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Project

Introduction

The purpose of this project is to create a network in which our group will have to configure the devices within the network according to the specifications in the lab book. Within this project, the network topology consists of 10 routers and 3 switches. There are also 4 end devices which are the VMs we used to act as end users. Due to the fact that there are many devices in the network, it is large and therefore the project is complex. We have to connect the routers, switches and VMs with each other and then configure them according to the project instructions. Configurations and Due to the fact that we are building a network for a small company, we also have to configure the network for the various departments in the organization such as Human resources and Marketing and also connect the users of various departments to each other through the switches. For the purpose of this project, we used the hardware kits available in the lab. Due to the fact that the network was large, we used 8 kits instead of using 2 kits as we normally do. In this document, we have explained all the steps we have taken in order to accomplish the tasks in the project including the Lab schematic, the description, instructions, and the deliverables.

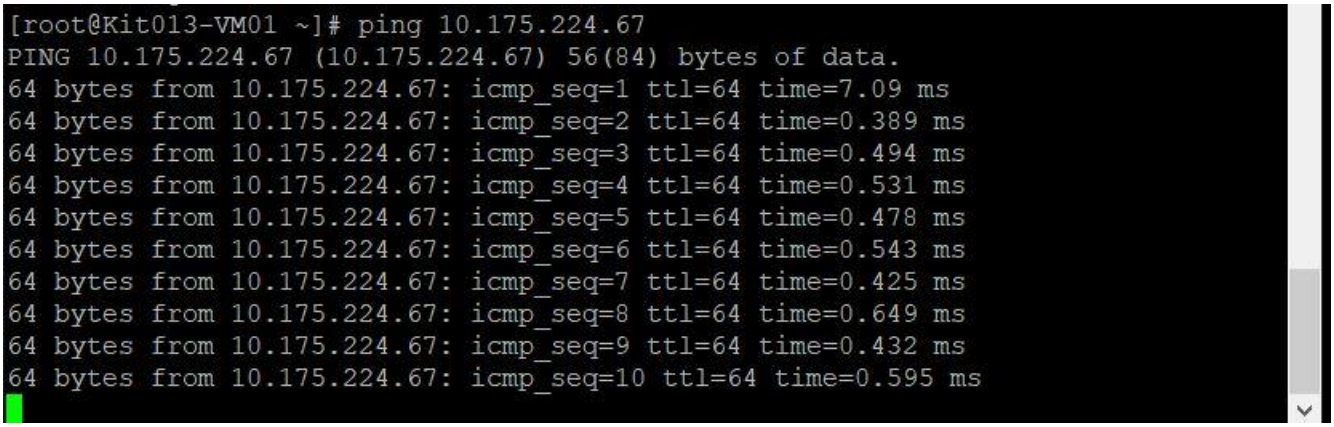
Requirements

The requirements for this lab are to have ethernet cables such as straight through cables and cross over cables so that it is possible to connect the network hardware devices together. It is also necessary to have the network hardware kits that are provided by the college in the lab. These devices are required in order to create the network and they will be used along with the cable to connect everything together and create a topology as per specifications in the project documentation. The third requirement is to have cisco packet tracer software installed to create a more understanding visual representation for the topology of the network.

Final Result

The final result was that we could get a ping between the users and access the server. Below are the screenshots which show the ping result being displayed as well as access to the server.

The screenshot of the ping:



The screenshot of access to the server:

Description

The network for this small business consists of several hardware devices such as routers and switches. The protocols used in this network consist of eigrp, ospf and also has aaa authentication. There is a static route that has been configured between router 8 and router 9 as well as between router 8 and router 10 There is a single area OSPF protocol configured between the routers 4, 5, 6, 7 and 8. There is also EIGRP protocol being used on the routers 1,2, 3 and 4. The IP address we decided to use for the network was 172.16.8.0 with a subnet mask of 22. The organization also consists of 3 departments which include human resources, production and marketing. They are all connected to each other through the network that has been configured for the purpose of this project.

