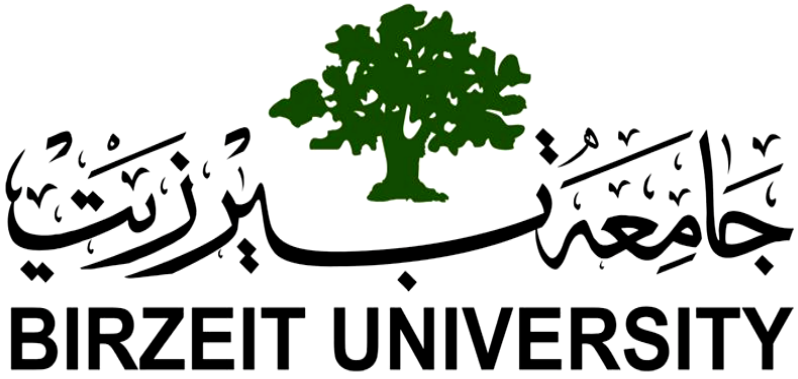

Faculty of Engineering &Technology
Electrical & Computer Engineering Department

ENCS4130

Report 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 how to use a dynamic routing Open Shortest Path First (OSPF) (a link state and intra-AS ‘interior gateway’ routing protocol) to update routing information and learn how to create loopbacks.

Table of Contents

Theory

Definition & Characteristic

Open shortest path first (OSPF) is an Interior Gateway and a link state Protocol. OSPF is a classless routing protocol where supports variable length subnet masks (VLSM). OSPF also allows packet authentication and uses IP multicast when sending/receiving packets.

Some important OSPF characteristics:

- The protocol is open.
- The second is that it is based on SPF algorithm (Dijkstra algorithm).
- Used when the network requires segmentation into areas or zones.
- OSPF uses bandwidth as metric (cost) with reference bandwidth 100 Mbps (cost = 1).

Route Summarization

This method minimizes the page table thus reduce the packet size and the traffic. That happens when use larger network to point a group of networks next to the router or loopbacks in the router, for example: (192.168.0.0/24, 192.168.1.0/24, 192.168.2.0 and 192.168.3.0/24) can be replaced by 192.168.0.0/22.

The command:

Router(config-router)#area AREA-ID range <SUMMARY-ADDRESS> <SUBNET-MASK>

Routing Hierarchy

Unlike RIP, OSPF can operate within a hierarchy. Where the largest entity is the autonomous system (AS) that contain some areas which includes a group of networks. When divide the AS into areas the page table shrinks therefore the traffic become less than before. Area 0 (OSPF backbone) is responsible for distributing routing information between areas.

OSPF Neighbor Relationships

Hello messages are sent on chosen interfaces once every 10 seconds on broadcast/point to point networks. These messages contain all sort of information:

Router ID	**Hello and dead timers**	**Network mask**
Area id	Neighbors	Router priority
DR/BDR IP addresses		Authentication password

Table 1 Information in OSPF Messages

The parameters in bold is must to be match between the routers to form the OSPF neighbor relationship.

Enabling OSPF

Enabling OSPF requires create an OSPF routing process done by that commands:

Starting OSPF routing process command:

Router(config)# router ospf <PROCESS-ID>

Adding networks to the OSPF protocol command:

Router(config-router)# network <ID-ADDRESS> <WILDCARD-MASK> area <AREA-ID>

Router ID

The OSPF router id identifies the router to OSPF neighbors. The default value is highest physical interface at startup. However, loopback interfaces beat physical one.

There is a command to hardcode the router id value that beats all:

Router(config-router)#router-id <A.B.C.D>

Procedure & Discussion

Building the Topology

First, build the topology, assign IPs and create loopbacks as we select an interface then assign its IP as normal, look at these two commands for setting loopback 0:

```
Router(config)#interface loopback 0
%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 172.16.0.1 255.255.255.0
```

