Al-Najah National University
Department of Engineering and Information technology
Computer Network and Information Security

OSPF-Single Area

Ahmad Abu-Ajaj

Instructor: Dr. Othman m. Othman

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1 Abstract

We will build the topology, network the devices, and then give the required IPs to the interfaces, routers, and PC devices. Then we will check the connections between the devices and routers using Ping to make sure that the connection process and IPs are correct, then we will configure OSPFv2 routing on all the routers in the network and then check that the routing tables are updated correctly. After checking the OSPF, you will configure OSPF authentication on the links for more security after that and we will deactivate and activate the 'auto summary' to see the traffic passing through certain links, In our experiment, we will use Single area (backbone Area 0), and the goal is to monitor the behavior and changes of the Routing Table to get a completely different result from Non-backbone Area .

2 Introduction

Open Shortest Path First (OSPF) is a routing protocol which is used to allow routers to dynamically learn routes from other routers and to advertise routes to other routers. open means publicly available, advertisements containing routes are referred to as Link State Advertisements (LSAs) in OSPF uses Link State algorithm and Dijkstra algorithm to calculate route, link-state routing protocol: keeps track of the state of all the various network connections(links) between itself and a network it is trying to send data to and this means every router has a complete topology, each routers learns about its own directly connected networks (Hello Packets), Link State Packet (LSP), flooding to all neighbors and Calculating SPF(shortest Path First). as used areas to organize a network into a hierarchal structure to reduce the number of advertised routes and thereby reduce network load, all router interfaces (links) are given a cost. The cost (also called metric) of an interface in OSPF is an indication of the overhead required to send packets across a certain interface ospf selects the best routes by finding the lowest cost paths to a destination. OSPF Areas: are introduced to put a boundary on the explosion of link-state updates. flooding and calculation of the Dijkstra algorithm on a router is limited to changes within an area to minimizes routing table entries, detailed LSA flooding stops at the area boundary and localizes impact of a topology change within an area.
Two types of OSPF areas:
1- Transit Area: (Backbone Area 0).
2- Non-backbone areas.

