Faculty of Engineering and Technology

Electrical and Computer Engineering Department

COMMUNICATIONS LAB ENEE4113

Report I

Experiment # 4: Dynamic Routing 2 (Link State Routing Protocols) Open Shortest Path First (OSPF)

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Abstract

The aim of this experiment is to learn and understand the Open Shortest Path First (OSPF) protocol. Which is an example of the internal dynamic routing protocol that belong to the link state protocol. This experiment applies using Cisco Packet Tracer.

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Acronyms and Abbreviations

- ⇨ OSPF: Open Shortest Path First
- ⇨ W.M: WILDCARD-MASK
- ⇨ CLI: Command Line Interface

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1. Introduction

"An interior gateway protocol (IGP) or Interior routing protocol is a type of routing protocol used for exchanging routing table information between gateways (commonly routers) within an autonomous system (for example, a system of corporate local area networks). This routing information can then be used to route network-layer protocols like IP. Interior gateway protocols can be divided into two categories: distance-vector routing protocols and link-state routing protocols. Specific examples of IGPs include Open Shortest Path First (OSPF), Routing Information Protocol (RIP), Intermediate System to Intermediate System (IS-IS) and Enhanced Interior Gateway Routing Protocol (EIGRP)." [1]

1.1 Routing Summarization

"Route summarization is a method where we create one summary route that represent multiple networks/subnets. It's also called route aggregation or superwetting.

Summarization has several advantages:

- Saves memory: routing tables will be smaller which reduces memory requirements.
- Saves bandwidth: there are less routes to advertise so we save some bandwidth.
- Stability: Prevents routing table instability due to flapping networks." [2]

1.2 Routing Hierarchy

"In hierarchical routing, the routers are divided into regions. Each router has complete details about how to route packets to destinations within its own region. But it does not have any idea about the internal structure of other regions." [3]

1.3 OSPF

"OSPF is a dynamic link-state routing protocol that efficiently exchanges routing information within an autonomous system, employing the Shortest Path First (SPF) algorithm to calculate optimal routes. It features hierarchical network design, support for Variable-Length Subnet Masking (VLSM), and dynamic adaptation to network changes, making it widely utilized in large and complex IP networks." [4]

- ⇨ "Dynamic routing: is a process where a router can forward data via a different route for a given destination based on the current conditions of the communication circuits within a system." [5]

1.3.1 OSPF Configuration

“This command starts the OSPF routing process with your process number. The process number is an arbitrary number. It is recommended that the number match on all routers, but it is not required.

⇨ Router(config)# router ospf <PROCESS - ID>” [6]

1.3.2 Adding Network to the OSPF protocol

“This command defines an interface on which OSPF runs and defines the area ID for that interface. Once OSPF is configured, you can check the status using these commands

⇨ Router(config-router) # network < ID - ADDRESS> <W.M> area <AREA - ID>

Once OSPF is configured, you can check the status using these commands

- show ip route
- show ip ospf neighbor
- show ip protocols” [6]

1.4 Router ID

“The OSPF router id identifies the router to OSPF neighbours. It is in IP format. The default value is highest physical interface at startup. However, loopback interfaces beat physical interfaces. There is a command to hardcode the router id value that beats all:

⇨ Router(config-router) #router-id <A.B.C.D>” [6]

1.5 loopback interface

“The loopback address, also called localhost, is probably familiar to you. It is an internal address that routes back to the local system.” [7]

1.6 Cost Changing

The cost applies to the serial number between the routers. Using this rule:

Bandwidth = 100M / Cost “The result should be in Kilobits”

And it applies using this command:

⇨ Router(config-if) #bandwidth <Bandwidth>

2. Procedure and Discussion

2.1 Building the Topology

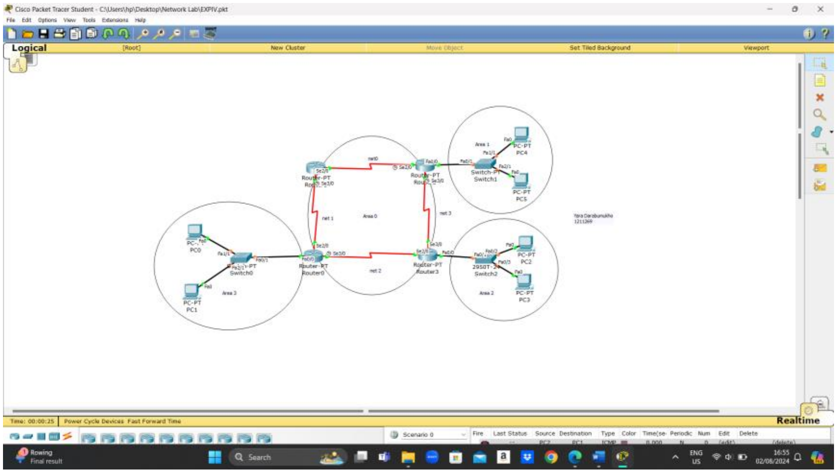

Figure 2- 1: Topology.

This is the IP address for the topology requirements "There are some differences between this table and the built in topology in the serial numbers to match it."

Area/ Summarization	Network	Device	Interface	IP	Subnet Mask	Wildcard Mask
Area 0	Network 0 192.X.0.0/30	Router 2	Se2/0	192.X.0.1	255.255.255.252	0.0.0.3
		Router 1	Se3/0	192.X.0.2	255.255.255.252	0.0.0.3
	Network 1 192.X.0.4/30	Router 0	Se2/0	192.X.0.5	255.255.255.252	0.0.0.3
		Router 1	Se2/0	192.X.0.6	255.255.255.252	0.0.0.3
	Network 2 192.X.0.8/30	Router 0	Se3/0	192.X.0.9	255.255.255.252	0.0.0.3
		Router 3	Se3/0	192.X.0.10	255.255.255.252	0.0.0.3
	Network 3 192.X.0.12/30	Router 2	Se3/0	192.X.0.13	255.255.255.252	0.0.0.3
		Router 3	Se2/0	192.X.0.14	255.255.255.252	0.0.0.3
Area 1	Network 4 192.X.1.0/24	Router 2	Fa0/0	192.X.1.1	255.255.255.0	0.0.0.255
		PC4	Fa0	192.X.1.2	255.255.255.0	0.0.0.255
		PC5	Fa0	192.X.1.3	255.255.255.0	0.0.0.255
Area 2	Network 5 192.X.2.0/25	Router 3	Fa0/0	192.X.2.1	255.255.255.128	0.0.0.127
		PC2	Fa0	192.X.2.2	255.255.255.128	0.0.0.127
		PC3	Fa0	192.X.2.3	255.255.255.128	0.0.0.127
Area 3	Network 6 192.X.2.128/25	Router 0	Fa0/0	192.X.2.129	255.255.255.128	0.0.0.127
		PC0	Fa0	192.X.2.130	255.255.255.128	0.0.0.127
		PC1	Fa0	192.X.2.131	255.255.255.128	0.0.0.127

Table 2- 1: IP Address.

- ⇨ Adding the serial numbers and the FastEthernet numbers done by open the CLI for each router then enter each interface, add the IP address, and activate the interface. As such:

  Router(config) # interface se2/0

  Router(config-if) # ip address 192.69.0.2 255.255.255.252 “This command for Router 1”

- ⇨ The FastEthernet for the PCs add using IP configurations in the desktop tab for each one.

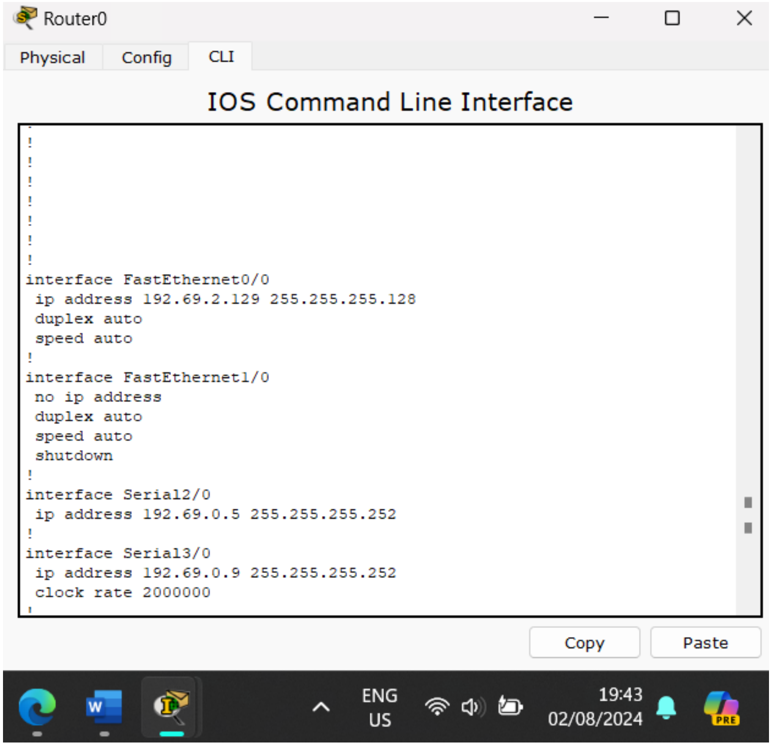

Figure 2- 2: Router 0.