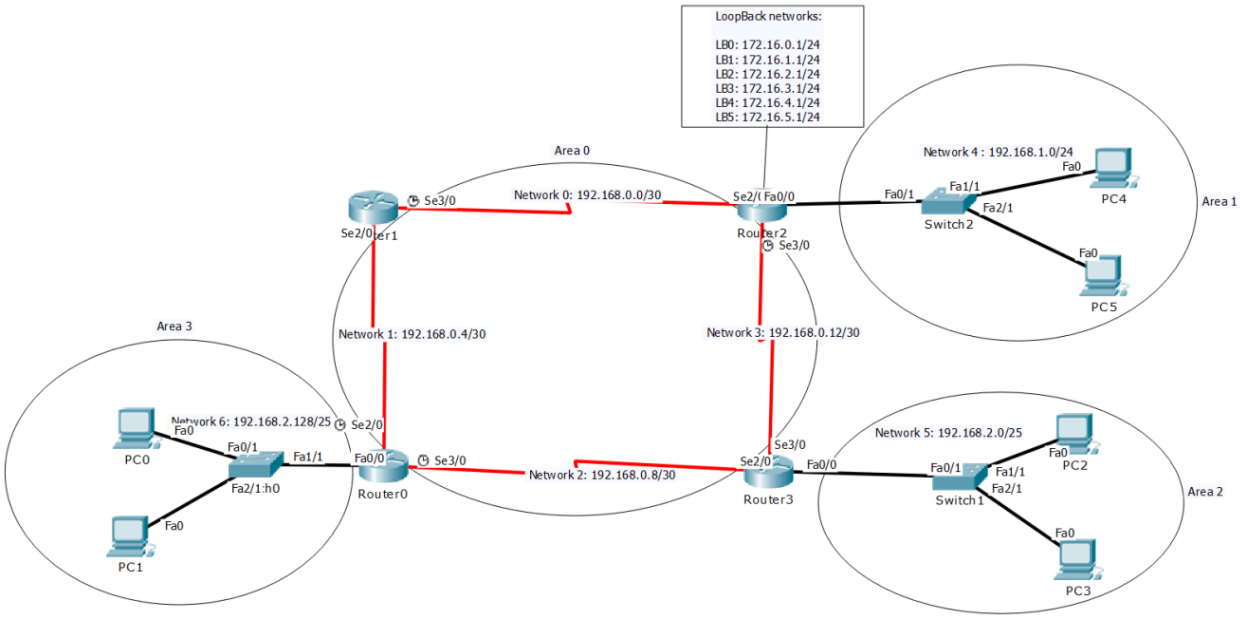


Figure 1

Configuring OSPF Routing

In router 0 hove to start OSPF process and assign the network near the router:

```
Router(config)#router ospf 1                                  "can be  another number"
Router(config-router)#network 192.115.0.4 0.0.0.3 area 0      'WILDCARD MASK'
Router(config-router)#network 192.115.0.8 0.0.0.3 area 0
Router(config-router)#network 192.115.2.128 0.0.0.127 area 3
```

Then it where Repeated for all routers.

While adding a network between two routers in the second one, you can see a message like this that tells you that you added the network in the routers correctly:

> 00:02:20: %OSPF-5-ADJCHG: Process 1, Nbr 192.115.0.1 on Serial2/0 from LOADING to FULL, Loading Done

Changing the Cost

When the bandwidth the interfaces that pointed by red has been maximized, the packets that went from R0 to R2 always traveled throw R1, but the packets that went from R2 to R0 was balanced between R3 and R1 until maximized the bandwidth on interfaces that pointed by blue, Where the cost varies from one direction to another.