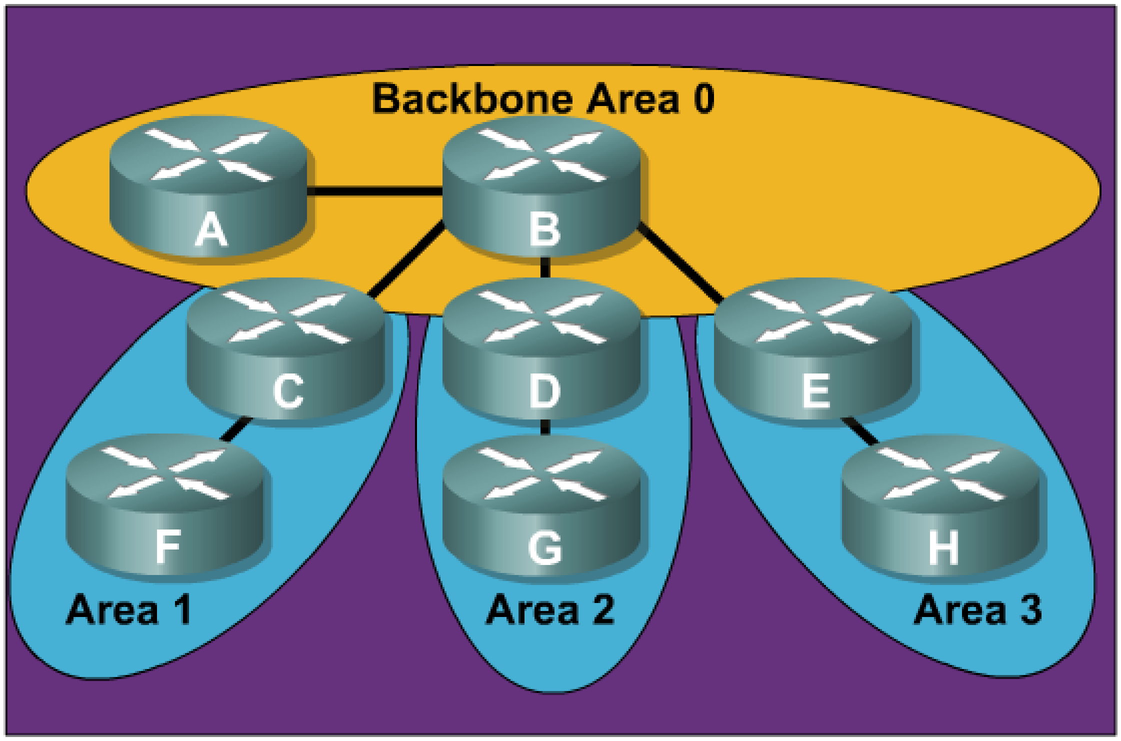

Figure 1: OSPF Area

Transit Area (Backbone Area 0): which combines a set of independent areas into a single domain, must exist and divided into smaller pieces.
area border routers: distances to nets in own area, advertise to other area border routers.
backbone routers: run OSPF routing limited to backbone.
boundary routers: connect to other AS's.
link-state advertisements only in area and each nodes has detailed area topology, as shown in Figure 2. only know direction (shortest path) to nets in other areas. areas are introduced to put a boundary on the explosion of link-state updates flooding and calculation of the Dijkstra algorithm on a router is limited to changes within an area and all routers within an area have the exact link-state database any change in routing information is flooded to all routers in the network.

What are the features of OSPF (not in RIP)?

security: All OSPF messages are authenticated (to prevent malicious intrusion)
multiple paths allowed at the same cost (only one path in RIP)
for each link, multiple cost metrics for different terms of service. (OSPF Advance)
integrated unicast and multicast support: multicast OSPF (MOSPF) uses the same architecture database as OSPF.
OSPF is hierarchical in large domains.