The production department and the human resource department are all connected through switch 1 while the users of the marketing department are connected with switch 2. The server which is in this case the laptop we used is connected with switch 3. With this configuration, it is possible for all the departments to communicate with each other.

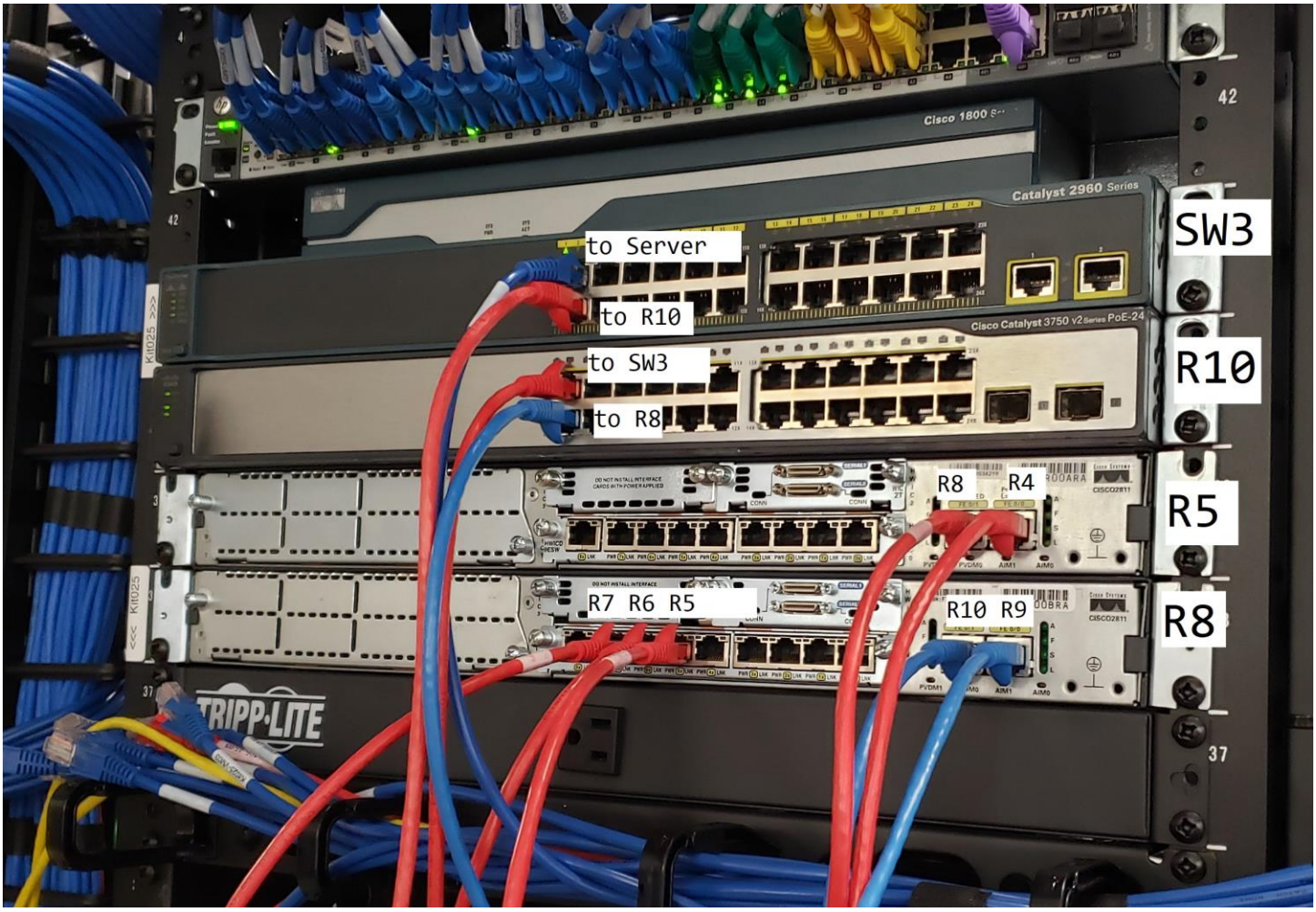
Deliverables

1) Mention brief description about your company

The company is a small business with a few departments within it such as human resources, marketing and production. It has a total of 49 employees with 30 being in Production, 14 being in Marketing and 5 being in human resources. The company has a small network and all the departments are connected to each other and the server through the network that has been configured.