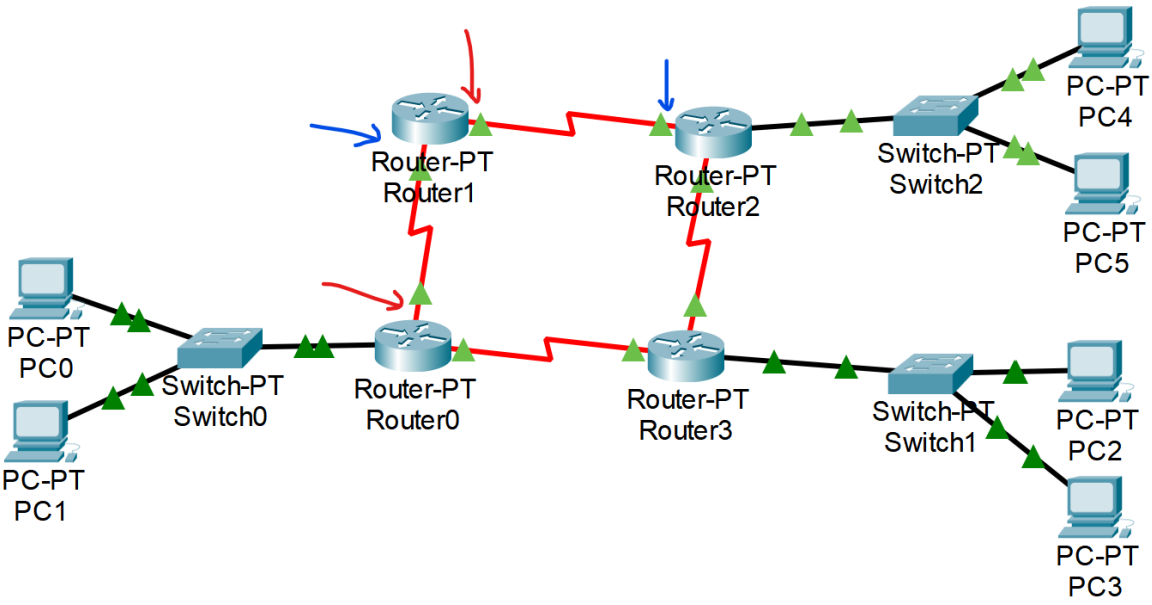


Figure 2

Here is a example that how the bandwidth was changed:

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

➔ the cost = 100M/20M = 5

Summarization

A **loopback interface** is a virtual interface in our network device that is always up and active after it has been configured. Like our physical interface, we assign a special IP address which is called a loopback address or loopback IP address. [1]

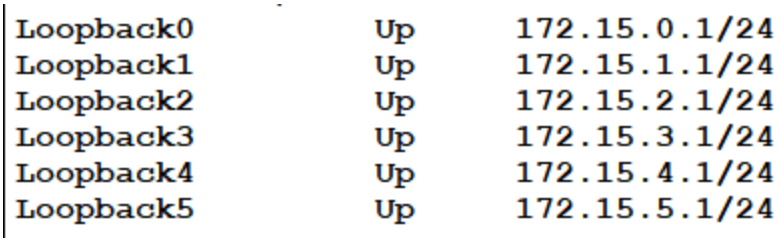


Figure 3

After adding these loopbacks, they summarized into 2 networks instead of 6:

```
Router(config)#router ospf 1
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
```

Hardcore the router-id:

Router ID identifies the router to other routers on OSPF protocol. By default the ID is the highest IP address in the router interfaces. but if there is loopbacks the highest on IP address is the ID. Last thing, we can hardcore the ID by this command as done in the figure blow:

```
Router(config-router)#router-id <A.B.C.D>
```

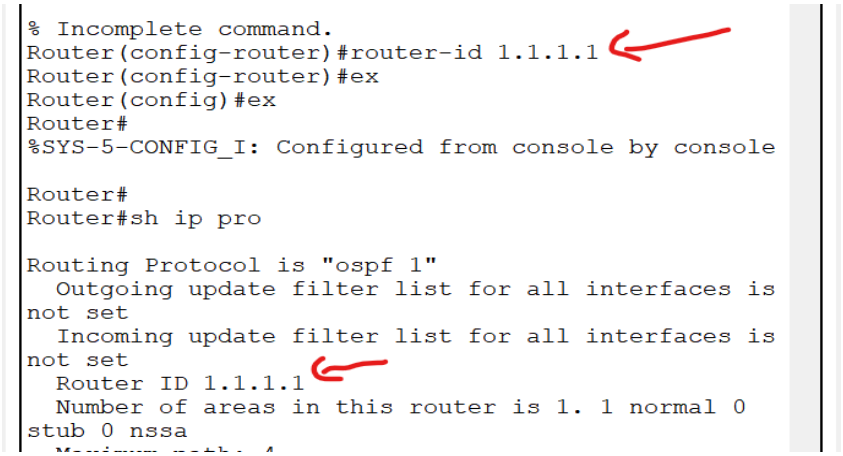
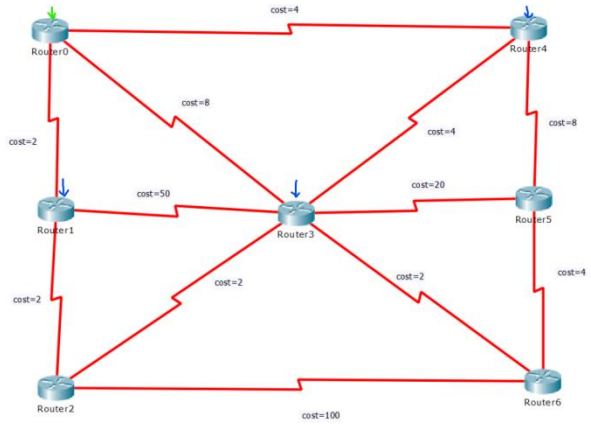


