



***Faculty of Engineering and Technology***  
***Electrical and Computer Engineering Department***  
***ENCS4130 // Computer Networks Laboratory***  
***Problem Solution in***

***EXP. No. 4. Dynamic Routing 2***

***(Link State Routing Protocols)***

***Open Shortest path first (OSPF)***

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***Date of submission:*** 22/3/2024

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## Part One:

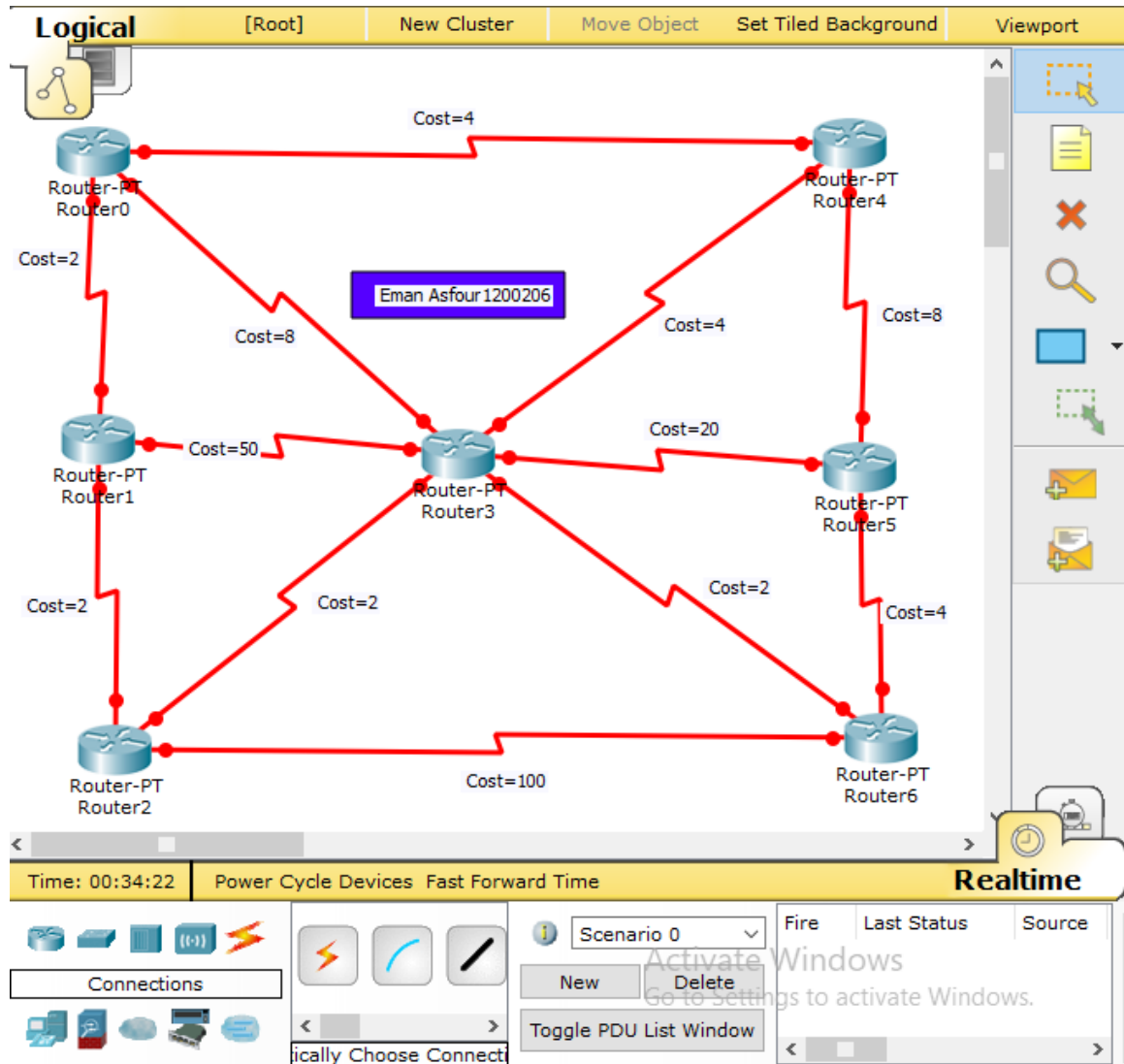


Figure 1: The Topology for TODO

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

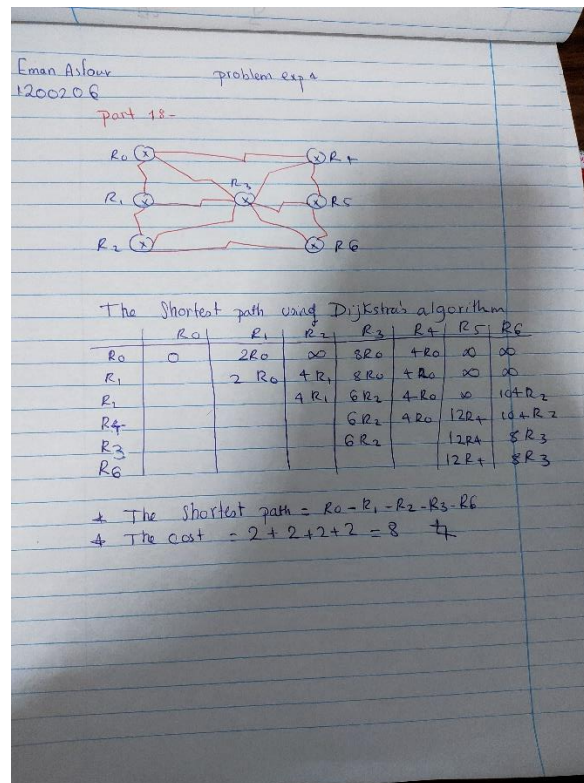


Figure 2: Dijkstra's algorithm

- What is the cost of the shortest path from Router 0 to Router 6? The cost = 8

### Part Two:

For addressing:

My ID = 1200206, So A=2 and B=6

The address = 192.2.6.0/30

Using Packet Tracer software, the topology is:

Network	Device	Interface	IP	Subnet Mask	Wildcard Mask
<b>Network 0</b> <b>192.2.6.0/30</b>	R0	Se2/0	192.2.6.1	255.255.255.252	0.0.0.3
	R1	Se2/0	192.2.6.2	255.255.255.252	0.0.0.3
<b>Network 1</b> <b>192.2.6.4/30</b>	R1	Se3/0	192.2.6.5	255.255.255.252	0.0.0.3
	R2	Se2/0	192.2.6.6	255.255.255.252	0.0.0.3
<b>Network 2</b> <b>192.2.6.8/30</b>	R0	Se6/0	192.2.6.9	255.255.255.252	0.0.0.3
	R4	Se2/0	192.2.6.10	255.255.255.252	0.0.0.3
<b>Network 3</b> <b>192.2.6.12/30</b>	R0	Se3/0	192.2.6.13	255.255.255.252	0.0.0.3
	R3	Se6/0	192.2.6.14	255.255.255.252	0.0.0.3
<b>Network 4</b> <b>192.2.6.16/30</b>	R1	Se6/0	192.2.6.17	255.255.255.252	0.0.0.3
	R3	Se3/0	192.2.6.18	255.255.255.252	0.0.0.3
<b>Network 5</b> <b>192.2.6.20/30</b>	R2	Se6/0	192.2.6.21	255.255.255.252	0.0.0.3
	R3	Se2/0	192.2.6.22	255.255.255.252	0.0.0.3
<b>Network 6</b> <b>192.2.6.24/30</b>	R2	Se3/0	192.2.6.25	255.255.255.252	0.0.0.3
	R6	Se2/0	192.2.6.26	255.255.255.252	0.0.0.3
<b>Network 7</b> <b>192.2.6.28/30</b>	R3	Se7/0	192.2.6.29	255.255.255.252	0.0.0.3
	R4	Se6/0	192.2.6.30	255.255.255.252	0.0.0.3
<b>Network 8</b> <b>192.2.6.32/30</b>	R3	Se8/0	192.2.6.33	255.255.255.252	0.0.0.3
	R5	Se3/0	192.2.6.34	255.255.255.252	0.0.0.3
<b>Network 9</b> <b>192.2.6.36/30</b>	R3	Se9/0	192.2.6.37	255.255.255.252	0.0.0.3
	R6	Se6/0	192.2.6.38	255.255.255.252	0.0.0.3