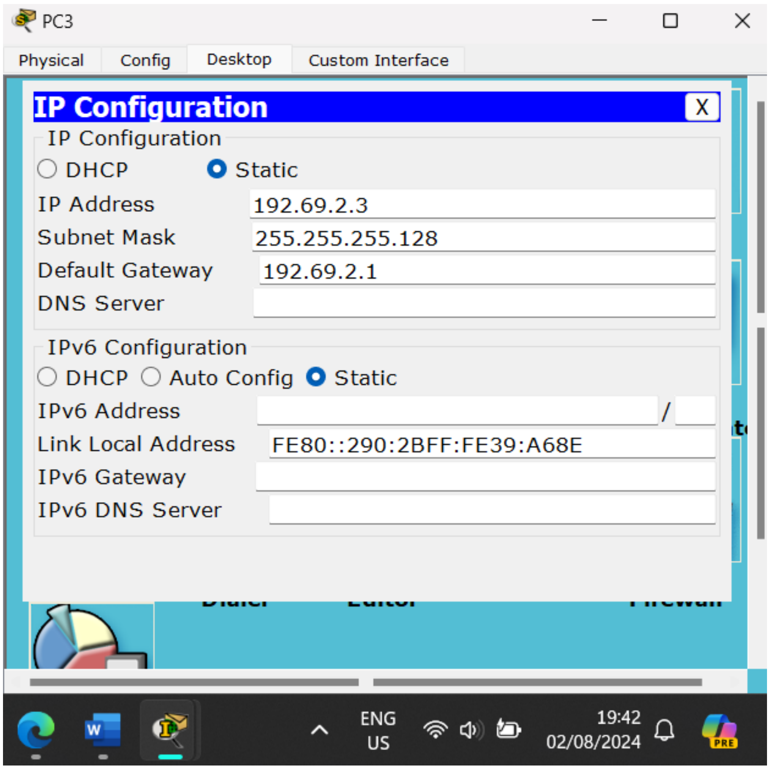

Figure 2- 3: PC3.

This is PC 3 IP for example and Router 0 address.

2.2 Loopback

Adding the loopback interfaces routing for Router 2 using these commands for loopback 0:

Router(config) # interface loopback 0

Router(config-if) # ip address 172.16.0.1 255.255.255.0

Then activate the interface using "no shutdown" command.

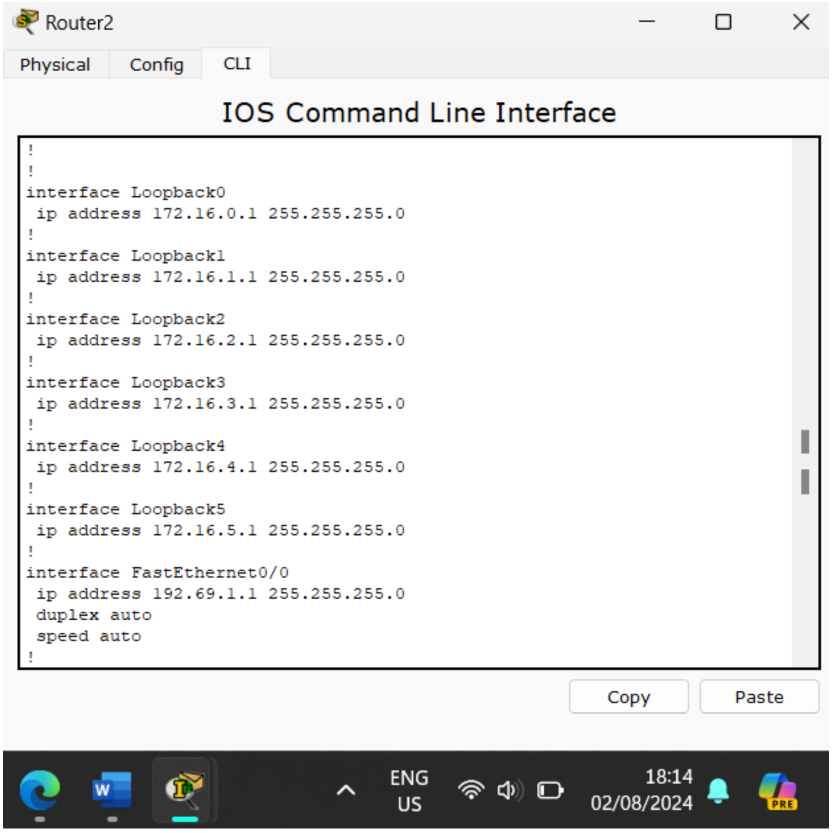

Figure 2- 4: Loopback.

This is all loopback interfaces for Router 2 which added same as loopback 0.

2.2 OSPF

After building the topology the network ready to apply any routing protocol. In this experiment the routing protocol is OSPF. It applies using connecting networks ID and there W.M.

These commands will set the OSPF for router 3:

⇨ Router(config)#router ospf 1

Router(config-router) #network 192.69.0.8 0.0.0.3 area 0

Router(config-router) #network 192.69.0.12 0.0.0.3 area 0

Router(config-router) #network 192.69.2.0 0.0.0.127 area 2

Figure 2- 5: OSPF on Router 0.

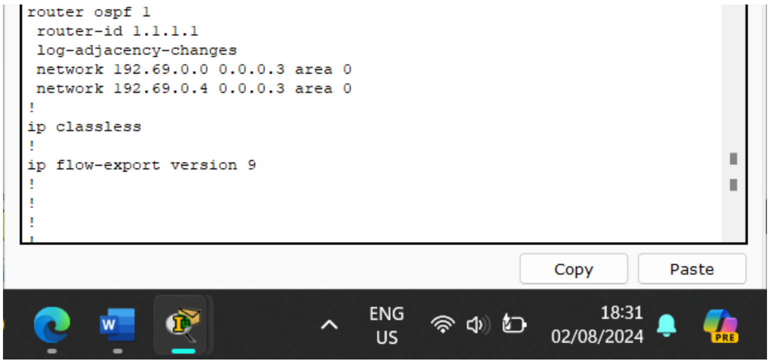

Figure 2- 6: OSPF on Router 1.

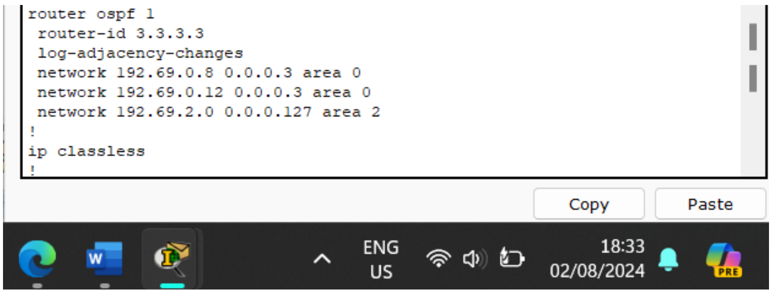

Figure 2- 7: OSPF on Router 3.

Same instruction uses for Router 0, 1, and 2. Each OSPF get the attached networks ID same as their networks neighbour.

Router 2 has a loopback interfaces, so as an extra step the loopback IPs added to the OSPF.