2) Lab schematic/Topology

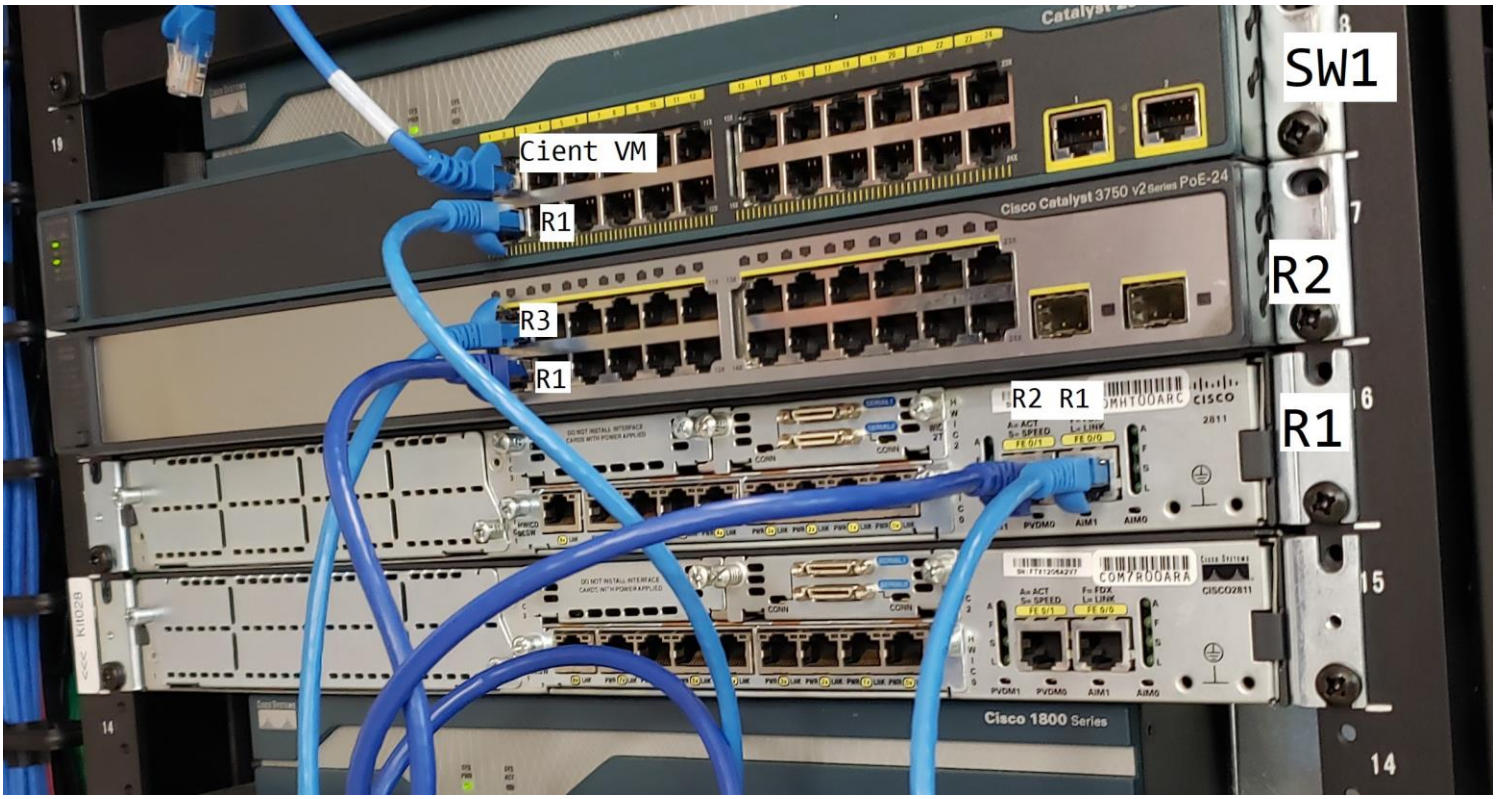
To prepare the lab schematic, we decided to take pictures of the network hardware that we had configured in the lab. As shown in the below pictures, the devices are all connected to each other through the use of ethernet cables such as cross over cables and straight through cables. The connections are all labeled so that it is easier to understand.