Figure 4

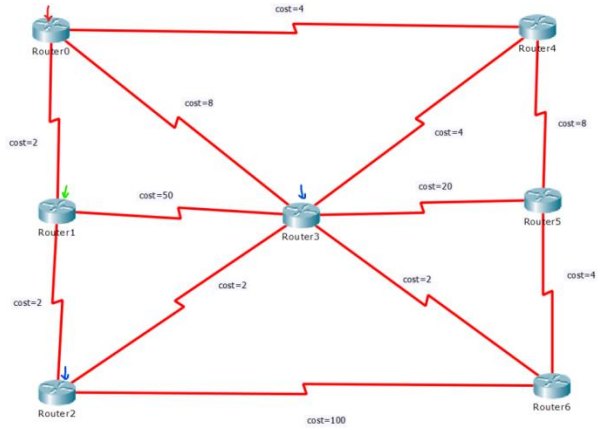
Todo:

Part1



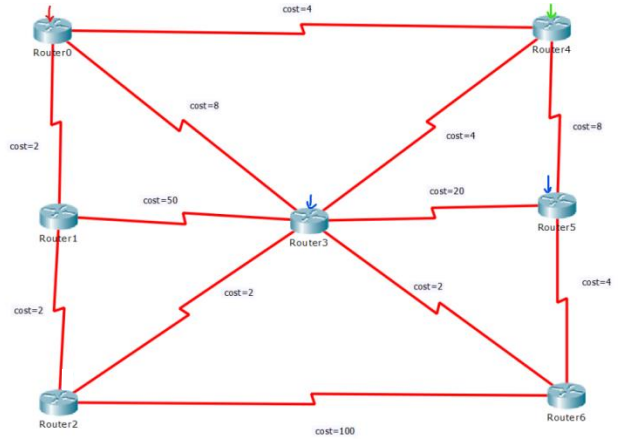
R0: 0
R1: ~~∞~~ 2
R2: ∞
R3: ~~∞~~ 8
R4: ~~∞~~ 4
R5: ∞
R6: ∞