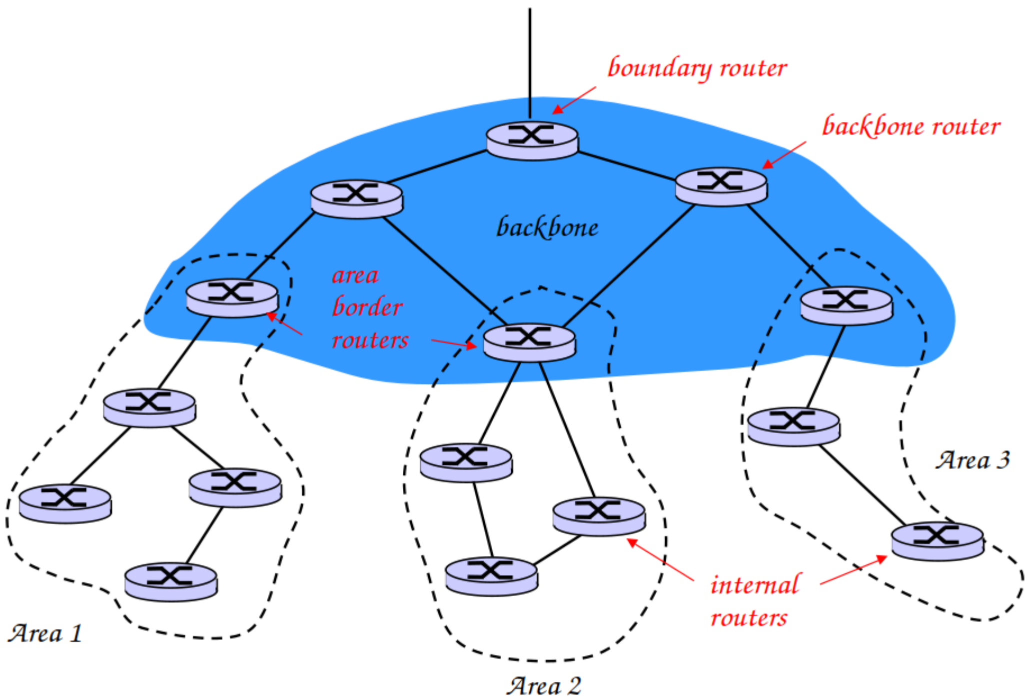

Figure 2: Detailed area topology

Routers that belong to multiple areas, and connect these areas to the backbone area are called area border routers (ABR). ABRs must therefore maintain information describing the backbone areas and other attached areas. In our experiment, we will use Single area (backbone Area 0), and the goal is to monitor the behavior and changes of the Routing Table to get a completely different result from Non-backbone Area and everything has its use.
OSPF Cost (OSPF Metric): It is a value on the amount or load needed to send the traffic through this particular interface (the Cost is not a fixed value, but we can change it) the cost is an indication for the interface, the cost account for the interface is always associated with the bandwidth For this interface (higher bandwidth indicates lower cost) there is more overhead "higher cost" and time delays involved in crossing a 56k serial line than crossing a 10M Ethernet line , as shown in Figure 3 any cost number is between 1 - 65.535.

The formula used to calculate the cost is: cost= 10000 0000/bandwith in bps.
For example, it will cost $10^8/10^7 =$

10 to cross a 10M Ethernet line while it will cost 10 $^8/1544000 = 64 to cross a T1 line.$

If the interface bandwidth is 10 Mbps, then the resulting cost would be 10:

100,000,000/10,000,000 = 10

If the interface bandwidth is 100Mbps, then the resulting cost would be 1:

100,000,000/100,000,000 = 1

Medium	Nominal bandwidth	Default Cost	Changing reference bandwidth to 10Gbps	Cost with 1/square root model
9.6kbps line	9.6kbps	10,416	1,041,666	1,020
56kbps line	56kbps	1,785	178,571	422
64kbps line	64kbps	1,562	156,250	395
T1 circuit	1.544Mbps	64	6,476	80
E1 circuit	2.048Mbps	48	4,882	69
T3 circuit	45Mbps	2	222	14
4Mbps Token Ring	4Mbps	25	2,500	50
16Mbps Token Ring	16Mbps	6	625	25
Ethernet	10Mbps	10	1,000	31
Fast Ethernet	100Mbps	1	100	10
Gigabit Ethernet	1Gbps	1	10	3
10 Gigabit Ethernet	10Gbps	1	1	1

Figure 3: OSPF Cost.

By default, the cost of an interface is calculated based on the bandwidth; you can force the cost of an interface with the
ip ospf cost (value)
interface subconfiguration mode command.
Finally all router interfaces (links) are given a cost. The cost of an interface in OSPF is an indication of the overhead required to send packets across a certa in interface ospf selects the best routes by finding the lowest cost paths to a destination.

3 Procedures and Analyzes

3.1 Network topology and configure basic settings

We configured the routers and switches and connected them to Serials and Fast Ethernet, as shown in Figure. 4.