In the first picture that we took, we can see that there are several connections to other routers such as R7, R6 and R5 with the use of the orange cables. We can also see that there are connections to R8, R4, R10 and R9 in the ethernet ports. There is also a connection the server. The hardware devices shown in this picture include r8 on the bottom, R5 on top of R8 and then R10 on top of R5 and then SW3 on the very top.

In the second image we took of the network topology, it is possible to see that we have also made a connection to the client VM(which is acting as a end user device) and that we have connections to switch 2. There are also connections to R8 that are being used to connect those routers to the router devices in the picture which are R6 and R7. There is also R9 which is being connected to SW2 and R8 and also the hardware device SW2 which is being connected to R9 and Client VM.

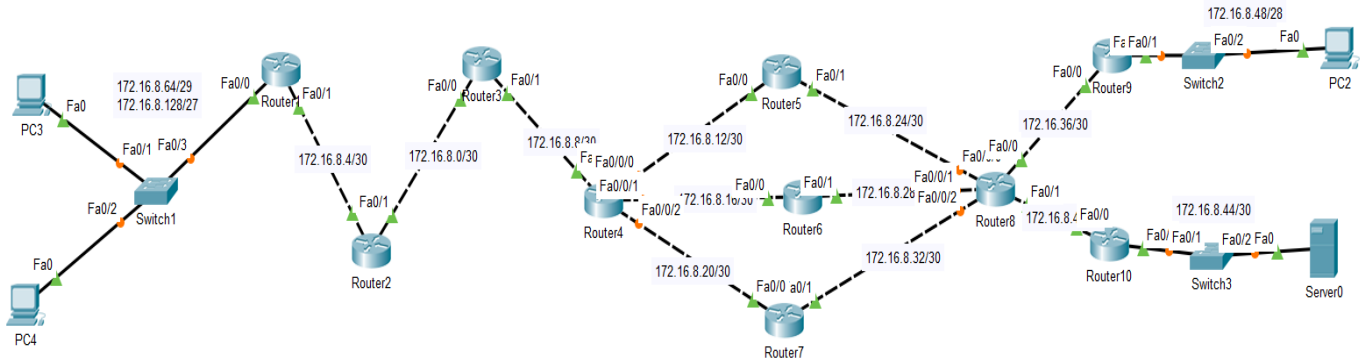
In this next picture, we can see the hardware devices R3 and R3. These are again being used to connect to other devices such as how R4 is being used to connect to R7, R6, R5 and also R4 whereas R3 is being used to connect to R4 and R2.



The final picture above shows how R1, R2 and SW1 are being used to connect to the other devices. R1 is being used to connect to R2 and R1 to R2 while R2 is being used to connect to R1 and R3 and SW1 is being used to connect to R1 and the Client VM.

As can be seen from the above pictures of the network hardware kits are showing that they are all connected to each other through ethernet cables. It is also possible to see that the ports which are connected are all labeled appropriately so that it is easier to understand which devices is connected where.

For further understanding, we also decided to add a screenshot of the topology in cisco packet tracer so that there



would be better understanding of where and how each device is configured.

As can be seen from the above image, the network topology is much easier to understand here.