Figure 5



R0: 0
R1: ~~∞~~ 2
R2: ∞ 4
R3: ~~∞~~ 8
R4: ~~∞~~ 4
R5: ∞
R6: ∞

Figure 6



R0: 0
R1: ~~∞~~ 2
R2: ∞ 4
R3: ~~∞~~ 8
R4: ~~∞~~ 4
R5: ~~∞~~ 12
R6: ∞

Figure 7

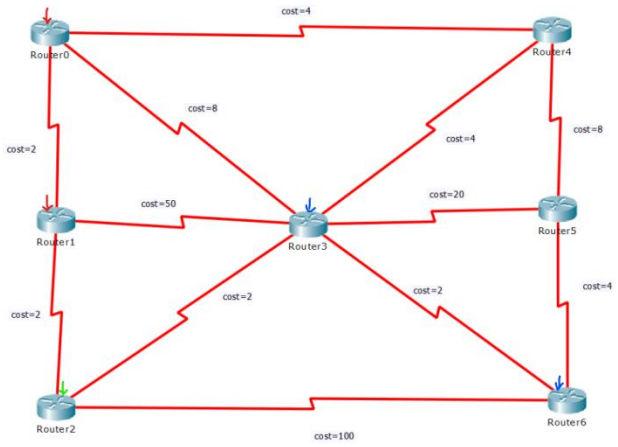


Figure 8

R0: 0
R1: ~~∞~~ 2
R2: ∞ 4
R3: ~~∞~~ ~~8~~ 6
R4: ~~∞~~ 4
R5: ~~∞~~ 12
R6: ~~∞~~ 104

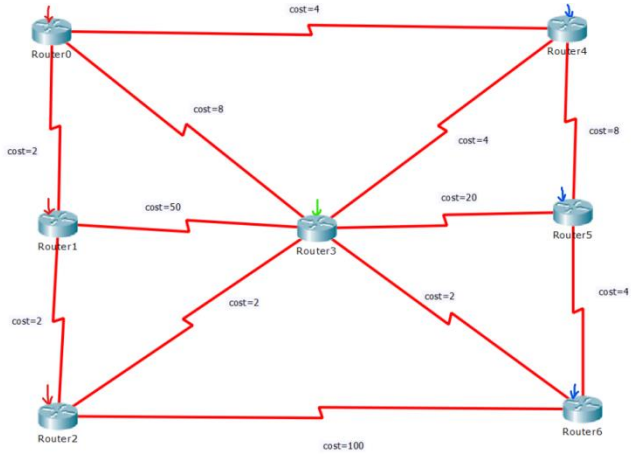


Figure 9

R0: 0
R1: ~~∞~~ 2
R2: ∞ 4
R3: ~~∞~~ ~~8~~ 6
R4: ~~∞~~ 4
R5: ~~∞~~ 12
R6: ~~∞~~ ~~104~~ 8

Shortest path: R_0 → R_1 → R_2 → R_3 → R_6

Shortest path cost: 8

Part2

5)