<b>Network10</b> <b>192.2.6.40/30</b>	R4	Se6/0	192.2.6.41	255.255.255.252	0.0.0.3
	R5	Se2/0	192.2.6.42	255.255.255.252	0.0.0.3
<b>Network11</b> <b>192.2.6.44/30</b>	R5	Se6/0	192.2.6.45	255.255.255.252	0.0.0.3
	R6	Se3/0	192.2.6.46	255.255.255.252	0.0.0.3
<b>7.7.7.0/24</b>	Router6	Loopback0	7.7.7.7	255.255.255.0	0.0.0.255

Table 1: Subnetting

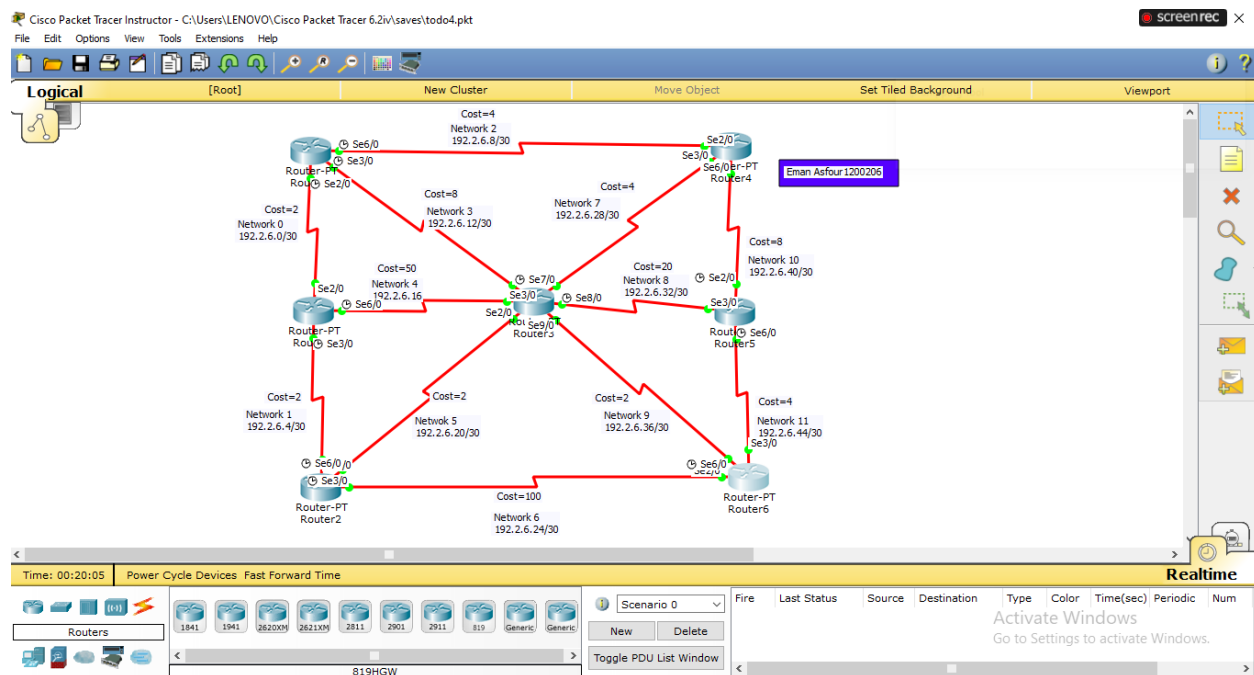


Figure 3: The Topology on packet tracer

Cisco Packet Tracer Instructor - C:\Users\LENOVO\Cisco Packet Tracer 6.2iv\saves\todo4.pkt

File Edit Options View Tools Extensions Help

Logical [Root] New Cluster Move Object Set Tiled Background Viewport

Routing Table for Router3

Type	Network	Port	Next Hop IP	Metric
C	192.2.6.12/30	Serial5/0	---	0/0
C	192.2.6.16/30	Serial3/0	---	0/0
C	192.2.6.20/30	Serial2/0	---	0/0
C	192.2.6.28/30	Serial7/0	---	0/0
C	192.2.6.32/30	Serial8/0	---	0/0
C	192.2.6.36/30	Serial9/0	---	0/0

Router-PT Router2 Cost=100 Network 6 192.2.6.24/30 Router-PT Router6

Time: 03:32:05 Power Cycle Devices Fast Forward Time

Connections

Automatically Choose Connection Type

Scenario 0

New Delete

Toggle PDU List Window

Realtime

Fire Last Status Source Destination Type Color Time(sec) Periodic Num

Activate Windows  
Go to Settings to activate Windows.