Device Name	Interface Number	IP address	Subnet Mask	Gateway
Router 1	FastEthernet0/0	172.16.8.65	255.255.255.192	N/A
	FastEthernet0/1	172.16.8.5	255.255.255.252	N/A
Router 2	FastEthernet0/0	172.16.8.6	255.255.255.252	N/A
	FastEthernet0/1	172.16.8.1	255.255.255.252	N/A
Router 3	FastEthernet0/1	172.16.8.2	255.255.255.252	N/A
	FastEthernet0/0	172.16.8.9	255.255.255.252	N/A
Router 4	FastEthernet0/0	172.16.8.10	255.255.255.252	N/A
	FastEthernet0/1/5	172.16.8.13	255.255.255.252	
	FastEthernet0/1/6	172.16.8.17	255.255.255.252	
	FastEthernet0/1/7	172.16.8.21	255.255.255.252	
Router 5	FastEthernet0/0	172.16.8.14	255.255.255.252	N/A
	FastEthernet0/1	172.16.8.25	255.255.255.252	N/A
Router 6	FastEthernet0/0	172.16.8.18	255.255.255.252	N/A
	FastEthernet0/1	172.16.8.29		
Router 7	FastEthernet0/0	172.16.8.22	255.255.255.252	N/A
	FastEthernet0/1	172.16.8.33		
Router 8	FastEthernet0/0	172.16.8.37	255.255.255.252	N/A
	FastEthernet0/1	172.16.8.41		
	FastEthernet0/1/5	172.16.8.26		
	FastEthernet0/1/6	172.16.8.30		
	FastEthernet0/1/7	172.16.8.34		
Router 9	FastEthernet2/0/1	172.16.8.49	255.255.255.240	N/A
	FastEthernet2/0/2	172.16.8.38	255.255.255.252	
Router 10	FastEthernet2/0/1	172.16.8.45	255.255.255.252	N/A
	FastEthernet2/0/2	172.16.8.42		
PC1	N/A	172.16.8.17	255.255.255.192	172.16.8.65
PC2	N/A	172.16.8.15	255.255.255.240	172.16.8.49
Server	N/A	172.16.8.46	255.255.255.252	172.16.8.45

4) Description of the devices (E.g. Router 2811 router devices are used as R1 and R2 whereas 3750 multilayer switches is used as R5 and R6)

Labels R1-R8 are routers 2811 , Router 9 and Router 10 are 3750 multilayer switches .

5) Labelling of the devices (E.g. Project#3-R1)

Router 1 and Router 2 have the label of R1-8027237 and R2-8027237

Router 3 and Router 4 have the label of R3-8047771 and R4-8047771

Router 6, Router 7 and Router 9 have the label of R6-8119794, R7-8119794 and R9-8119794

Router 5, Router 8 and Router 10 have the label of R5-8569394, R8-8569394 and R10-8569394

6) Specify any if strategy or plans was used by your group for accomplish the project task.

To accomplish the task, since the network was so big, we split the configurations of the different part of the network amongst the 4 of us. After this, we connected our configurations and tested the settings to see if

everything was correctly implemented such as the protocols and the ip addressing. After this, we accomplished the tasks according to the instructions given in the lab.

7) Describe the type of static route used (standard or default) and why?

R8 has two standard static routes. R9 and R10 has default static routes that point on R8 since all the traffic from R9 and R10 will go trough R8.

```
R8-8569394#sh ip route static
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 13 subnets, 4 masks
S        172.16.8.44/30 [1/0] via 172.16.8.42
S        172.16.8.48/28 [1/0] via 172.16.8.38
```

```
R9#sh ip route static
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is 172.16.8.37 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 172.16.8.37
```

```
R10#sh ip route static
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is 172.16.8.41 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 172.16.8.41
```

8) Describe and explain the metric used and why for inter-routing protocol communication.

R8 redistributes static routes. We used default metrics because R8 is the only way to get from server and marketing department to production and HR department. R4 redistributes ospf routes to eigrp and vise versa. Again, we used default metrics and the reason is the same.

9) Observer the routing table on the router R2. Look for the EIGRP external routes and their metric. Pick any one external route metric and explain the metric calculation.

The metric value is 56320. 56320 = 256 * (100 + 120), where 100 is interfaces bandwidth and 120 is total delay, 20 is R2 and R3 total delay and 100 is R4 redistributed delay.