Using the summarization to make it easier instead of adding six loopbacks. So, after adding networks neighbour, these commands evaluated:

- ⇨ Router(config-router) #network 172.16.0.0 0.0.3.255 area 1
  Router(config-router) #network 172.16.4.0 0.0.1.255 area 1

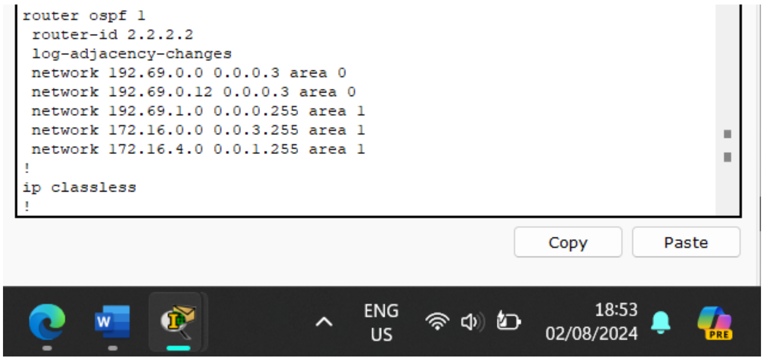

Figure 2- 8: OSPF on Router 2.

2.3 Changing the Cost

This section asked to change the cost between two different routers by changing the bandwidth for the serial number.

So, to change the cost between Router 1 and Router 2:

First calculate the bandwidth:

⇨ If the cost is 5, then the bandwidth = 100M / 5 = 20000K

Then enter se interface then change the bandwidth for both routers.

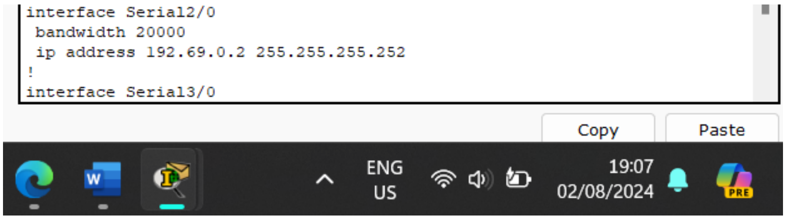

Figure 2- 9: Cost.

As shown in the figure above the cost for serial number 2/0 changed to 20000 using these commands:

⇨ Router(config) # interface se2/0
Router(config-if) # bandwidth 20000

<u>Note:</u>

This part asked to change the cost for this path “R0-R2”, but I changed for this path “R1-R3”, and I realise that late.

2.4 Important Questions

2.4.1 First Question

Why do we need for loopback interfaces?

- ⇨ A loopback interface is a virtual interface that is always up and reachable as long as at least one of the IP interfaces on the switch is operational. As a result, a loopback interface is useful for debugging tasks since its IP address can always be pinged if any other switch interface is up. Configuring loopback interfaces when using the OSPF routing protocol is important. interfaces are logical interfaces, which are virtual, software-only interfaces; they are not real router interfaces. Using loopback interfaces with your OSPF configuration ensures that an interface is always active for OSPF processes. [8,9]

2.4.2 Second Question

What is the router-id for OSPF? And why do we need it?

- ⇨ Each OSPF router selects a router ID that must be unique on your network. OSPF stores the topology of the network in its LSDB (Link State Database), and each router is identified with its unique router ID, if you have duplicate router IDs then you will run into reachability issues. This ID is important for the routers to become neighbours and share information around the network. [10]

2.4.3 Third Question

Hardcode the router-id for R1, R2, and R3 as 1.1.1.1, 2.2.2.2, and 3.3.3.3 respectively. And verify that.

- ⇨ This process done using to steps "Router1 for example":
  - First:
    Router# config
    Router (config) # router ospf 1
    Router (config- router) # router-id 1.1.1.1
  - Second:
    Router (config- router) # exit
    Router (config) # exit
    Router# clear ip ospf process

  Using these two steps the Router ID will changed to the new ID and delete the previous temporary ID.

Figure 2- 10: Router 1 ID.

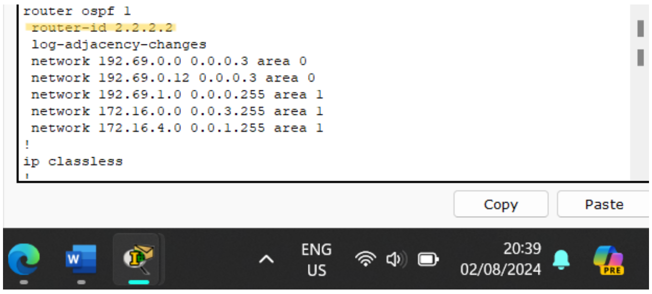

Figure 2- 11: Router 2 ID.

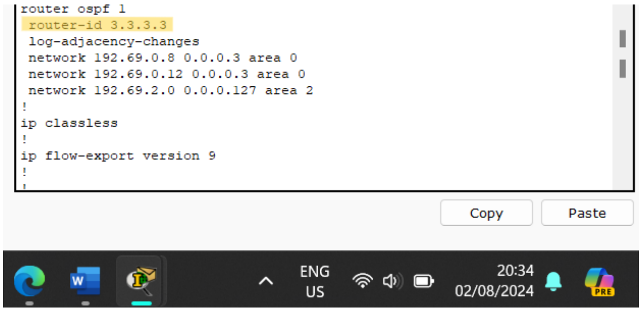

Figure 2- 12: Router 3 ID.

So, as shown in the figures above routers IDs changed to the requirements IDs.

3. Results

The results for each section above added next to the description. This part contains the routing table for each Router and PC testing using “Ping” command.

3.1 Routing Tables

Routing Table for Router0

Type	Network	Port	Next Hop IP	Metric
O	172.16.0.1/32	Serial2/0	192.69.0.6	110/70
O	172.16.1.1/32	Serial2/0	192.69.0.6	110/70
O	172.16.2.1/32	Serial2/0	192.69.0.6	110/70
O	172.16.3.1/32	Serial2/0	192.69.0.6	110/70
O	172.16.4.1/32	Serial2/0	192.69.0.6	110/70
O	172.16.5.1/32	Serial2/0	192.69.0.6	110/70
O	192.69.0.0/30	Serial2/0	192.69.0.6	110/69
C	192.69.0.4/30	Serial2/0	---	0/0
C	192.69.0.8/30	Serial3/0	---	0/0
O	192.69.0.12/30	Serial3/0	192.69.0.10	110/69
O	192.69.1.0/24	Serial2/0	192.69.0.6	110/70
O	192.69.2.0/25	Serial3/0	192.69.0.10	110/65
C	192.69.2.128/25	FastEthernet0/0	---	0/0

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Figure 3- 1: Routing Table for R0.

Routing Table for Router1

Type	Network	Port	Next Hop IP	Metric
	172.16.0.1/32	Serial2/0	192.69.0.1	110/6
	172.16.1.1/32	Serial2/0	192.69.0.1	110/6
	172.16.2.1/32	Serial2/0	192.69.0.1	110/6
	172.16.3.1/32	Serial2/0	192.69.0.1	110/6
	172.16.4.1/32	Serial2/0	192.69.0.1	110/6
	172.16.5.1/32	Serial2/0	192.69.0.1	110/6
	192.69.0.0/30	Serial2/0	---	0/0
	192.69.0.4/30	Serial3/0	---	0/0
	192.69.0.8/30	Serial3/0	192.69.0.5	110/128
	192.69.0.12/30	Serial3/0	192.69.0.5	110/133
	192.69.1.0/24	Serial2/0	192.69.0.1	110/6
	192.69.2.0/25	Serial3/0	192.69.0.5	110/129
	192.69.2.128/25	Serial3/0	192.69.0.5	110/65