Figure 4: Checking for addressing

## Configure the loopback IP

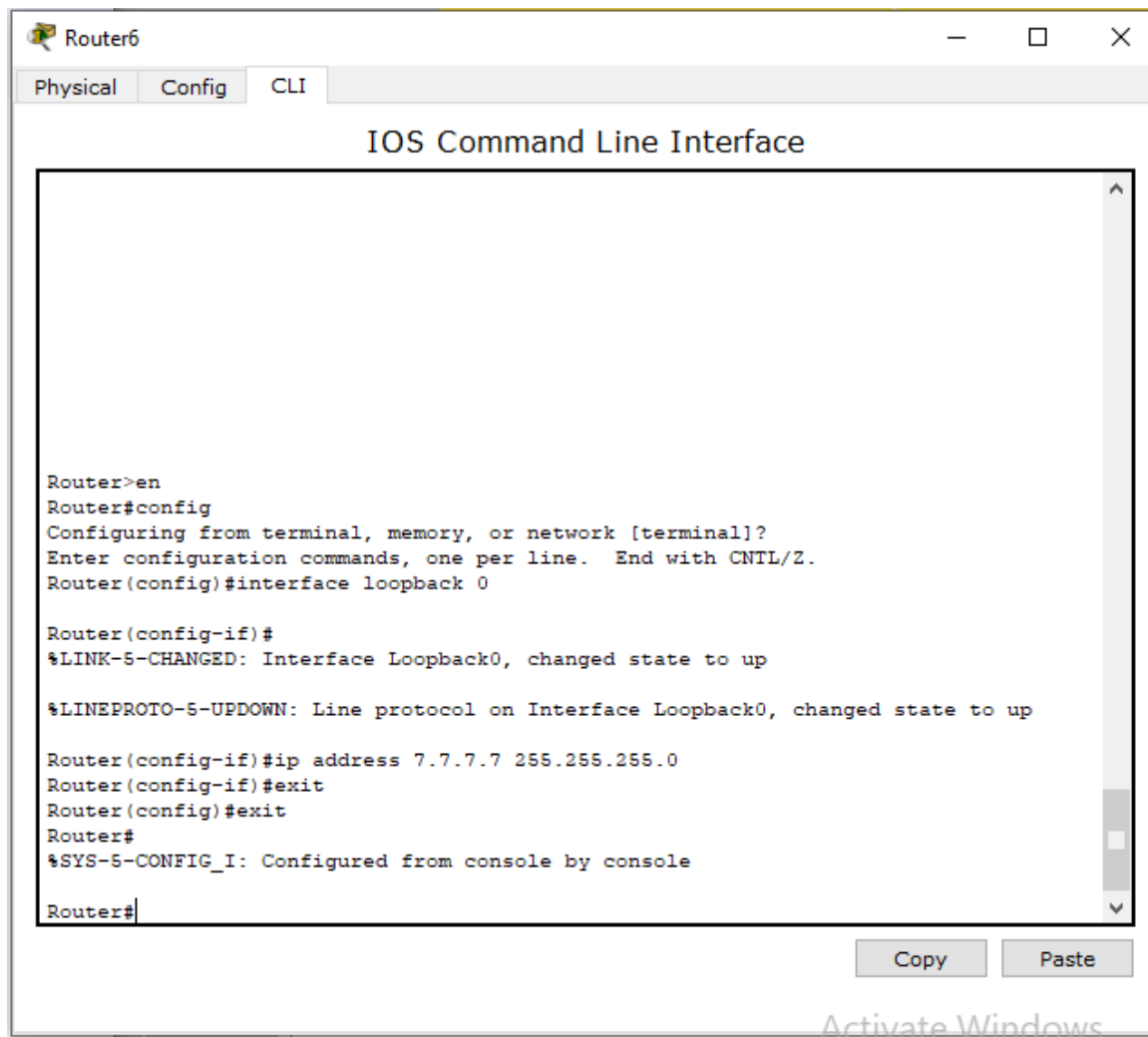


Figure 5: loopback on R6

## OSPF

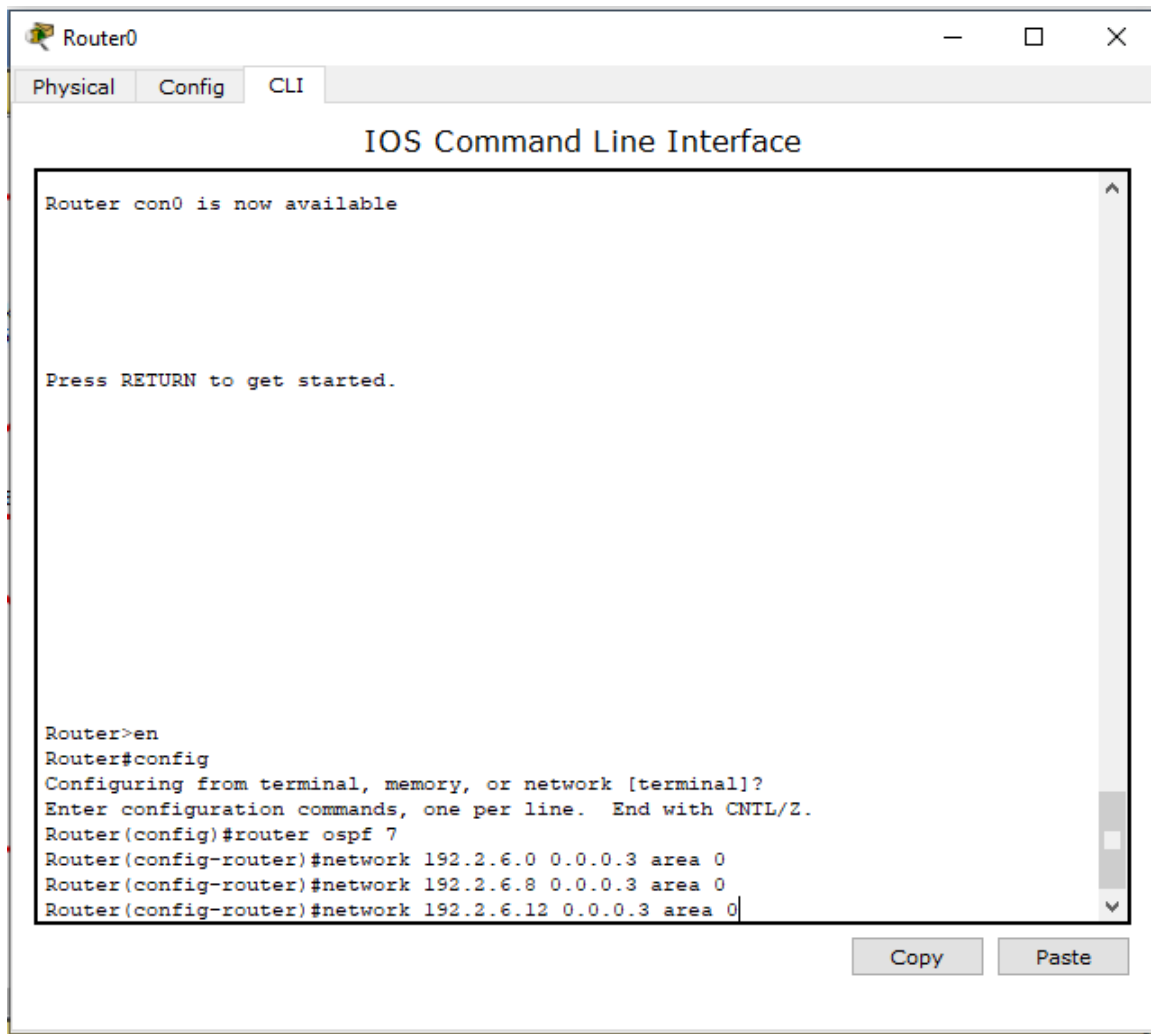


Figure 6: OSPF on R0

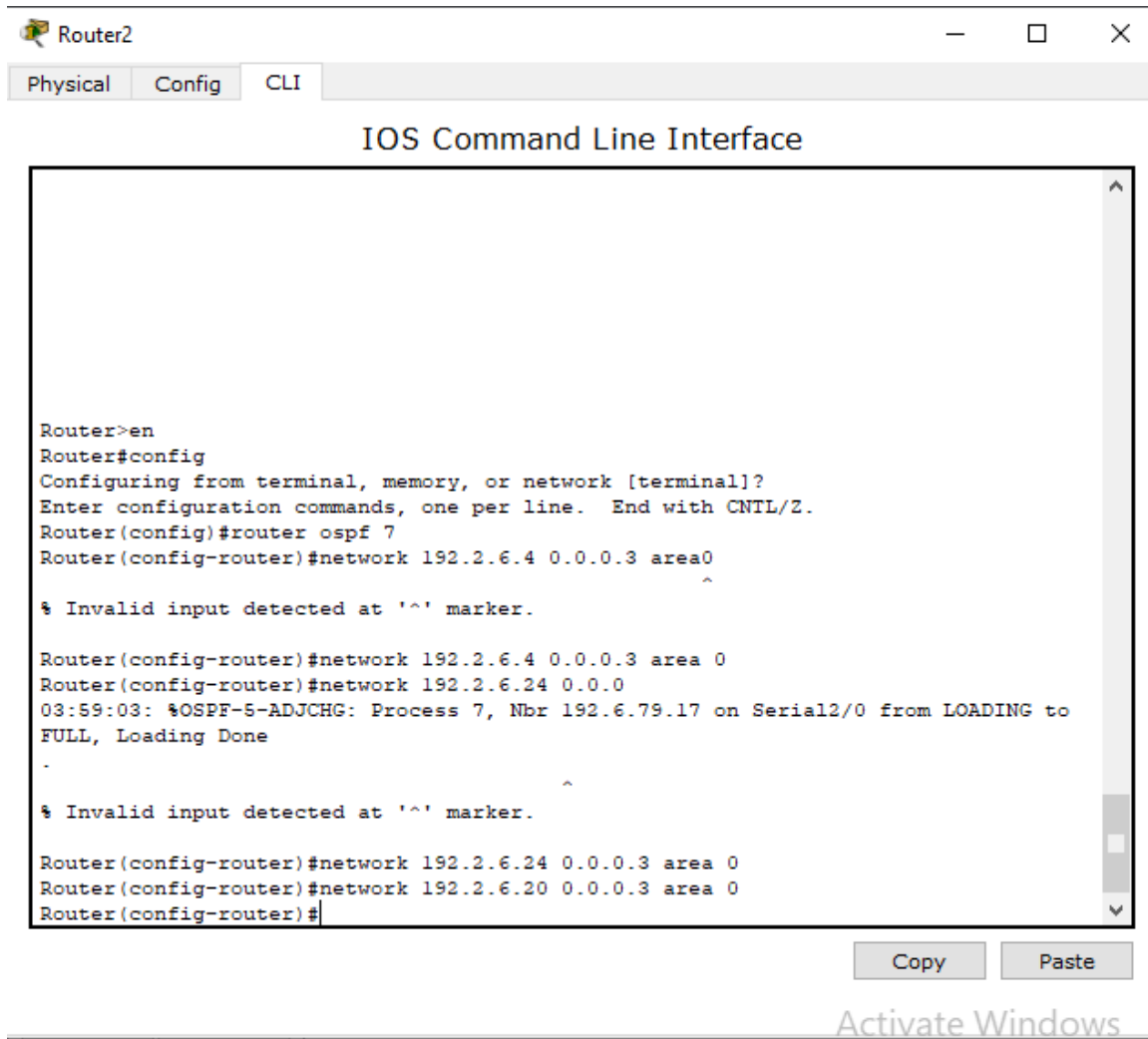


Figure 7: OSPF of R2

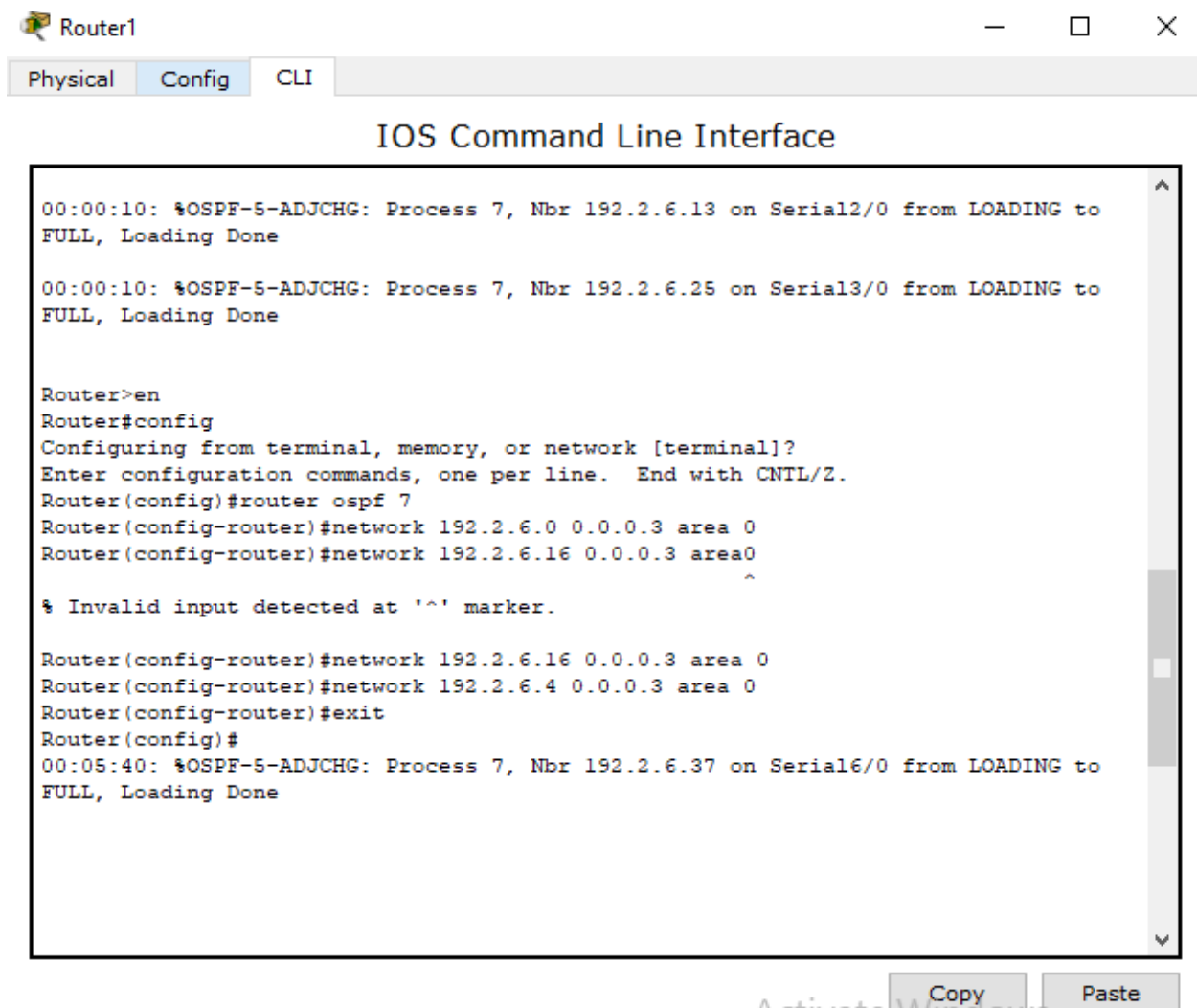


Figure 8: OSPF for R1

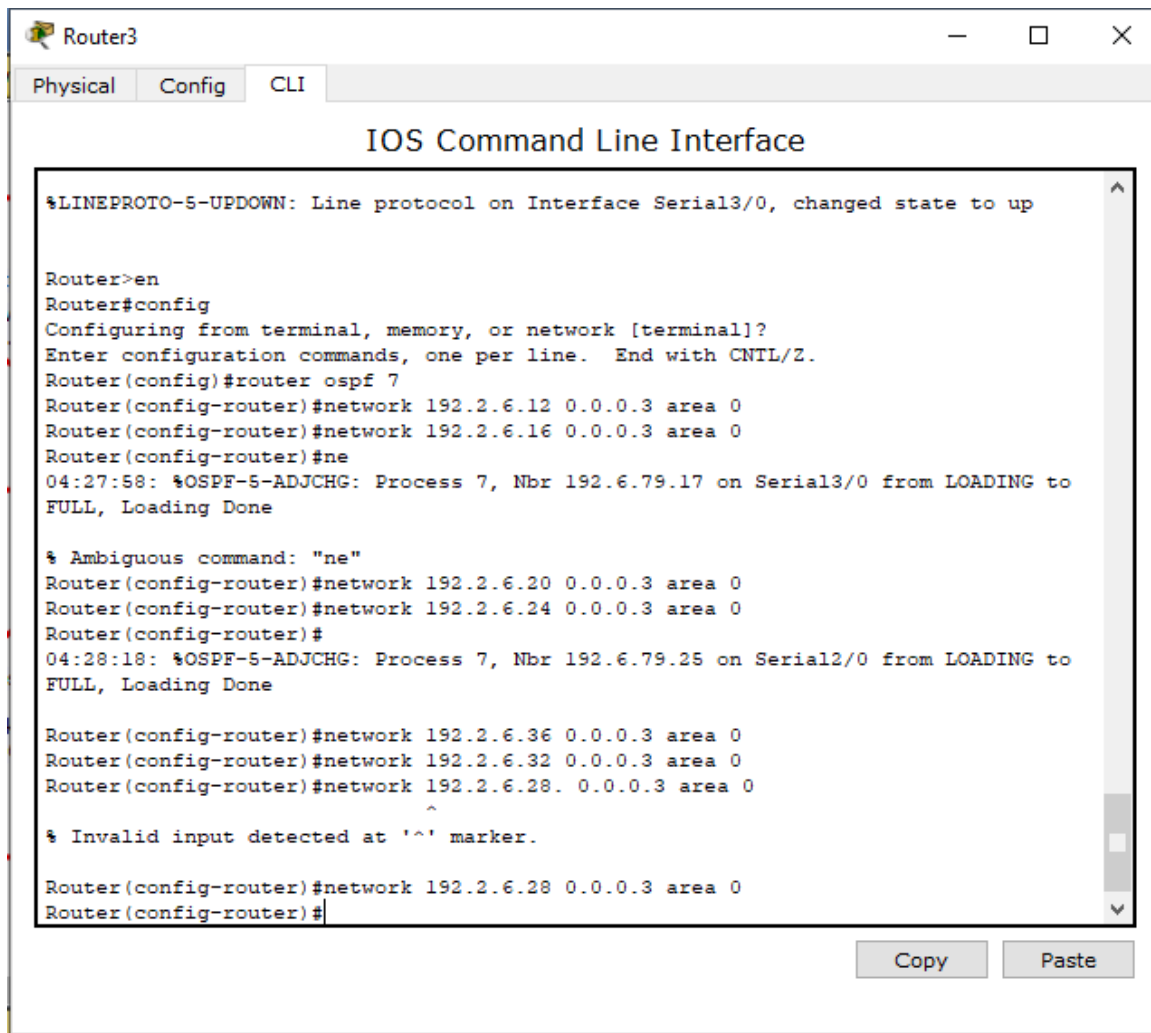


Figure 9: OSPF of R3

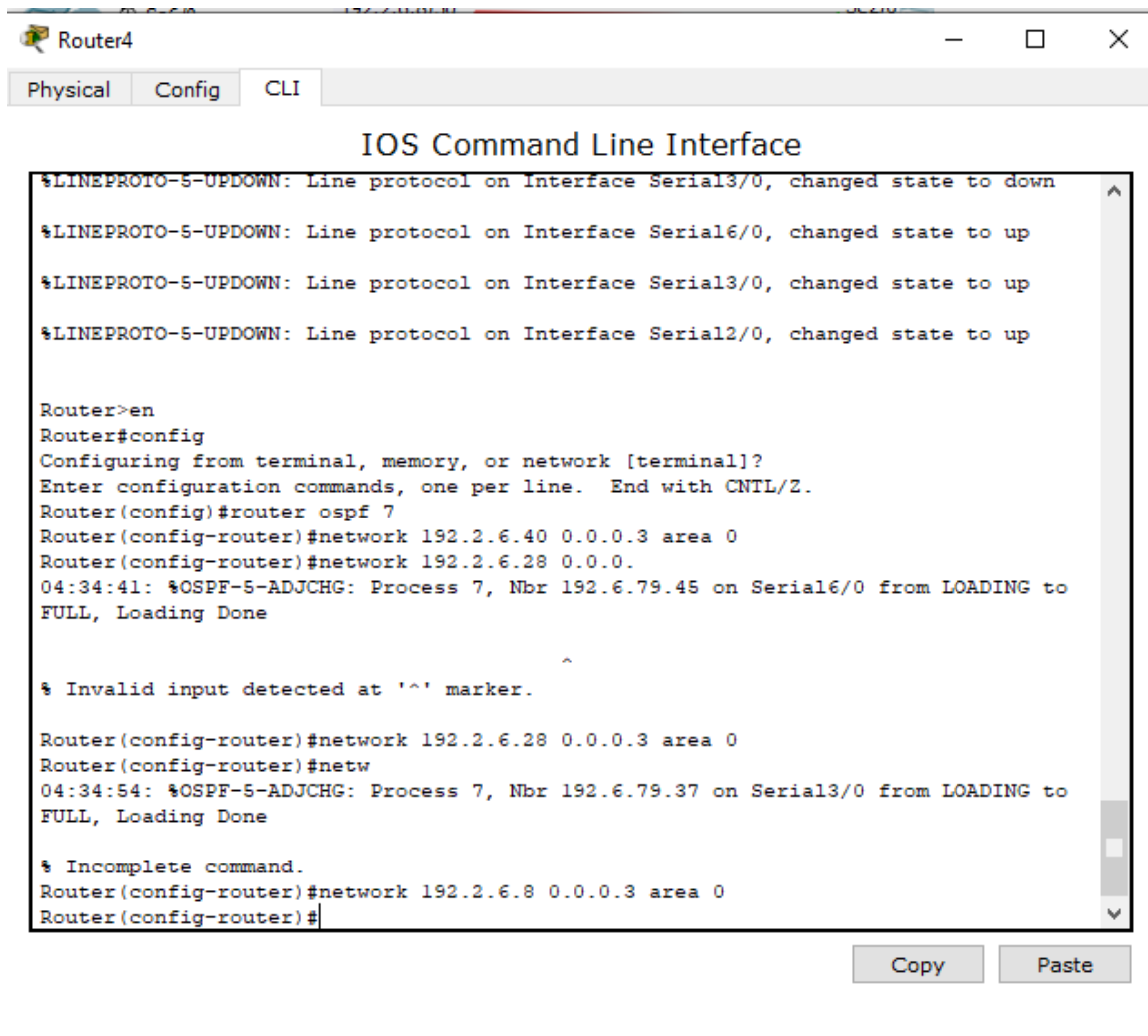


