**Name & ID**: Syed Asghar Abbas Zaidi **Date:** 14th November 2023

| **EE-424L Data Communication & Networking**  **Fall 2023**  **Habib University**  **Dhanani School of Science & Engineering** |
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**LAB 12: Open Shortest Path First (OSPF) Routing**

| **Lab #12 Marks distribution:**   |  |  | **LR2=30** | **LR4=30** | **LR5=30** | **AR4=10** | | --- | --- | --- | --- | --- | --- | | **In-Lab Tasks** | **Task 1** | 10 | 10 | 10 | 10 | | **Task 2** | 20 | 20 | 20 | | **Total Marks** | **100** | | | | |   **Lab #12 Marks Obtained:**   |  |  | **LR2=30** | **LR4=30** | **LR5=30** | **AR4=10** | | --- | --- | --- | --- | --- | --- | | **In-Lab Tasks** | **Task 1** |  |  |  |  | | **Task 2** |  |  |  | | **Marks Obt.** |  | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |

| o**bjectives** | **The objective of this lab is to configure and verify Single and Multi-Area Open Shortest Path First (OSPF) Routing.** |
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**Introduction**

**OSPF (Open Shortest Path First)** is a link state routing protocol. Because it is an open standard, it is implemented by a variety of network vendors. OSPF will run on most routers that doesn’t necessarily have to be Cisco routers (unlike EIGRP which can be run only on Cisco routers).

Here are the most important features of OSPF:

* a classless routing protocol
* supports VLSM, CIDR, manual route summarization, equal cost load balancing
* incremental updates are supported
* uses only one parameter as the metric – the interface cost.
* the administrative distance of OSPF routes is, by default, 110.
* uses multicast addresses 224.0.0.5 and 224.0.0.6 for routing updates.

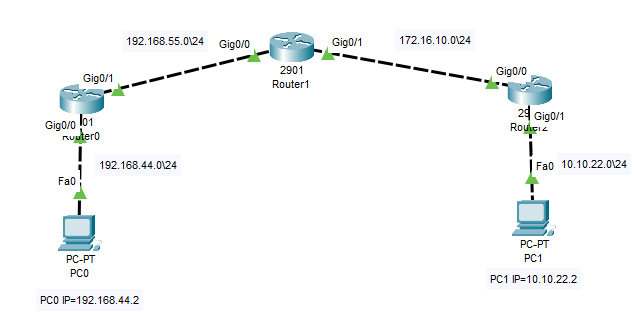
Routers running OSPF have to establish neighbor relationships before exchanging routes. Because OSPF is a link state routing protocol, neighbors don’t exchange routing tables. Instead, they exchange information about network topology. Each OSFP router then runs SFP algorithm to calculate the best routes and adds those to the routing table. Because each router knows the entire topology of a network, the chance for a routing loop to occur is minimal.

Each OSPF router stores routing and topology information in three tables:

* **Neighbor table** – stores information about OSPF neighbors
* **Topology table** – stores the topology structure of a network
* **Routing table** –  stores the best routes

| **Task 1: Configuration of Single Area OSPF** |  | |
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Configure and create the below topology in packet tracer and complete the IP configuration and interface configuration in Table 1 according to your Network Topology. Attach your network topology with labelled IPs and interfaces below.



**Note: Make sure to enter correct subnet masks as mentioned in above topology**

| **Device Name** | **Protocol Configuration** | **IP Scheme/Interface Configuration** |
| --- | --- | --- |
| PC0 | -- | 192.168.44.2 |
| PC1 | -- | 10.10.22.2 |
| Router0 | OSPF (it is done later in the question) | Gig 0/0: 192.168.44.1/24  Gig 0/1: 192.168.55.1/24 |
| Router1 | OSPF (it is done later in the question) | Gig 0/0: 192.168.55.2/24  Gig 0/1: 172.16.10.1/24 |
| Router2 | OSPF (it is done later in the question) | Gig 0/0: 172.16.10.2/24  Gig 0/1: 10.10.22.1 |

**Router Configuration:**

| **My Network Topology:**    **Router0 Configuration:**    **Router1 Configuration:**    **Router2 Configuration:** |
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**Ping PC0 to PC1 and note the response below.**

| **I got the following response:**    **Observation:**  It makes sense as we haven’t defined any routing on any router on how PC0 could reach the network of 10.10.22.0 |
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**Configure and verify Open Shortest Path First (OSPF) Routing**

Configure an OSPF routing process on all routers. Use OSPF process number 1 and ensure all networks  
are in area 0. For configuring any router with OSPF you need to advertise all the directly connectednetwork in OSPF process**.** For example, on router0 you have the networks 192.168.44.0/24 and  
192.168.55.0/24

**Router 0 OSPF Configuration:**

Router0#conf t  
Router0(config)#router ospf 1  
Router0(config-router)#network 192.168.44.0 0.0.0.255 area 0  
Router0(config-router)#network 192.168.55.0 0.0.0.255 area 0

Router0(config-router)#router-id 1.1.1.1

We have used the**router-id 1.1.1.1** command to manually specify the router ID of this router. OSPF process will use that RID (router-id) when communicating with other OSPF neighbors. Do it for Router 1 & 2 with router-ids 2.2.2.2 and 3.3.3.3 respectively and attach its screenshot below:

| **Router0’s OSPF Configuration:**    **Router1’s OSPF Configuration:**    **Router2’s OSPF Configuration:** |
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**Ping PC0 to PC1 and write down the response.**

| **Response:**    **Observation:**  The ping was successful |
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**OSPF verification commands:**