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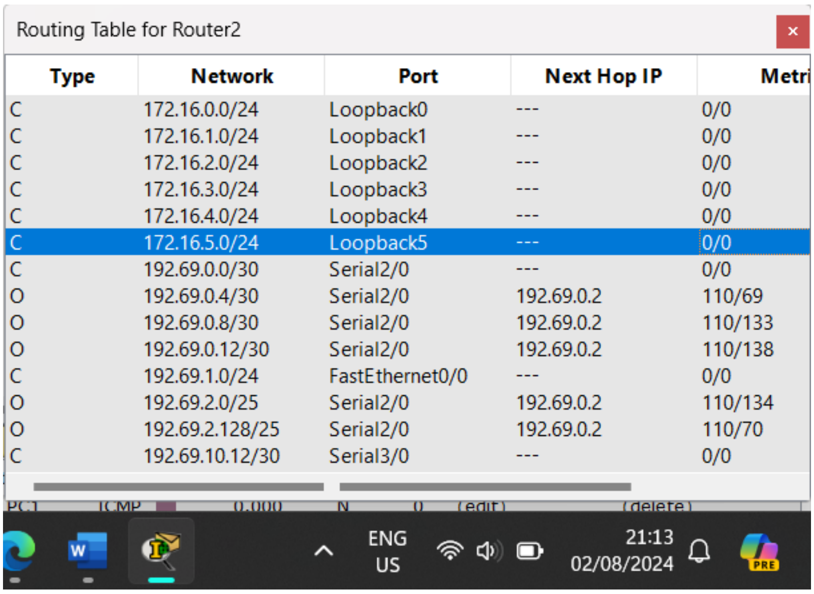
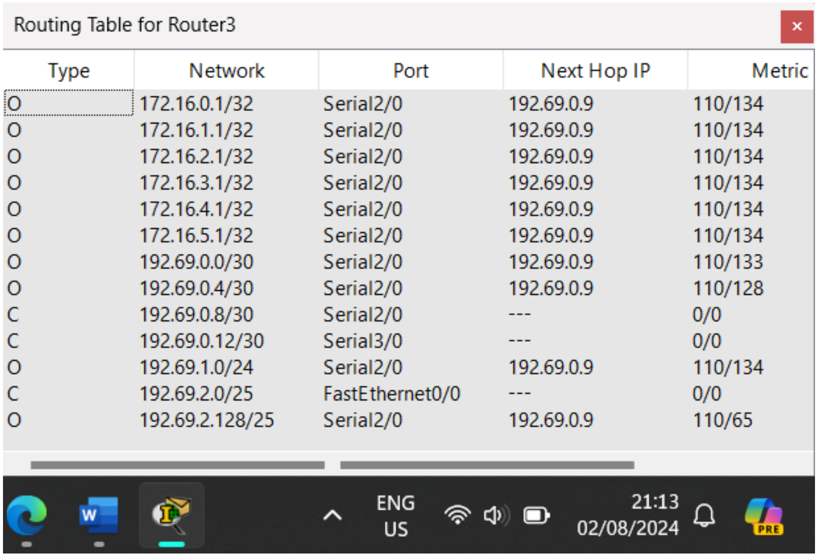
Figure 3- 2: Routing Table for R1.



Routing Table for Router2

Type	Network	Port	Next Hop IP	Metri
C	172.16.0.0/24	Loopback0	---	0/0
C	172.16.1.0/24	Loopback1	---	0/0
C	172.16.2.0/24	Loopback2	---	0/0
C	172.16.3.0/24	Loopback3	---	0/0
C	172.16.4.0/24	Loopback4	---	0/0
C	172.16.5.0/24	Loopback5	---	0/0
C	192.69.0.0/30	Serial2/0	---	0/0
O	192.69.0.4/30	Serial2/0	192.69.0.2	110/69
O	192.69.0.8/30	Serial2/0	192.69.0.2	110/133
O	192.69.0.12/30	Serial2/0	192.69.0.2	110/138
C	192.69.1.0/24	FastEthernet0/0	---	0/0
O	192.69.2.0/25	Serial2/0	192.69.0.2	110/134
O	192.69.2.128/25	Serial2/0	192.69.0.2	110/70
C	192.69.10.12/30	Serial3/0	---	0/0

Figure 3- 3: Routing Table for R2.



Routing Table for Router3

Type	Network	Port	Next Hop IP	Metric
O	172.16.0.1/32	Serial2/0	192.69.0.9	110/134
O	172.16.1.1/32	Serial2/0	192.69.0.9	110/134
O	172.16.2.1/32	Serial2/0	192.69.0.9	110/134
O	172.16.3.1/32	Serial2/0	192.69.0.9	110/134
O	172.16.4.1/32	Serial2/0	192.69.0.9	110/134
O	172.16.5.1/32	Serial2/0	192.69.0.9	110/134
O	192.69.0.0/30	Serial2/0	192.69.0.9	110/133
O	192.69.0.4/30	Serial2/0	192.69.0.9	110/128
C	192.69.0.8/30	Serial2/0	---	0/0
C	192.69.0.12/30	Serial3/0	---	0/0
O	192.69.1.0/24	Serial2/0	192.69.0.9	110/134
C	192.69.2.0/25	FastEthernet0/0	---	0/0
O	192.69.2.128/25	Serial2/0	192.69.0.9	110/65

Figure 3- 4: Routing Table for R3.

As shown in the figures above each router has routing table include all IPs and neighbour networks IP.

3.2 PC Testing

This section is to test the topology and sending the packets through the network.

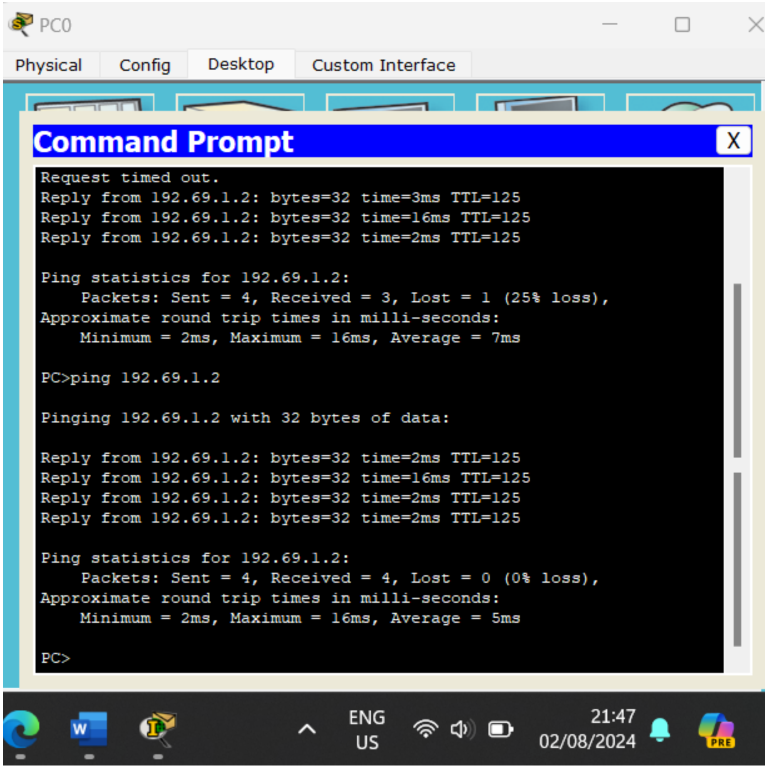


Figure 3- 5: PC0 – PC4.

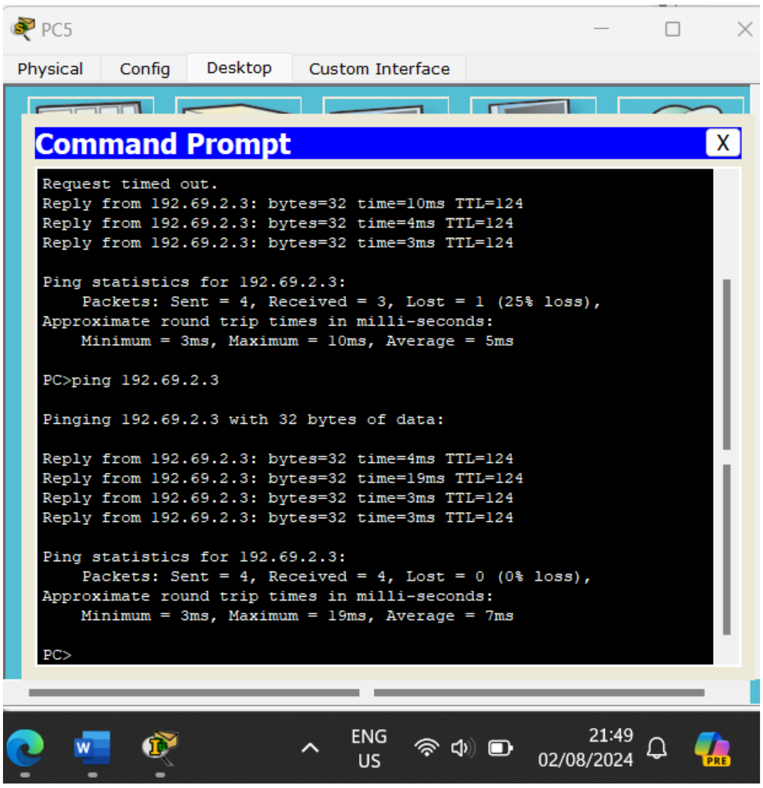


Figure 3- 6: PC5 – PC3.