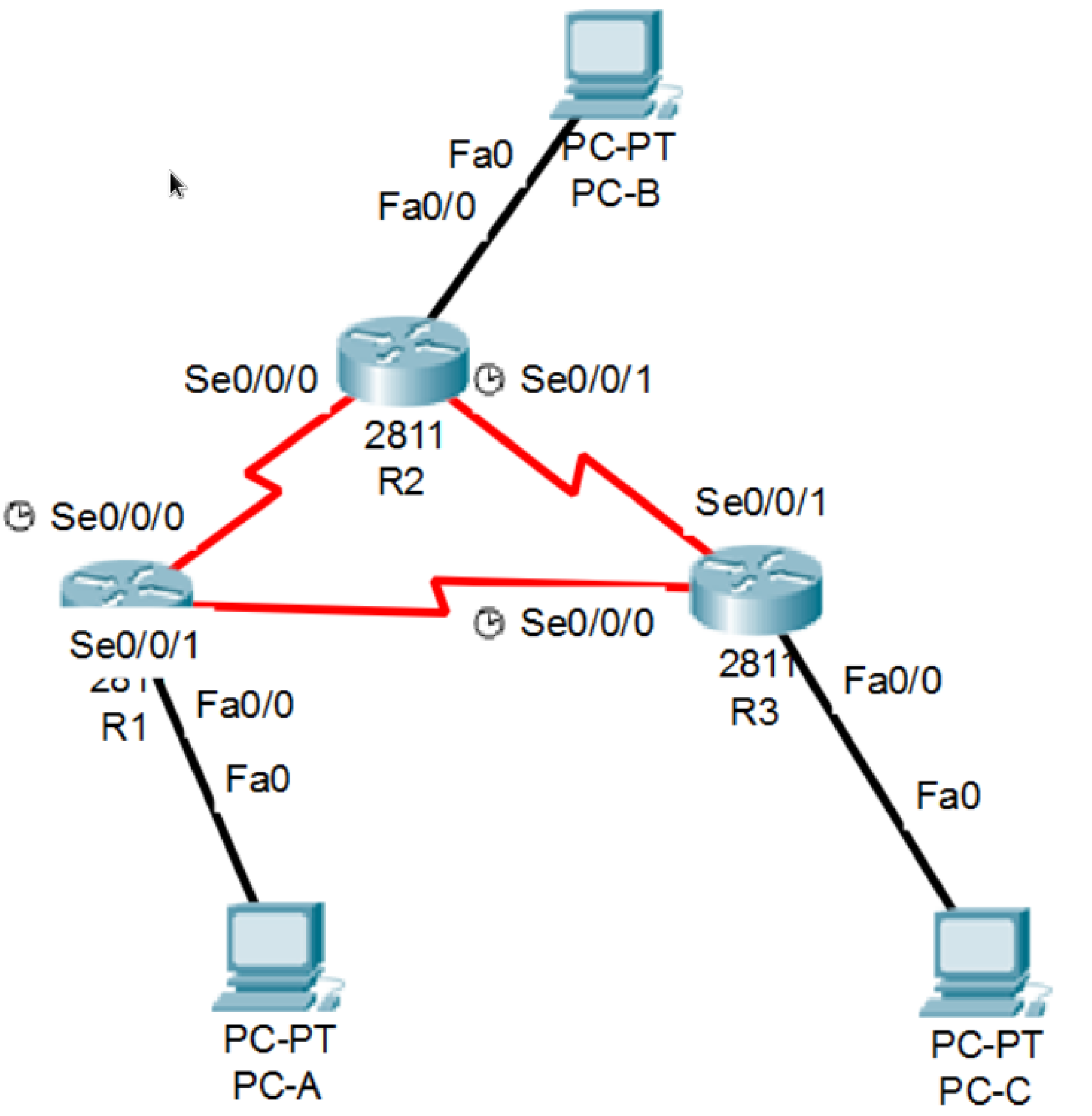

Figure 4: OSPF Topology

3.2 Addressing Table

We created the interfaces and serials, and we gave an IPs for PCs, Interfaces and serials, as shown in Figure 5.

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	F0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0 (DCE)	192.168.12.1	255.255.255.252	N/A
	S0/0/1	192.168.13.1	255.255.255.252	N/A
R2	F0/0	192.168.2.1	255.255.255.0	N/A
	S0/0/0	192.168.12.2	255.255.255.252	N/A
	S0/0/1 (DCE)	192.168.23.1	255.255.255.252	N/A
R3	F0/0	192.168.3.1	255.255.255.0	N/A
	S0/0/0 (DCE)	192.168.13.2	255.255.255.252	N/A
	S0/0/1	192.168.23.2	255.255.255.252	N/A
PC-A	NIC	192.168.1.3	255.255.255.0	192.168.1.1
PC-B	NIC	192.168.2.3	255.255.255.0	192.168.2.1
PC-C	NIC	192.168.3.3	255.255.255.0	192.168.3.1

