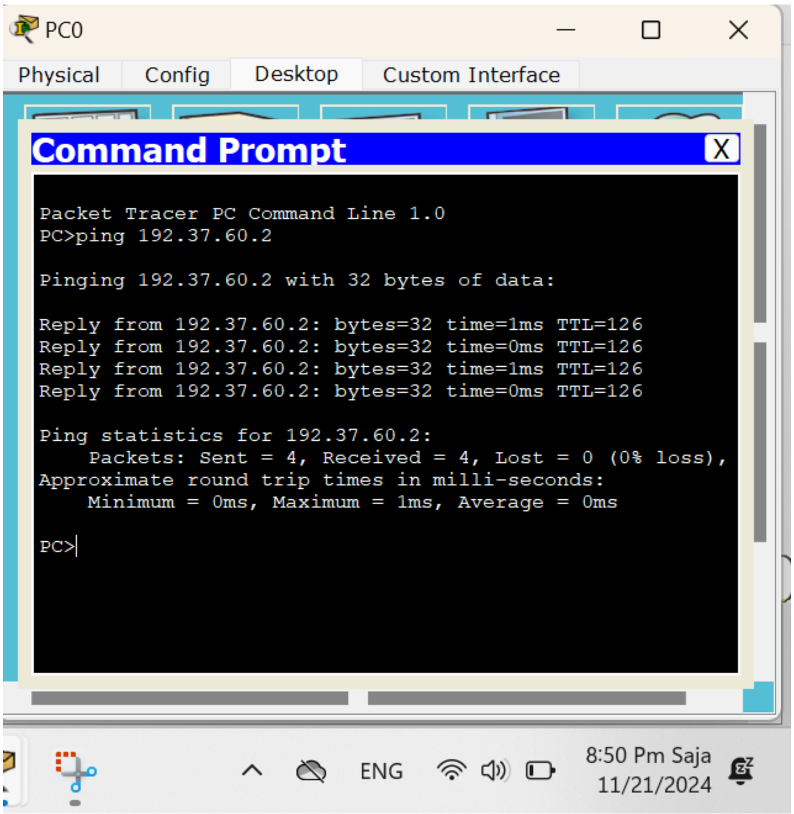
```
Ping statistics for 192.37.10.4:
    Packets: Sent = 4, Received = 3, Lost = 1 (25%
loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 3ms, Average = 2ms

PC>ping 192.37.10.4

Pinging 192.37.10.4 with 32 bytes of data:

Reply from 192.37.10.4: bytes=32 time=2ms TTL=126
Reply from 192.37.10.4: bytes=32 time=1ms TTL=126
Reply from 192.37.10.4: bytes=32 time=1ms TTL=126
Reply from 192.37.10.4: bytes=32 time=2ms TTL=126

Ping statistics for 192.37.10.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0%
loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms

PC>
```

Figure 5 - 10 : Ping from PC9 to PC10



```
Packet Tracer PC Command Line 1.0
PC>ping 192.37.30.2

Pinging 192.37.30.2 with 32 bytes of data:

Reply from 192.37.30.2: bytes=32 time=0ms TTL=126
Reply from 192.37.30.2: bytes=32 time=0ms TTL=126
Reply from 192.37.30.2: bytes=32 time=0ms TTL=126
Reply from 192.37.30.2: bytes=32 time=0ms TTL=126

Ping statistics for 192.37.30.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

PC>
```

Figure 5 - 11 : Ping from PC7 to PC2



```
Packet Tracer PC Command Line 1.0
PC>ping 192.37.60.2

Pinging 192.37.60.2 with 32 bytes of data:

Reply from 192.37.60.2: bytes=32 time=1ms TTL=126
Reply from 192.37.60.2: bytes=32 time=0ms TTL=126
Reply from 192.37.60.2: bytes=32 time=1ms TTL=126
Reply from 192.37.60.2: bytes=32 time=0ms TTL=126

Ping statistics for 192.37.60.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

PC>
```

Figure 5 - 12 : Ping from PC0 to PC8

6. Conclusion

In summary, all goals of this experiment were accomplished and both practical and theoretical learning were enhanced. Such configuration involved Cisco IOS switches configured in command line, the effective use of a switch simulator, and creation of subinterfaces of a router for inter-VLAN routing. Farther on, the experiment consisted of dividing Cisco switches and switches unity into a number of VLANs which improves the network structure and traffic congestion control. A Cisco IOS multilayer switch configuration was introduced which provided more features in operation. These processes assisted in reinforcing critical aspects of computer networking and also equipping the necessary skills for effective handling of advanced networking systems.

7. Feedback

The experiment was interesting and not too quick, and it deeply investigated VLAN configuration, subinterfaces, and multi-layer switch management. The time set aside was enough and all tasks were completed without any stress that was brought about by time constraints, enabling a better appreciation of the concepts and their implementations. The balance between theoretical learning and hands-on experience made the experiment rewarding and insightful, strengthening essential networking skills effectively.

8. References

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[3] https://en.wikipedia.org/wiki/IEEE_802.1Q [Accessed in 21/11/2024 at 11:25 AM]

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[7] https://www.networkacademy.io/ccna/ethernet/trunk-native-vlan [Accessed in 21/11/2024 at 11:55 Am]

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