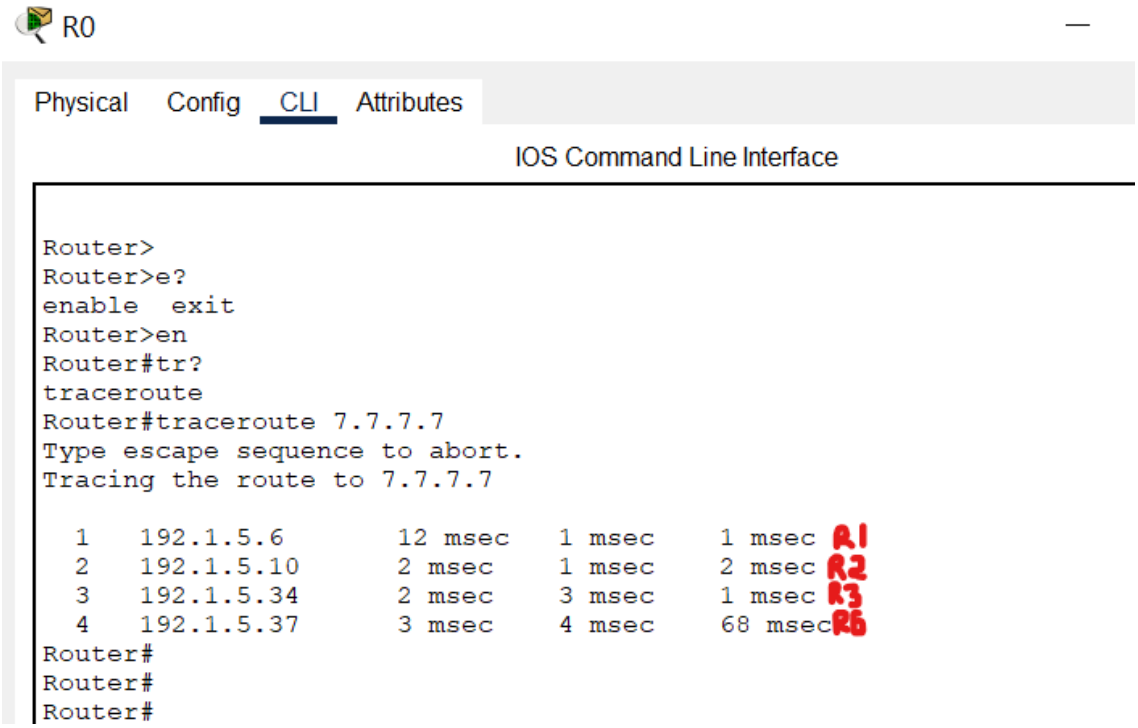


Figure 10

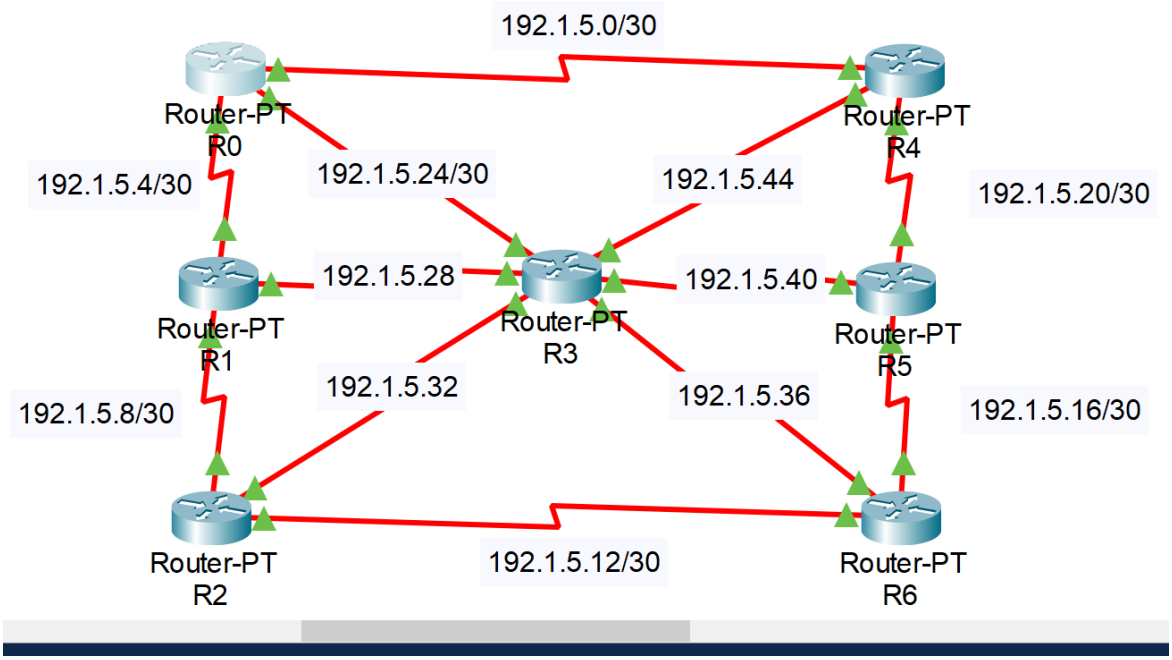


Figure 11

6)