The full calculation is as follows:

Formula: 256*[10,000,000/Bandwidth + [Sum of Delay /10]]

So therefore, when we calculated it, the process was as follows:

First we calculated the numbers in the bracket. The result was 100+120.

Then we multiplied by 256

The result was then 56320.

Therefore, the metric value is 56230.

```
router-2#sh ip rout
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 12 subnets, 3 masks
C        172.16.8.0/30 is directly connected, FastEthernet0/1
C        172.16.8.4/30 is directly connected, FastEthernet0/0
D        172.16.8.8/30 [90/30720] via 172.16.8.2, 00:00:00, FastEthernet0/1
D EX     172.16.8.12/30 [170/56320] via 172.16.8.2, 00:00:59, FastEthernet0/1
D EX     172.16.8.16/30 [170/56320] via 172.16.8.2, 00:00:59, FastEthernet0/1
D EX     172.16.8.20/30 [170/56320] via 172.16.8.2, 00:00:59, FastEthernet0/1
D EX     172.16.8.24/30 [170/56320] via 172.16.8.2, 00:00:10, FastEthernet0/1
D EX     172.16.8.28/30 [170/56320] via 172.16.8.2, 00:00:00, FastEthernet0/1
D EX     172.16.8.32/30 [170/56320] via 172.16.8.2, 00:00:10, FastEthernet0/1
D EX     172.16.8.44/30 [170/56320] via 172.16.8.2, 00:00:00, FastEthernet0/1
D EX     172.16.8.48/28 [170/56320] via 172.16.8.2, 00:00:00, FastEthernet0/1
D        172.16.8.64/26 [90/30720] via 172.16.8.5, 00:00:59, FastEthernet0/0
```

10) Which router is acting as ABR and why?

ABR routers are R8 and R4. These routers are located on the borders of the OSPF area.

```
R5-8569394#sh ip ospf border-routers

            OSPF Router with ID (172.16.8.25) (Process ID 10)


                Base Topology (MTID 0)

Internal Router Routing Table
Codes: i - Intra-area route, I - Inter-area route

i 172.16.8.21 [1] via 172.16.8.13, FastEthernet0/0, ASBR, Area 0, SPF 5
i 172.16.8.41 [1] via 172.16.8.26, FastEthernet0/1, ASBR, Area 0, SPF 5
```

11) Observe the topological database created on R8 by OSPF protocol and explain various type of LSA recorded by the protocol

We have LSA type 1,2 and 5 on R8. Type 1 is generated by all routers using OSPF protocol. Type 2 is generated by DR routers. Since R8 is ASBR router it is supposed to send information about external routes, which is LSA 5.

```
R8-8569394#sh ip ospf database

            OSPF Router with ID (172.16.8.41) (Process ID 10)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
172.16.8.21     172.16.8.21     480         0x80000030 0x00F2B6 1
172.16.8.25     172.16.8.25     1087        0x80000032 0x00676C 2
172.16.8.41     172.16.8.41     942         0x80000030 0x00E087 1

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.16.8.14     172.16.8.25     1087        0x8000002E 0x009F08
172.16.8.26     172.16.8.41     942         0x8000002E 0x009FD7

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
172.16.8.0      172.16.8.21     1213        0x8000002D 0x005682 0
172.16.8.4      172.16.8.21     1213        0x8000002D 0x002EA6 0
172.16.8.8      172.16.8.21     1213        0x8000002E 0x0004CB 0
172.16.8.44     172.16.8.41     942         0x8000002E 0x002275 0
172.16.8.48     172.16.8.41     942         0x8000002E 0x00B1ED 0
172.16.8.64     172.16.8.21     1213        0x8000002D 0x006A6A 0
```

Lessons Learned

The project taught us how a real-life scenario would work for setting up a network for a company. While there are much larger networks in other companies, a medium sized company such as the small business which we configured the network for is better for learning and understanding how exactly the network is set up and configured. We got valuable knowledge using network hardware and cables which helped us better prepare for future tasks. It also helped us learn how to connect various departments and users in the network to each other.