Figure 10: OSPF of R4



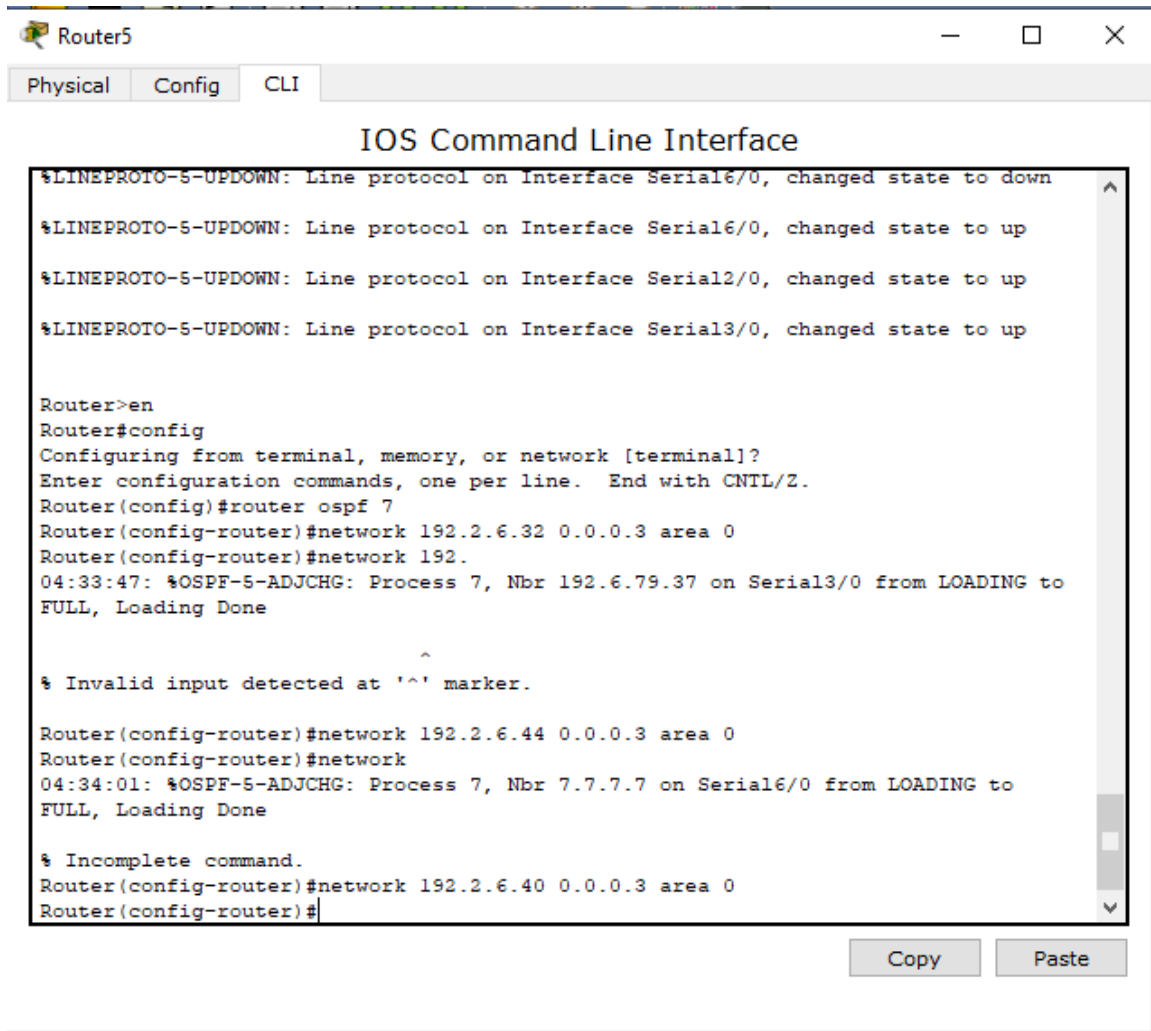
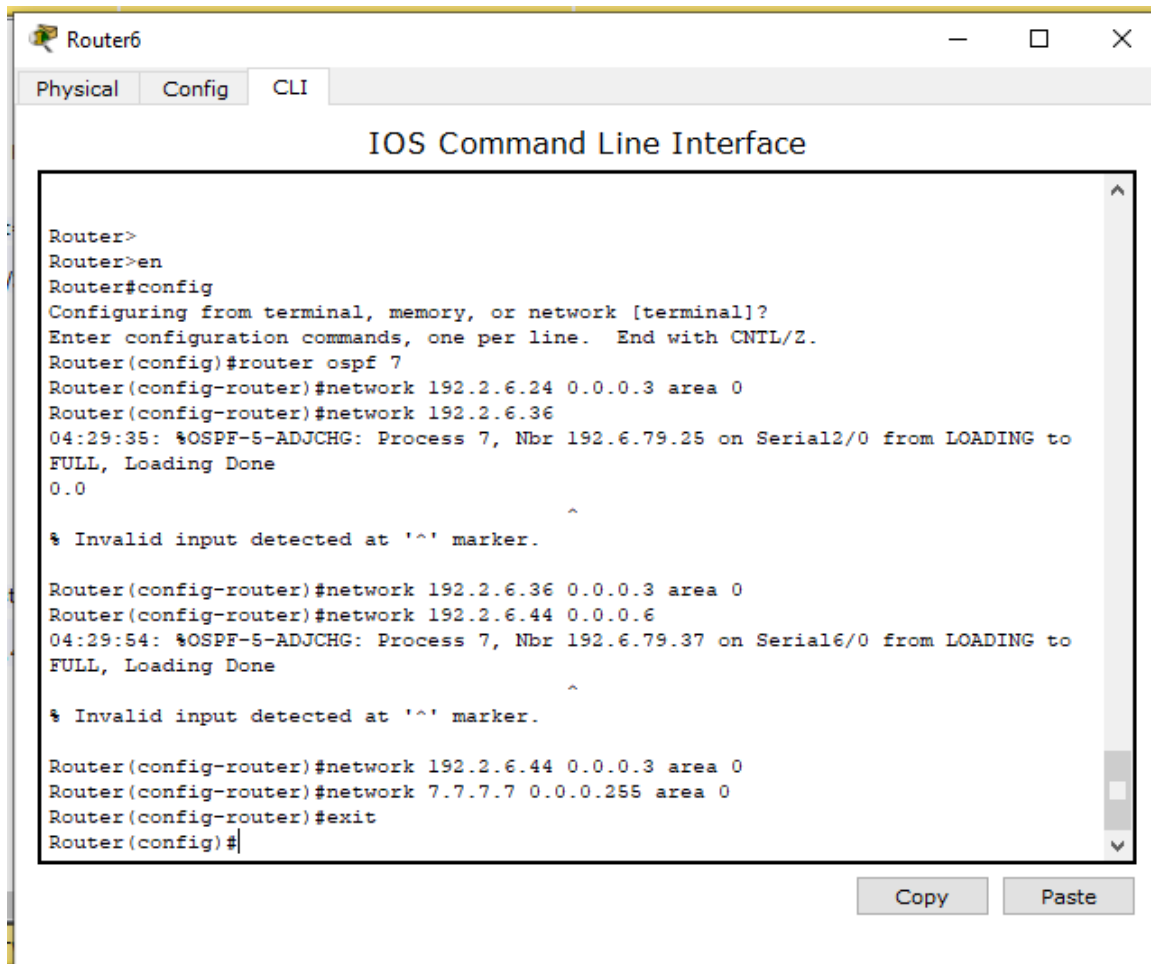


Figure 11: OSPF of R5



The screenshot shows a window titled "Router6" with tabs for "Physical", "Config", and "CLI". The "CLI" tab is active, displaying the "IOS Command Line Interface". The terminal output shows the following sequence of commands and responses:

```
Router>
Router>en
Router#config
Configuring from terminal, memory, or network [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router ospf 7
Router(config-router)#network 192.2.6.24 0.0.0.3 area 0
Router(config-router)#network 192.2.6.36
04:29:35: %OSPF-5-ADJCHG: Process 7, Nbr 192.6.79.25 on Serial2/0 from LOADING to FULL, Loading Done
0.0
^
% Invalid input detected at '^' marker.

Router(config-router)#network 192.2.6.36 0.0.0.3 area 0
Router(config-router)#network 192.2.6.44 0.0.0.6
04:29:54: %OSPF-5-ADJCHG: Process 7, Nbr 192.6.79.37 on Serial6/0 from LOADING to FULL, Loading Done
^
% Invalid input detected at '^' marker.

Router(config-router)#network 192.2.6.44 0.0.0.3 area 0
Router(config-router)#network 7.7.7.7 0.0.0.255 area 0
Router(config-router)#exit
Router(config)#
```

At the bottom of the window, there are "Copy" and "Paste" buttons.

Figure 12: OSPF on R6

All of the routers had OSPF routing enabled. Set the loopback IP address 7.7.7.7/24 on Router 6.