Figure 5: Addressing Table

3.2.1 Test connectivity

We changed the status to up then we test connectivity between devices by PING, as shown in Figure 6.

```
C:\Users\user>ping 192.168.3.3

Pinging 192.168.3.3 with 32 bytes of data:
Reply from 192.168.3.3: bytes=32 time=1ms TTL=126
Reply from 192.168.3.3: bytes=32 time=2ms TTL=126
Reply from 192.168.3.3: bytes=32 time=2ms TTL=126
Reply from 192.168.3.3: bytes=32 time=1ms TTL=126

Ping statistics for 192.168.3.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms
```

Figure 6: Test connectivity

3.3 OSPF configration

3.3.1 Neighboring networks

We configure the OSPF protocol and then add the neighboring networks. We issued show ip ospf neighbor commands on all routers to verify that OSPF is configured correctly, as shown in Figure 7.

```
R1# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.23.2      0   FULL/  -        00:00:38    192.168.13.2    Serial0/0/1
192.168.23.1      0   FULL/  -        00:00:32    192.168.12.2    Serial0/0/0
```

Figure 7: Test connectivity

3.3.2 OSPF information

We issued show ip protocols command verify OSPF configuration information OSPF process ID, router ID, networks the router is advertising, neighbors and the default administrative distance, which is 110 for OSPF, as shown in Figure 8.

```
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 192.168.13.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.1.0 0.0.0.255 area 0
    192.168.12.0 0.0.0.3 area 0
    192.168.13.0 0.0.0.3 area 0
  Routing Information Sources:
    Gateway          Distance      Last Update
    192.168.23.2          110      00:03:39
    192.168.23.1          110      00:05:36
  Distance: (default is 110)
```

Figure 8: show ip protocol

3.3.3 OSPF Summary

We Issued the show ip ospf interface brief command to display a summary of OSPF, cost of Serials, enabled interfaces, serials priority, Areas and states, as shown in Figure. 9.

```
R1# show ip ospf interface brief
Interface     PID   Area           IP Address/Mask    Cost  State Nbrs F/C
Se0/0/1       1     0              192.168.13.1/30    64    P2P   1/1
Se0/0/0       1     0              192.168.12.1/30    64    P2P   1/1
Fa0/0         1     0              192.168.1.1/24     1     DR    0/0
```

Figure 9: show ip ospf interface brief

3.3.4 Router ID assignment by loopback addresses

We issued show ip protocols command after we worked loopback addresses and we worked reload for routers to reset the router ID and display the new router ID, as shown in Figure 10 and Figure 11.

```
R1# show ip protocols
*** IP Routing is NSF aware ***

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 1.1.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.1.0 0.0.0.255 area 0
    192.168.12.0 0.0.0.3 area 0
    192.168.13.0 0.0.0.3 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: (default is 110)
```

Figure 10: show ip protocol after loopback addresses

```
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:31    192.168.13.2    Serial0/0/1
192.168.2.1       0   FULL/  -        00:00:32    192.168.12.2    Serial0/0/0
```

Figure 11: show ip ospf neighbor after loopback addresses

3.3.5 Router-ID assignment by command

We issued show ip protocols command after we worked router-id and we issued clear ip ospf command for routers to reset the router ID and display the new router ID, shown in Figure 12.