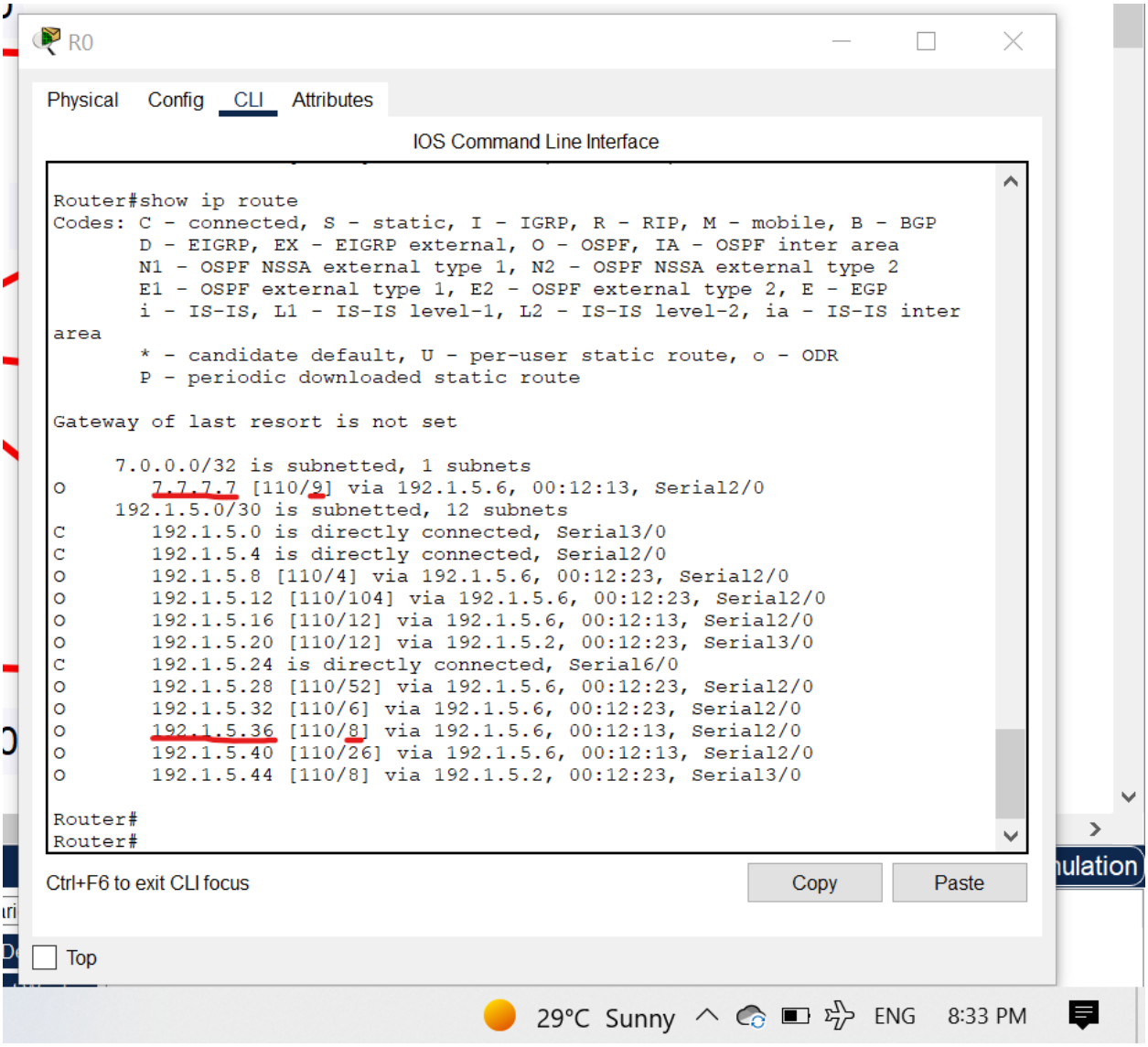
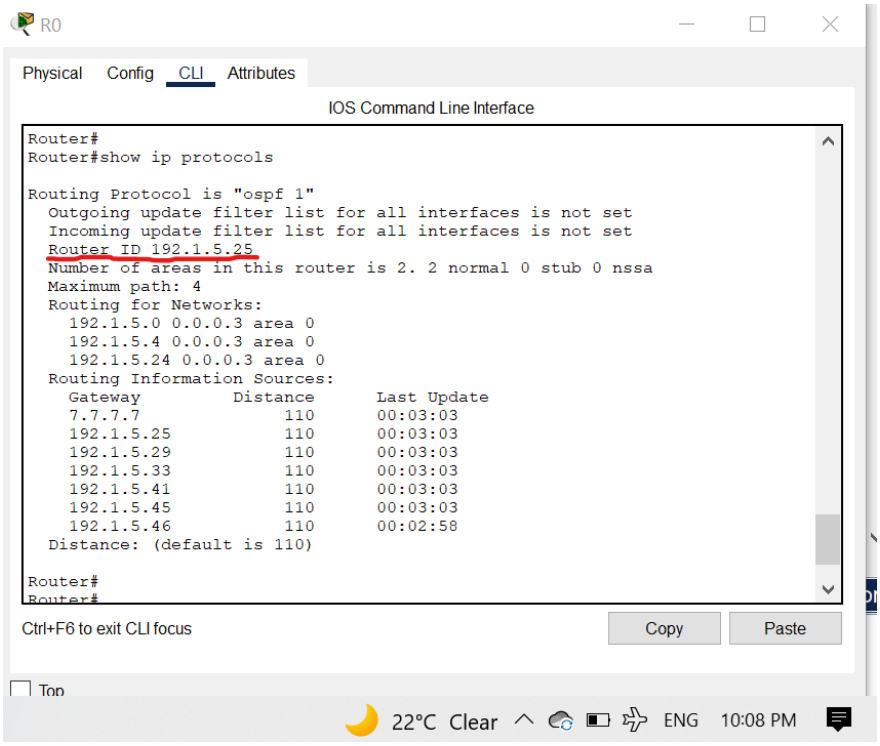