We must compute the bandwidth in order to set the bandwidth values between the links:

*Equation 1: The relationship between bandwidth and cost in the OSPF*

$$\text{Bandwidth} = 100\text{Mb}/\text{cost}$$

Cost = 2 → Bandwidth = 50Mb = 50000Kb

Cost = 4 → Bandwidth = 25Mb = 25000Kb

Cost = 8 → Bandwidth = 12.5Mb = 12500Kb

Cost = 20 → Bandwidth = 5Mb = 5000Kb

Cost = 50 → Bandwidth = 2Mb = 2000Kb

Cost = 100 → Bandwidth = 1Mb = 1000Kb

## Testing

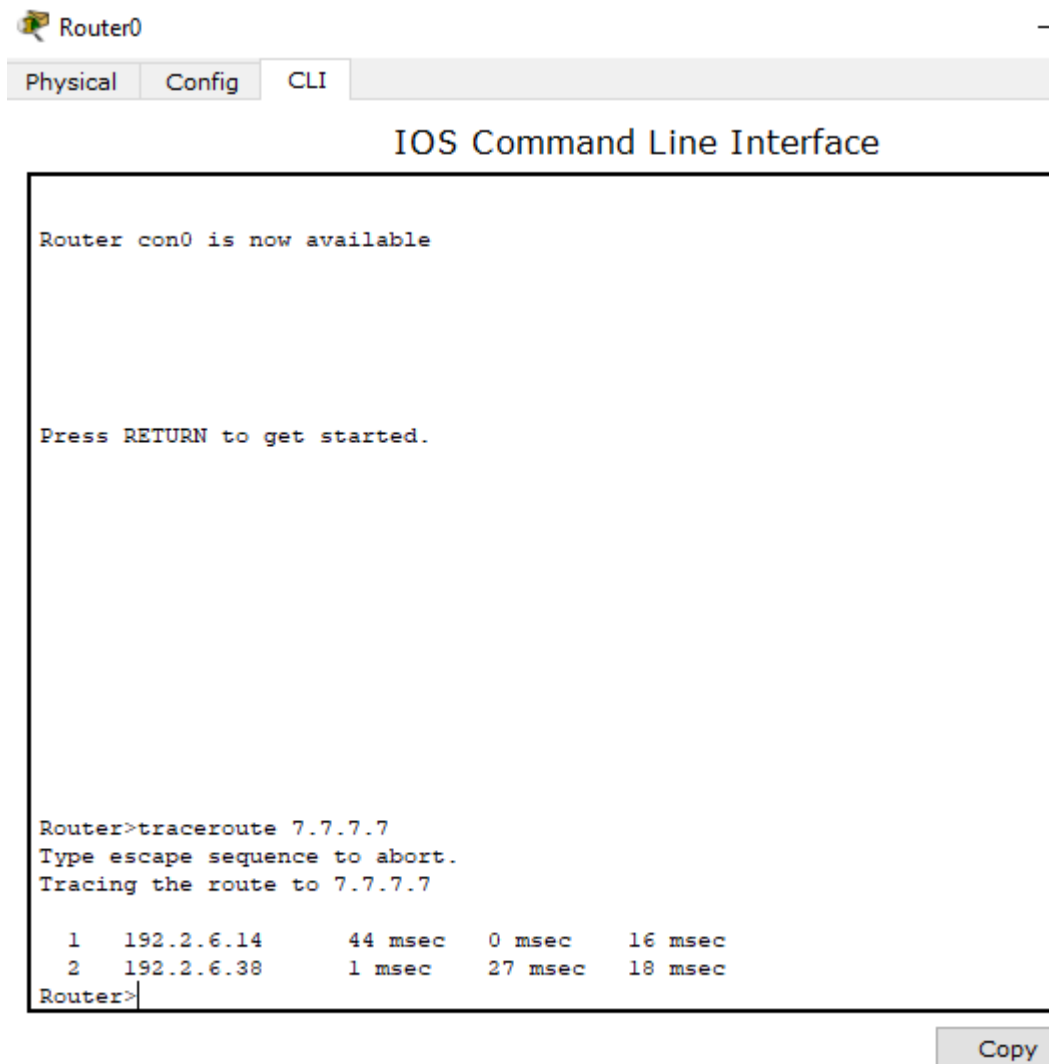


Figure 13: traceroute command

```
Router0
Physical Config CLI
IOS Command Line Interface

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

 1  192.2.6.14      44 msec    0 msec    16 msec
 2  192.2.6.39      1 msec     27 msec   18 msec
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

 7.0.0.0/32 is subnetted, 1 subnets
O   7.7.7.7 [110/128] via 192.2.6.14, 00:02:26, Serial3/0
O   192.2.6.0/30 is subnetted, 12 subnets
C   192.2.6.0 is directly connected, Serial2/0
O   192.2.6.4 [110/128] via 192.2.6.2, 00:09:46, Serial2/0
C   192.2.6.8 is directly connected, Serial6/0
C   192.2.6.12 is directly connected, Serial3/0
O   192.2.6.16 [110/128] via 192.2.6.2, 00:09:16, Serial2/0
O   192.2.6.20 [110/128] via 192.2.6.14, 00:09:06, Serial3/0
O   192.2.6.24 [110/128] via 192.2.6.2, 00:02:56, Serial2/0
O   192.2.6.28 [110/128] via 192.2.6.14, 00:02:56, Serial3/0
O   192.2.6.32 [110/128] via 192.2.6.10, 00:01:23, Serial6/0
O   192.2.6.36 [110/128] via 192.2.6.14, 00:02:36, Serial3/0
O   192.2.6.40 [110/128] via 192.2.6.10, 00:01:23, Serial6/0
O   192.2.6.44 [110/128] via 192.2.6.10, 00:01:23, Serial6/0
Router>
```