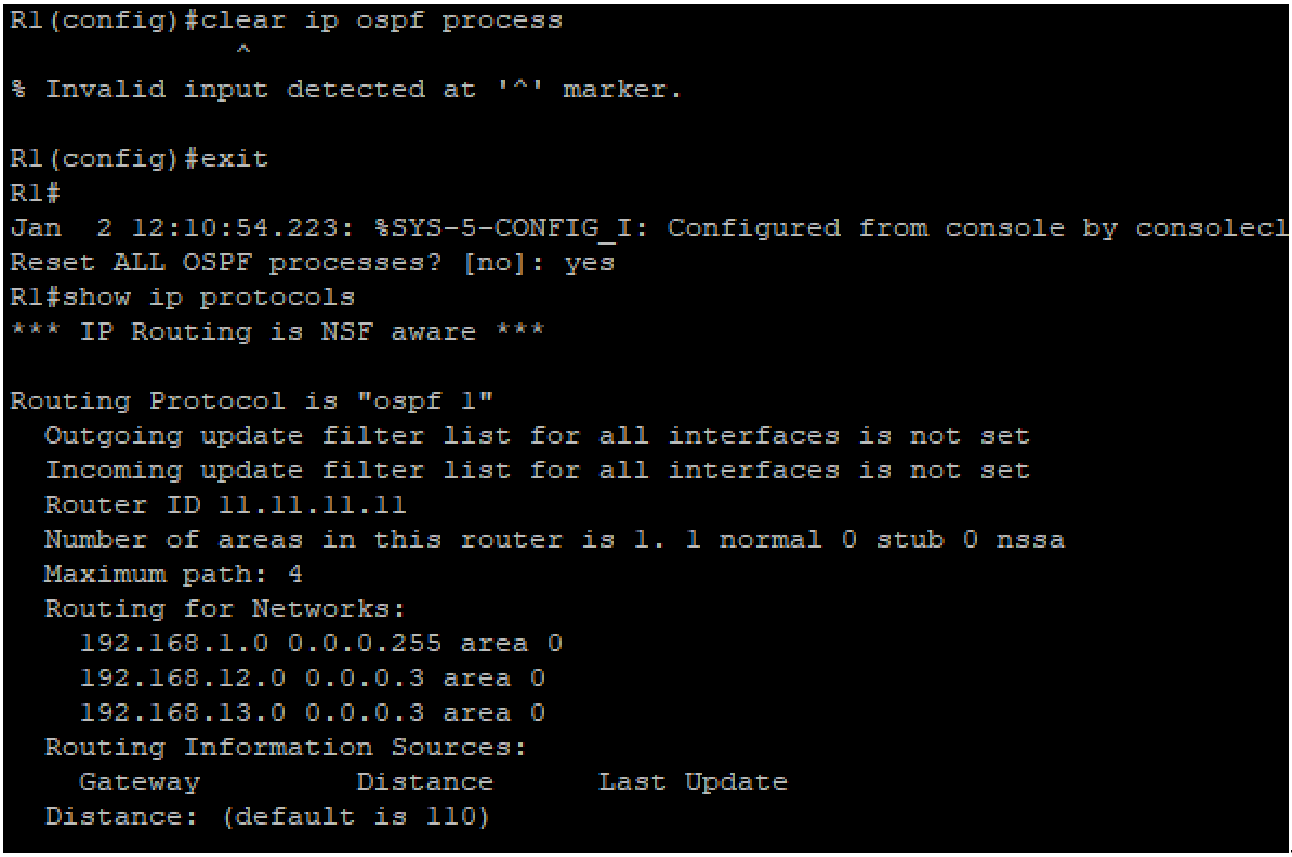

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Figure 12: clear ip ospf process

3.3.6 OSPF Passive interfaces

We issued show ip ospf interface FastEthernet 0/0 command to to check that FastEthernet 0/0 interface on router 1 not passive and we configure FastEthernet 0/0 interface on router 1 to passive, shown in Figure 13.

```
R1(config)# show ip ospf interface F0/0
              ^
% Invalid input detected at '^' marker.

R1(config)#do  show ip ospf interface F0/0
FastEthernet0/0 is up, line protocol is up
  Internet Address 192.168.1.1/24, Area 0, Attached via Network Statement
  Process ID 1, Router ID 11.11.11.11, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 11.11.11.11, Interface address 192.168.1.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:05
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
```

Figure 13: show ip ospf interface FastEthernet 0/0

We issued passive command to change the FastEthernet 0/0 interface on router 1 to passive, and we issued show ip ospf interface FastEthernet 0/0 command to to check that FastEthernet 0/0 interface on router 1 has become passive or not, shown in Figure 14.

```
FastEthernet0/0 is up, line protocol is up
  Internet Address 192.168.1.1/24, Area 0, Attached via Network Statement
  Process ID 1, Router ID 11.11.11.11, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State WAITING, Priority 1
  No designated router on this network
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    No Hellos (Passive interface)
    Wait time before Designated router selection 00:00:23
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
R1(config-router)#exit
```
.