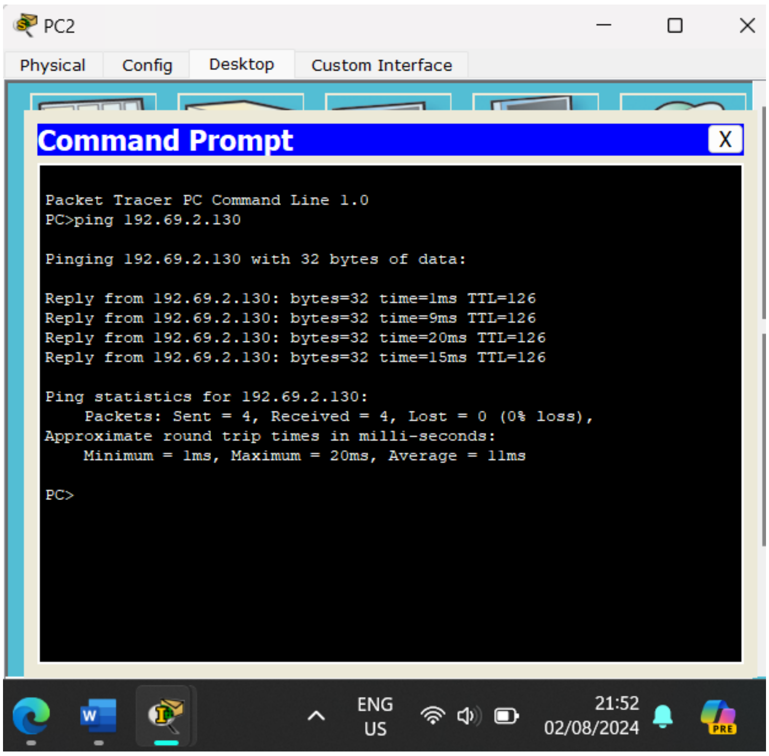


Figure 3- 7: PC2 – PC0.

So, as shown in the figures above the process done successfully for all testing.

- ⇨ The first packet sent from PC0 to PC4
- ⇨ The second packet sent from PC5 to PC3
- ⇨ The third packet sent from PC2 to PC0

These three cases cover the transmissions between all areas.

4. To Do

4.1 Question

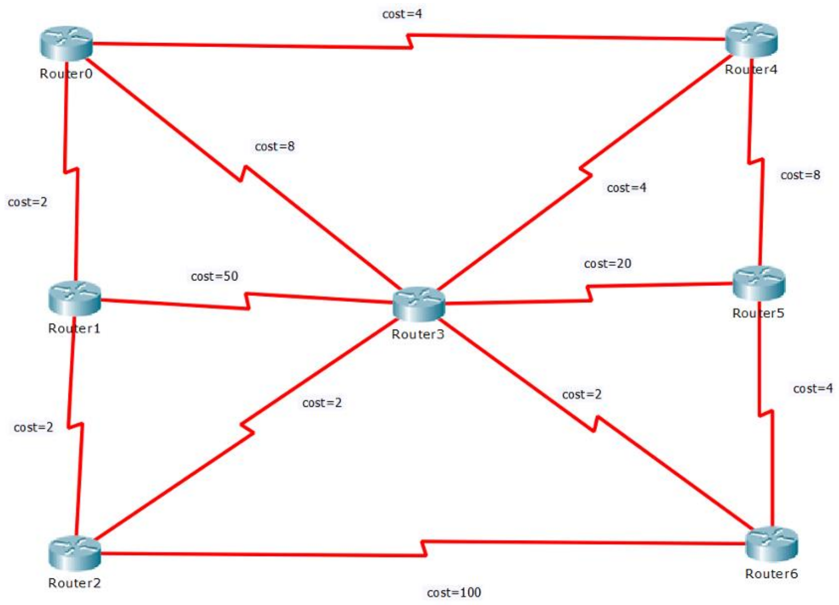


Figure 4- 1: Question.

Part I:

I. Find the shortest path from Router 0 to Router 6 using Dijkstra's algorithm. Show your steps.

II. What is the cost of the shortest path from Router 0 to Router 6?

Part II:

Build and configure the above topology using Packet Tracer software based on the following requirements.

• Requirements: To help guide this initial configuration, you've assembled a list of requirements:

I. For addressing the above network use the class C address 192.A.B.0 and use it to create networks (subnets) of 2 hosts each. A, and B represent the last four digits of your university ID. For example: if your university ID 1140302 then (A = 03 = 3) and (B = 02 = 2)

II. Enable OSPF routing. Assume all routers are in area 0 (backbone)

III. Configure Router 6 with a loopback IP address 7.7.7.7/24. Advertise this network into OSPF process.

IV. Don't forget to configure bandwidth values between links. These values should reflect the costs that are shown in the network diagram.

V. If a packet is sent from Router 0 to Router 7 (i.e. loopback 7.7.7.7). What routers it passes through until it reaches its destination? Use the traceroute command to test that.

VI. Run the show IP route command on Router 0. From the output result. What is the cost (metric) to get from Router 0 to Router 6? Explain that.

VII. What is the router-id for Router 0, and Router 6? Verify your answers

4.2 Solution

4.2.1 Part I

I

	1 (b)	2 (c)	3 (d)	4 (e)	5 (f)	6 (g)
a	2a	inf	8a	4a	inf	inf
ab	✓	4b	8a	4a	inf	inf
abc		✓	6c	4a	inf	104c
abce			6c	✓	12e	104c
abced			✓		12e	8d
abcedg					12e	✓
abcedf					✓	

Table 4- 1: Dijkstra's algorithm.

✓ : Selected

So, the path is: a b c d g

⇨ 0 1 2 3 6

II

Path cost equal to 8.

4.2.2 Part II

Topology

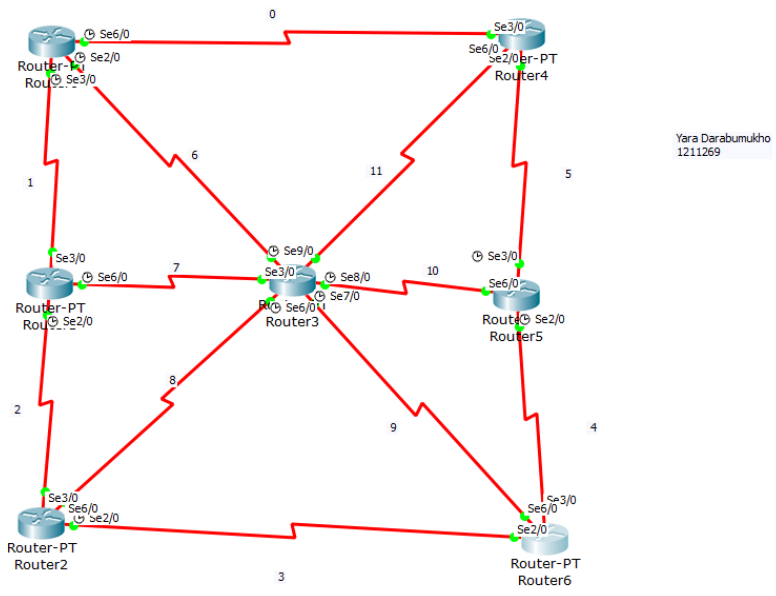


Figure 4- 2: Topology.

I

There are 12 networks.

Each network should have 2 hosts. So, the mask should be /30 “255.255.255.252”.

My ID is: 1211269

⇨ 192.12.69.0

Network 0: 192.12.69.0 / 32 Hosts: 192.12.69.1 192.12.69.2	Network 1: 192.12.69.4 / 32 Hosts: 192.12.69.5 192.12.69.6	. . . . .	Network 11: 192.12.69.44 / 32 Hosts: 192.12.69.45 192.12.69.46

Table 4- 2: Networks IP.

I apply the IPs to each router by the configuration global setting the by the terminal run “no shutdown” command for each serial number for all routers.