Figure 14: Show IP route

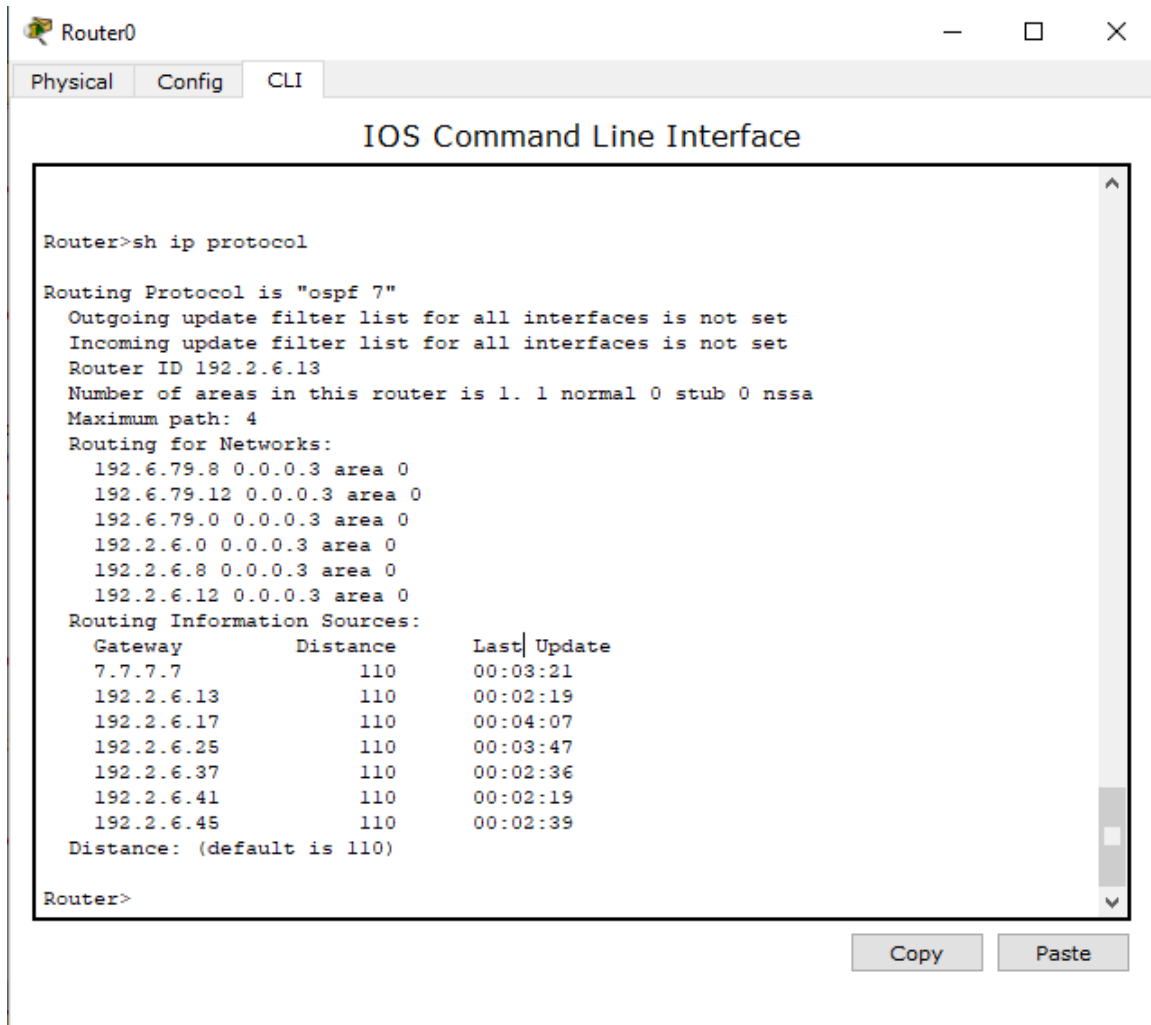


Figure 15: Show IP Protocol

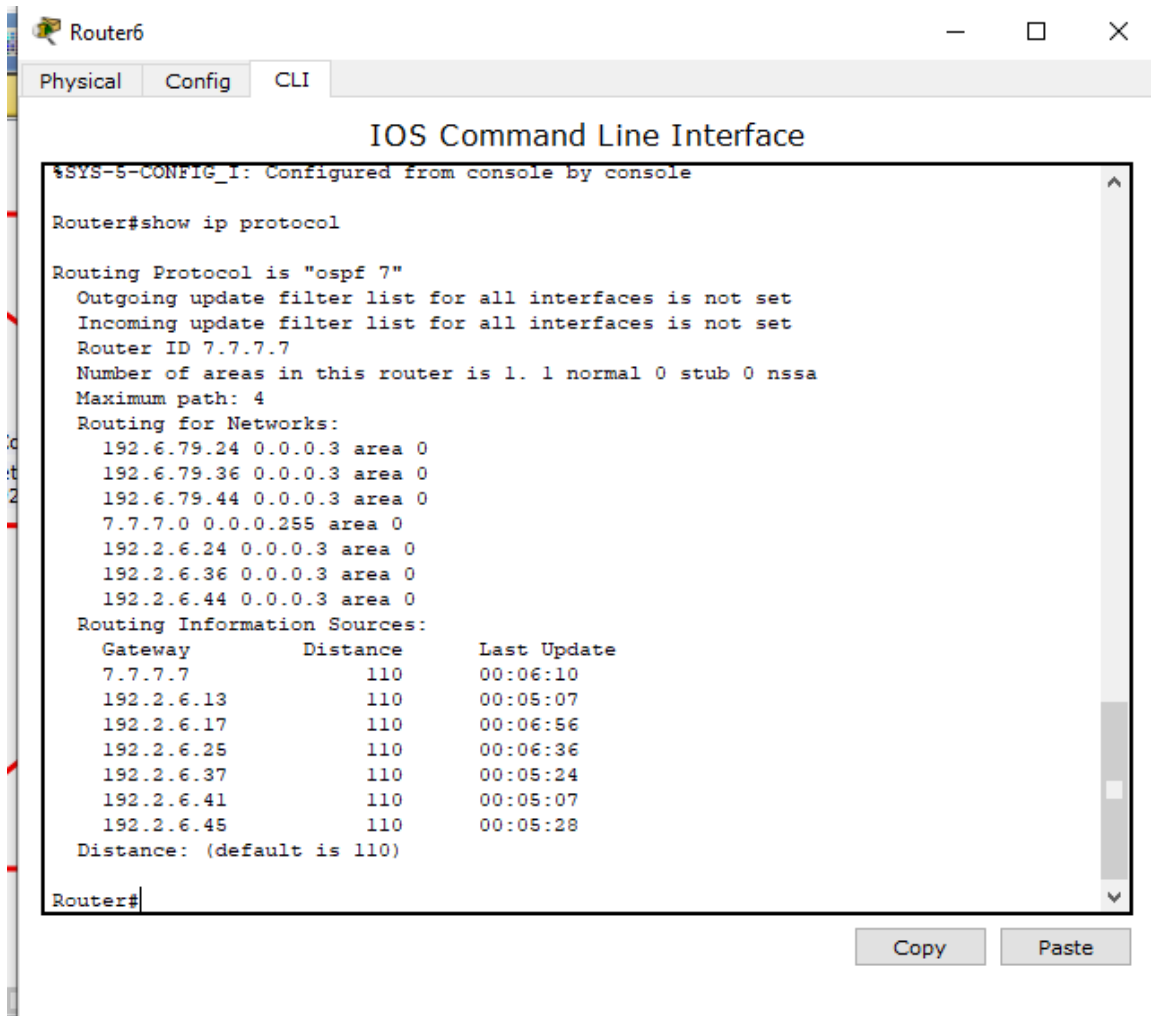


Figure 16: Show IP protocol on R6

To trace the path from Router 0 to Router 6's loopback address (7.7.7.7), the ``traceroute`` command is utilized from Router 0's command line interface. The output of this command indicates the sequence of intermediary routers through which the packet traverses before reaching its final destination. In this case, the packet passes through two intermediary routers. Firstly, it traverses router 192.2.6.14, followed by router 192.2.6.38.

Following the ``traceroute`` operation, the ``show ip route`` command is issued on Router 0 to inspect its routing table. This command displays information about known routes within the network. The output reveals that the route to reach Router 6's loopback address (7.7.7.7) is learned via OSPF (Open Shortest Path First), indicated by the 'O' code. The cost or metric associated with this route is 129. This cost metric represents the cumulative distance, based on various factors such as link

bandwidth, delay, reliability, and load, which OSPF uses to determine the best path. In this case, the route to 7.7.7.7 is reachable via next hop 192.2.6.14.

Furthermore, the ``show ip protocol`` command is executed on Router 0 to gather information about OSPF configuration parameters. This command provides details about OSPF routing, including the router ID, the number of areas, and routing for specific networks. The router ID for Router 0 is specified as 192.2.6.13, which serves as a unique identifier within the OSPF domain. Similarly, the router ID for Router 6 can be determined using the ``show ip protocol`` command on Router 6 itself.

Additionally, the provided figures describe specific configurations related to OSPF networks in area 0, which is the backbone area of OSPF. It outlines subnet addresses and subnet masks for the network topology. The note also associates bandwidth values with OSPF costs, where higher bandwidth corresponds to lower OSPF costs. These cost values play a crucial role in OSPF's path selection algorithm, influencing the determination of the most efficient routes within the OSPF network.

In conclusion, the process of setting up a network topology, configuring addressing, implementing OSPF, and understanding OSPF cost calculations involves several key steps. This includes designing the network layout, assigning IP addresses, configuring OSPF routing protocols, and determining OSPF costs based on factors like bandwidth. In analyzing the output of the ``show ip route`` command on Router 0, it's revealed that the cost (metric) to reach Router 6 is [110/128]. This indicates the OSPF cost associated with the path taken, where 110 represents the OSPF cost to reach the destination, and 128 is the cumulative metric. OSPF routing decisions are crucially influenced by these costs, which are calculated based on various network parameters. Additionally, the Router IDs for Router 0 and Router 6, specified as 192.15.85.13 and 192.15.85.46 respectively, play significant roles in OSPF routing and network topology. Overall, understanding OSPF routing and its associated parameters is essential for effectively managing and optimizing network performance.