Figure 14: show ip ospf interface FastEthernet 0/0

3.4 Routing table

3.4.1 Routing Table before configuring OSPF

We issued the command show ip route to display the routing table for router 1 before configuring OSPF protocol and this is the result we got , as shown in Figure 15.

```
Gateway of last resort is not set

      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, FastEthernet0/0
L        192.168.1.1/32 is directly connected, FastEthernet0/0
      192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.12.0/30 is directly connected, Serial0/0/0
L        192.168.12.1/32 is directly connected, Serial0/0/0
      192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.13.0/30 is directly connected, Serial0/0/1
L        192.168.13.1/32 is directly connected, Serial0/0/1
```

Figure 15: show ip route before configuring OSPF .

3.4.2 Routing table after configuring OSPF

We issued the command show ip route to display the routing table for router 1 after configuring OSPF protocol and this is the result we got and the neighboring networks are added, as shown in Figure 16.

```
Gateway of last resort is not set

      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, FastEthernet0/0
L        192.168.1.1/32 is directly connected, FastEthernet0/0
O     192.168.3.0/24 [110/65] via 192.168.13.2, 00:01:13, Serial0/0/1
      192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.12.0/30 is directly connected, Serial0/0/0
L        192.168.12.1/32 is directly connected, Serial0/0/0
      192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.13.0/30 is directly connected, Serial0/0/1
L        192.168.13.1/32 is directly connected, Serial0/0/1
      192.168.23.0/24 is variably subnetted, 2 subnets, 2 masks
O        192.168.23.0/24 [110/128] via 192.168.13.2, 00:00:57, Serial0/0/1
O        192.168.23.0/30 [110/128] via 192.168.12.2, 00:02:53, Serial0/0/0
R1# show ip ospf neighbor
```

Figure 16: show ip route after configuring OSPF .

3.4.3 Routing table after router ID assignment

Finnaly, We issued the command show ip route to display the routing table for router 1 before configuring OSPF protocol and this is the result we got, as shown in Figure 17.

```
      1.0.0.0/32 is subnetted, 1 subnets
C        1.1.1.1 is directly connected, Loopback0
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, FastEthernet0/0
L        192.168.1.1/32 is directly connected, FastEthernet0/0
O     192.168.3.0/24 [110/65] via 192.168.13.2, 00:01:09, Serial0/0/1
      192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.12.0/30 is directly connected, Serial0/0/0
L        192.168.12.1/32 is directly connected, Serial0/0/0
      192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.13.0/30 is directly connected, Serial0/0/1
L        192.168.13.1/32 is directly connected, Serial0/0/1
      192.168.23.0/24 is variably subnetted, 2 subnets, 2 masks
O        192.168.23.0/24 [110/128] via 192.168.13.2, 00:01:09, Serial0/0/1
O        192.168.23.0/30 [110/128] via 192.168.12.2, 00:01:25, Serial0/0/0
```

Figure 17: show ip route after router ID assignment.

4 Conclusion

We gave the PC the required IPs and checked the connection between the devices through a link, and we also gave the IPs for each router, then we configured the OSPF protocol on all the routers via the command 'router ospf 1', then we added the neighboring networks as required, then we checked the router table and found The letter O and also 3 new networks, which are neighbors networks, which means that they were added through the OSPF protocol. Then we made a "passive" command to prevent sending and receiving "Hello Mesages" and we noticed how to force the traffic to pass from a specific path. We also configured IDs to uniquely identify the router in the OSPF routing domain using loopback addresses then note that the IDs of each router have changed.

5 References

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