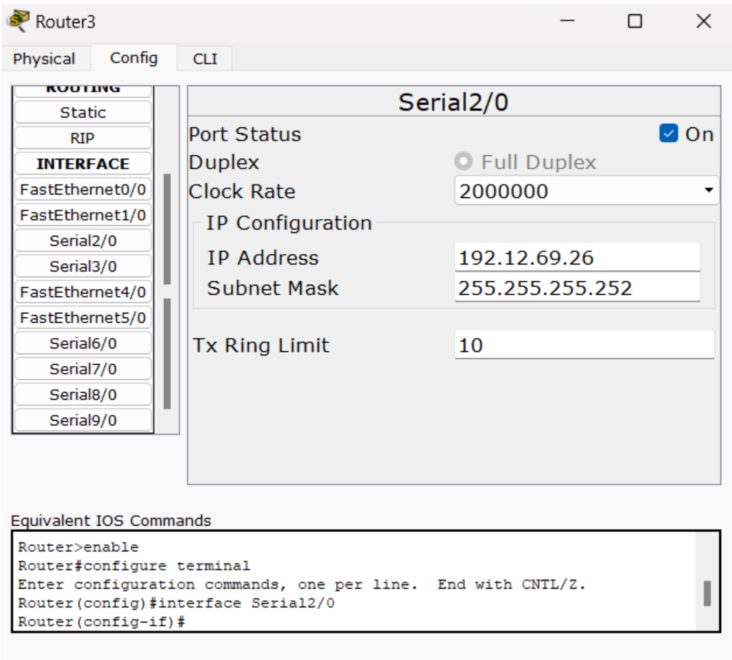


Figure 4- 3: set the IPs.

<u>Note:</u>

I took the to do screenshots previously without the data and the time, I will submit the packet tracker file to check if u want.

II

I apply the OSPF 1 for all routers, and this is router 0 for example:

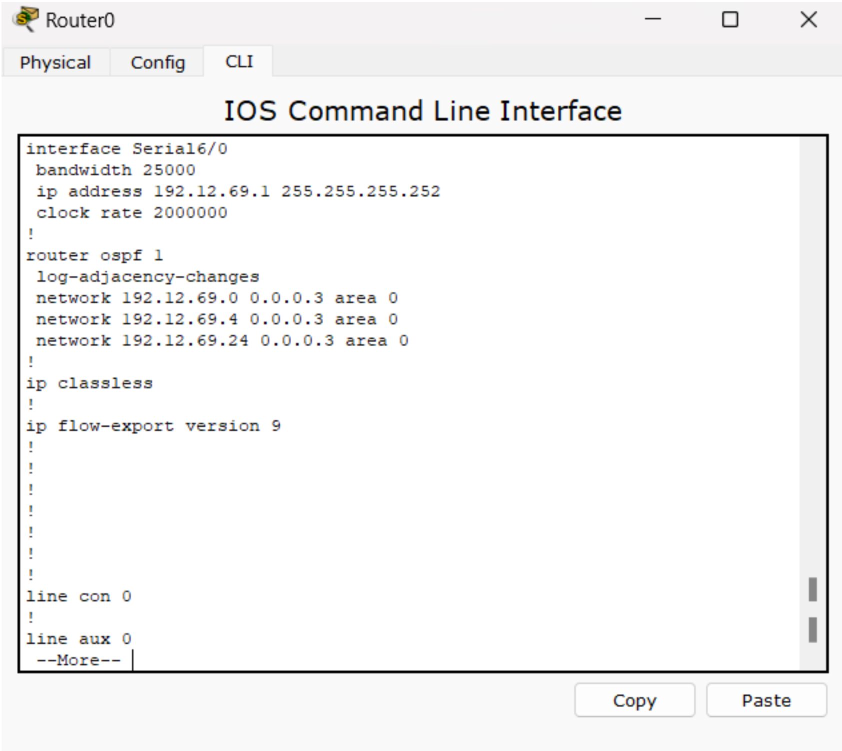
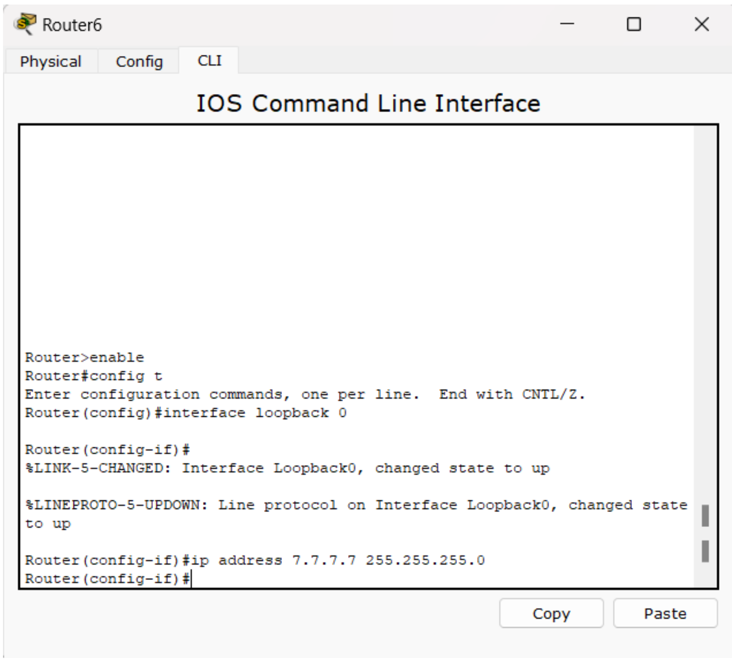


Figure 4- 4: Apply OSPF 1.

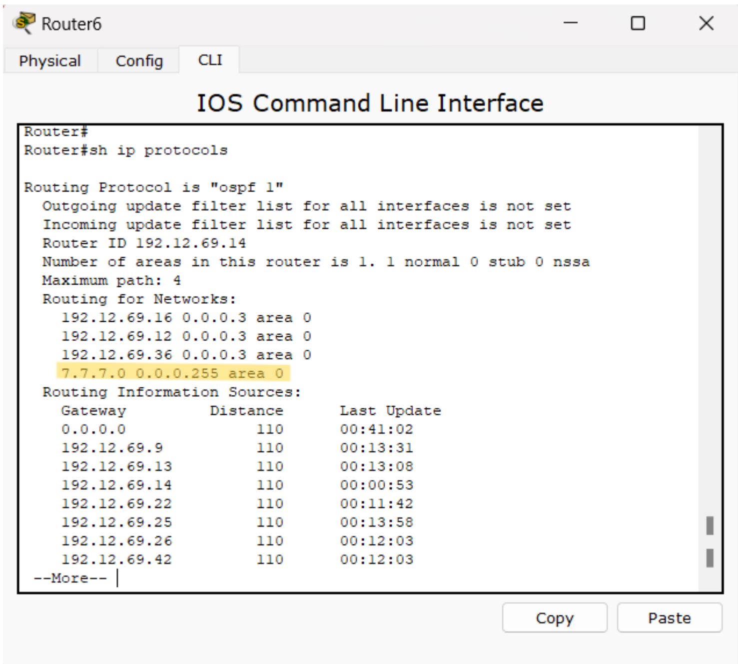
III

Applying the loopback for router 6 as shown in the next figure.




```
Router>enable
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface loopback 0

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 address 7.7.7.7 255.255.255.0
Router(config-if)#
```

Figure 4- 5: Applying the Loopback.




```
Router#
Router#sh ip protocols

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.12.69.14
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.12.69.16 0.0.0.3 area 0
    192.12.69.12 0.0.0.3 area 0
    192.12.69.36 0.0.0.3 area 0
    7.7.7.0 0.0.0.255 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    0.0.0.0              110      00:41:02
    192.12.69.9          110      00:13:31
    192.12.69.13         110      00:13:08
    192.12.69.14         110      00:00:53
    192.12.69.22         110      00:11:42
    192.12.69.25         110      00:13:58
    192.12.69.26         110      00:12:03
    192.12.69.42         110      00:12:03
 --More--
```

Figure 4- 6: Advertise this network into OSPF process.