Figure 12

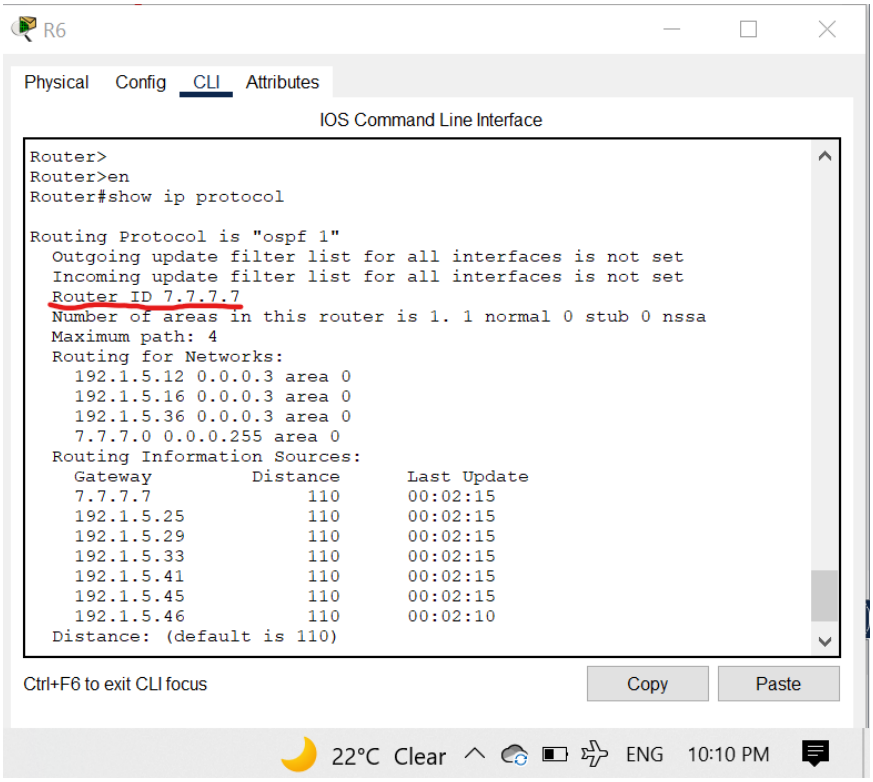
As shown on the image above the cost to get from router0 to router6 is 8 where the packets received on the interface that belong to 192.1.5.36/30 network and to reach loopback0 for router6 you need more 1 → 8 + 1 = 9.

7)



The highest IP on R0 is 192.1.5.25

Figure 13



Because is there an loopback on R6 then its IP is the router ID 7.7.7.7

Figure 14

Conclusion

In conclusion, OSPF differs with RIP when start the process where requires PROCESS-ID and when adding the neighbor networks where requires WILDCARD-MASK and area AREA-ID. OSPF is a link state routing protocol where affected by changing the bandwidths. Summarization networks into larger one and participate the autonomous system (AS) into many areas are good methods to reduce the traffic by light the shard information between the routers. Router ID is the identity of the router between other OSPF routers that is the hardcoded one if exists, if not, is the biggest IP address of loopbacks if exist, if not, is the biggest IP address of interfaces. Finally, OSPF uses Dijkstra's algorithm to calculate the shortest path.

References

[1] Study-CCNA - loopback