Port	Link	IP Address	IPv6 Address	MAC Address
FastEthernet0/0	Down	<not set>	<not set>	00D0.5864.6639
FastEthernet1/0	Down	<not set>	<not set>	0060.4763.1C7A
Serial2/0	Up	192.12.69.14/30	<not set>	<not set>
Serial3/0	Up	192.12.69.17/30	<not set>	<not set>
FastEthernet4/0	Down	<not set>	<not set>	0003.E42B.2002
FastEthernet5/0	Down	<not set>	<not set>	0001.964B.983B
Serial6/0	Up	192.12.69.38/30	<not set>	<not set>
Loopback0	Up	7.7.7.7/24	<not set>	0001.968C.EBE3

Hostname: Router

Physical Location: Intercity, Home City, Corporate Office, Main Wiring Closet

Figure 4- 7: Router 6 table.

IV

To Calculate the Bandwidth, we use this rule:

Bandwidth = 100Mb/cost

Cost = 2	Bandwidth = 50000Kb
Cost = 4	Bandwidth = 25000Kb
Cost = 8	Bandwidth = 12500Kb
Cost = 20	Bandwidth = 5000Kb
Cost = 50	Bandwidth = 2000Kb
Cost = 100	Bandwidth = 1000Kb

Table 4- 3: Bandwidth Calculating.

This is some bandwidths for router 0 using “show run” command.

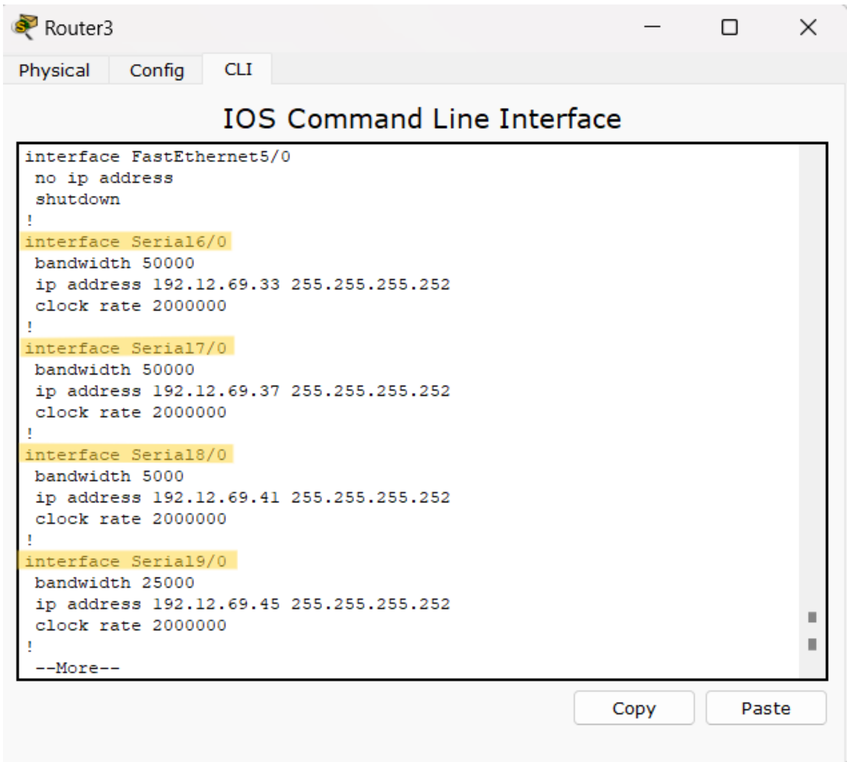


Figure 4- 8: Router 0 Bandwidths.

V

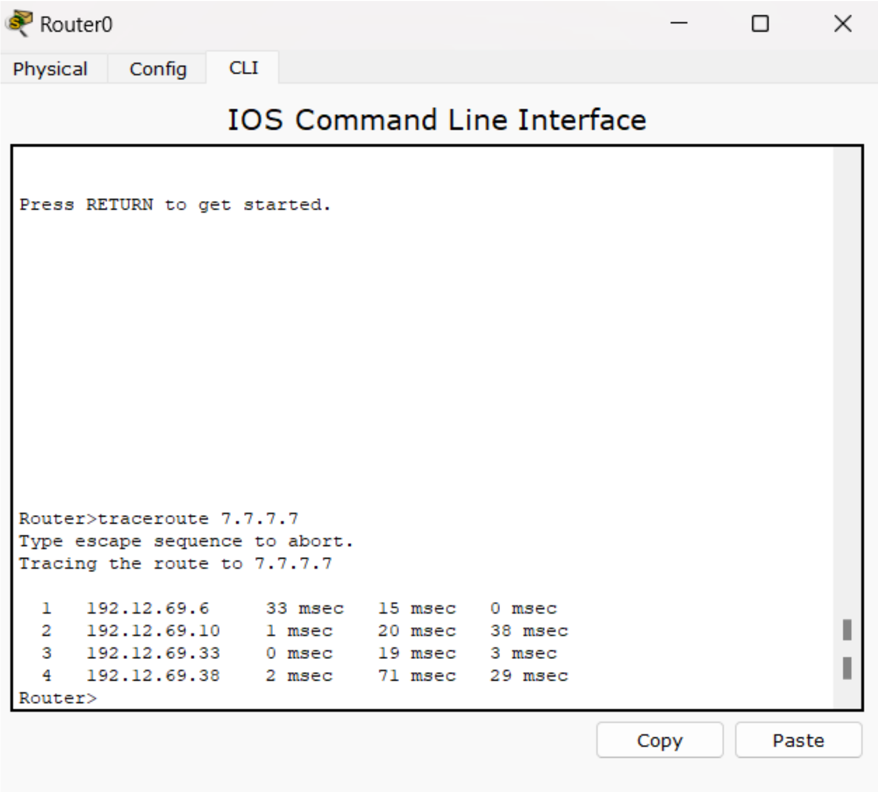
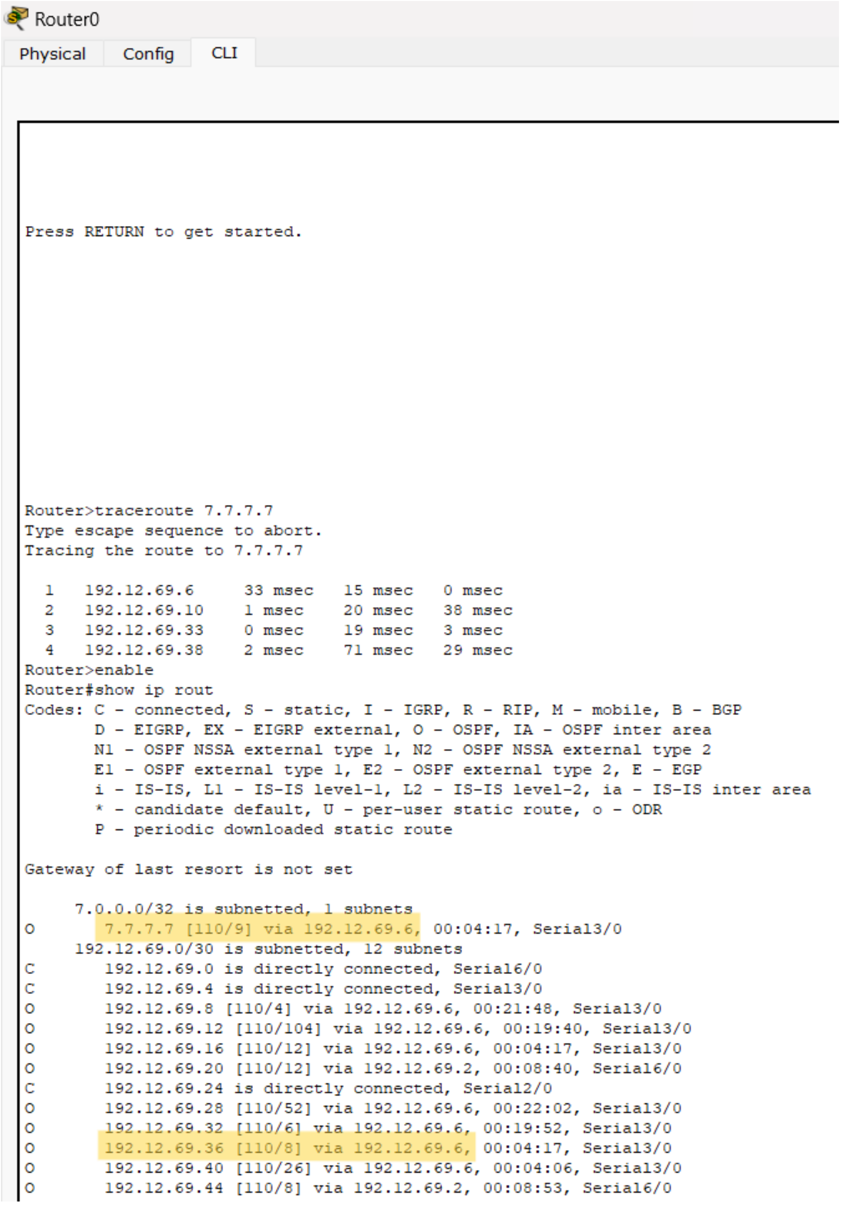


Figure 4- 9: Sending Packet.

So, as shown in the figure above the packet pass through router 1, 2, 3, and 4. Until its reach router 6 from router 0.

VI

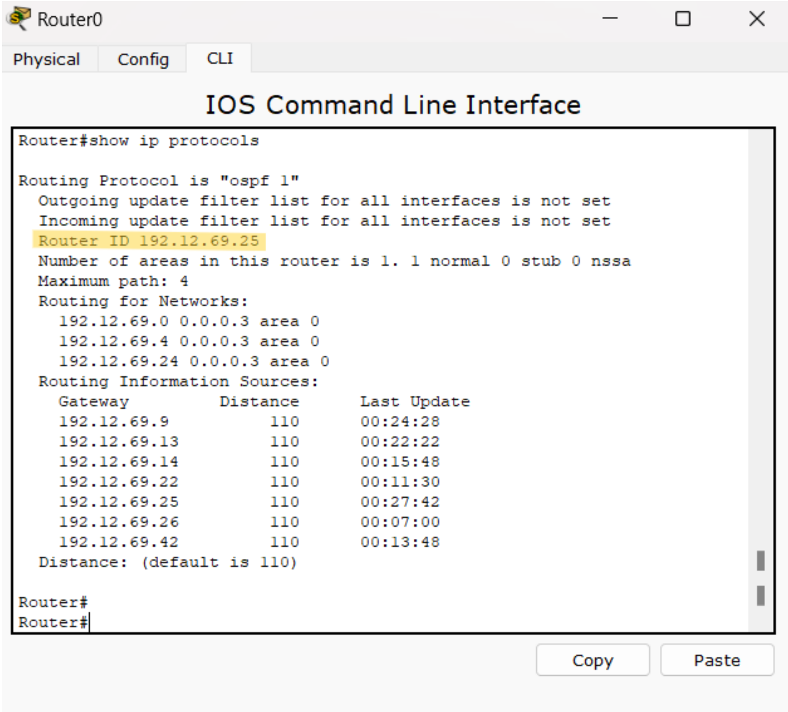


```
Router0
Physical   Config   CLI

Press RETURN to get started.

Router>traceroute 7.7.7.7
Type escape sequence to abort.
Tracing the route to 7.7.7.7

  1   192.12.69.6     33 msec   15 msec   0 msec
  2   192.12.69.10    1 msec    20 msec   38 msec
  3   192.12.69.33    0 msec    19 msec   3 msec
  4   192.12.69.38    2 msec    71 msec   29 msec
Router>enable
Router#show ip rout
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

     7.0.0.0/32 is subnetted, 1 subnets
O       7.7.7.7 [110/9] via 192.12.69.6, 00:04:17, Serial3/0
     192.12.69.0/30 is subnetted, 12 subnets
C       192.12.69.0 is directly connected, Serial6/0
C       192.12.69.4 is directly connected, Serial3/0
O       192.12.69.8 [110/4] via 192.12.69.6, 00:21:48, Serial3/0
O       192.12.69.12 [110/104] via 192.12.69.6, 00:19:40, Serial3/0
O       192.12.69.16 [110/12] via 192.12.69.6, 00:04:17, Serial3/0
O       192.12.69.20 [110/12] via 192.12.69.2, 00:08:40, Serial6/0
C       192.12.69.24 is directly connected, Serial2/0
O       192.12.69.28 [110/52] via 192.12.69.6, 00:22:02, Serial3/0
O       192.12.69.32 [110/6] via 192.12.69.6, 00:19:52, Serial3/0
O       192.12.69.36 [110/8] via 192.12.69.6, 00:04:17, Serial3/0
O       192.12.69.40 [110/26] via 192.12.69.6, 00:04:06, Serial3/0
O       192.12.69.44 [110/8] via 192.12.69.2, 00:08:53, Serial6/0
```

Figure 4- 10: IP route command.

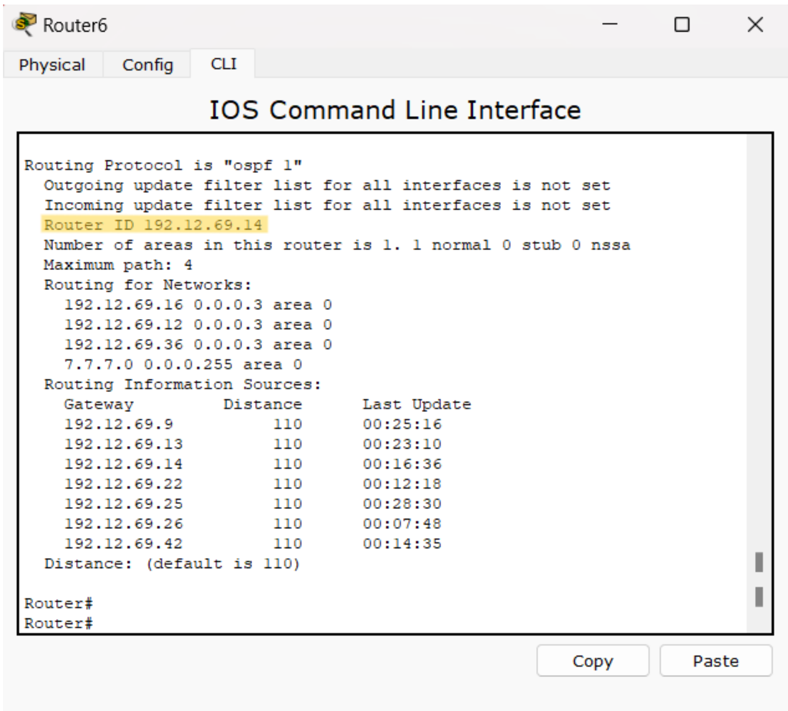
We have [110/9] and [110/8] we choose [110/8] to use because its more frequently.

VII




```
Router#show ip protocols

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.12.69.25
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.12.69.0 0.0.0.3 area 0
    192.12.69.4 0.0.0.3 area 0
    192.12.69.24 0.0.0.3 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.12.69.9          110      00:24:28
    192.12.69.13         110      00:22:22
    192.12.69.14         110      00:15:48
    192.12.69.22         110      00:11:30
    192.12.69.25         110      00:27:42
    192.12.69.26         110      00:07:00
    192.12.69.42         110      00:13:48
  Distance: (default is 110)

Router#
Router#
```

Figure 4- 11: Router-ID for Router 0.




```
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.12.69.14
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.12.69.16 0.0.0.3 area 0
    192.12.69.12 0.0.0.3 area 0
    192.12.69.36 0.0.0.3 area 0
    7.7.7.0 0.0.0.255 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.12.69.9          110      00:25:16
    192.12.69.13         110      00:23:10
    192.12.69.14         110      00:16:36
    192.12.69.22         110      00:12:18
    192.12.69.25         110      00:28:30
    192.12.69.26         110      00:07:48
    192.12.69.42         110      00:14:35
  Distance: (default is 110)

Router#
Router#
```

Figure 4- 12: Router-ID for Router 7.

So, as shown in the figures above each router has the IP of the serial number of another router.

“R0 -> R7

R0 has adjacent se of R7 and vice versa”.

5. Conclusion

In this experiment we build a topology and set the address for each router and PC in each area.

Learned about the loopback, summarization, OSPF routing protocol, router ID, and cost changing. For each topic of these we understand it then apply it into the topology and verify that its work successfully. The main aim of this experiment is to apply the OSPF routing protocol, and the other topics make the proses easier and faster.

The to do apply same topics but in addition we determine the path using Dijkstra’s algorithm and addressing the topology.

6. Feedback

It was an exciting experiment; the experiment requires less time than the lab time but this better actually to understand all details.

7. References

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[10]: https://networklessons.com/ospf/ospf-router-id

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