**Run show ip protocol on any one Router and discuss the findings.**

| Running the “show ip protocol” command:    **Observation:**  This command tells us about the “routing protocol” that is running on our router. As we recently configured our router to run “OSPF” running on protocol 1, it is showcasing us that.  It tells us about the update filters that we haven’t set yet.  It tells us about the “Router ID” that we have assigned to this Router 0 which is “1.1.1.1”.  As all the routers were configured to be in area 0, and this router doesn’t see any other areas, the number of area observed by this router is **1**  Routing: We configured the network routes within ospf, and that information can be seen from “Routing from networks”  Finally, it gives us all the Routing Information, the Gateway the router can see in this topology, when it was first noted down in our table, and “distance value” of it, if there was any other routing protocol defined which told router a “path” to the same network with less distance, it will prefer choosing that route.  As there are 4 networks in this topology, it is able to observe 4 paths. |
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**Run show ip route on all routers and discuss the findings.**

| **Running “show ip route” on all routers:**    **Router0:**    **Router1:**    **Router2:**    **Observation of the findings:**  Some networks are immediately visible and accessible to the router cause they are directly connected to that router’s interface which is denoted with the letter “C”. However, some networks like from the perspective of Router1, network 192.168.55.0 and 192.168.44.0 aren’t immediately available, and it is with the help of routing protocol of OSPF, that it comes to know that those networks exists with the help of other routers, and from where to access them. |
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Run below commands, attach its screenshot and **discuss the results.**

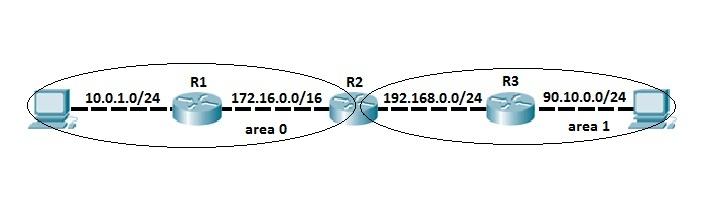
* show ip ospf neighbor: Run this command on Router 0, 1 and 2
* show ip ospf interface: Run this command on any one Router

| **Running “show ip ospf neighbor” on Router 0,1,2:**  **Router 1:**    **Router1:**    **Router2:**    **DISCUSSING THE RESULTS:**  This tells us about the neighbor router information that it have, and their Router IDs, and how to access them (through what gateway)  **Running “show ip ospf interface” on any one of the router:**  **CHOOSING TO RUN ON ROUTER0:**    **Observation:**  When we learn about from each interface is it the IP-address, OSPF Area, OSPF Process, OSPF Router ID, Network Type, OSPF Cost, The state of our router, DR ID, if there is a backup designated router, OSPF Timers (Hello time, Dead time, wait time, retransmit) , If there are neighbors on this networks or not. |
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| **Task 2: Configuration of Multi Area OSPF** |  |
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Although basic OSPF configuration can be very simple, OSPF provides many extra features that can get really complex. In this task, we will configure multiarea OSPF network and some other OSPF features.

Consider the following multiarea OSPF network:



In this task we have two OSPF areas – area 0 and area 1. As you can see from the network topology depicted above, routers R1 and R3 are in the area 0 and area 1, respectively. Router 2 connects to both areas, which makes him an**ABR (Area Border Router)**.

**Attach screenshot of all configuration steps done on R1, R2 and R3 and provide screenshot of your network topology.**

**CONFIGURATION:**

| **NETWORK TOPOLOGY:**    **R1 Configuration:**    **R2 Configuration:**    **R3 Configuration:** |
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Ping PCs and attach the response below.

| **Pinging from PC0 to PC1:**    **Pinging from PC1 to PC0:** |
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Again, run all below commands and discuss the differences observe in single and multi-area OSPF.

**OSPF verification commands:**

Run show ip protocol on any one Router and discuss the findings.

Run show ip route on all routers and discuss the findings.

Run below commands, attach its screenshot and **discuss the results.**

* show ip ospf neighbor: Run this command on Router 1, 2 and 3
* show ip ospf interface: Run this command on any one Router

| **Run “show ip protocol” on any one Router and discuss the findings:**  **Choosing R1:**    **Discussing the findings:**  This command tells us about the “routing protocol” that is running on our router. As we recently configured our router to run “OSPF” running on protocol 1, it is showcasing us that.  It tells us that we haven’t updated the outgoing and incoming filters yet as well.  It tells us about the “Router ID” that we have assigned to this Router 0 which is “1.1.1.1”.  No other immediate router to Router 1 exists in separate area, as such this router doesn’t see any other areas, the number of area observed by this router is **1.** HOWEVER, if we were to run “show ip protocol” on R2, the “number of areas observed in this router” would have been **2.**  **Routing:** We configured the network routes within ospf, and that information can be seen from “Routing from networks”  Finally, it gives us all the Routing Information, the Gateway the router can see in this topology, when it was first noted down in our table, and “distance value” of it, if there was any other routing protocol defined which told router a “path” to the same network with less distance, it will prefer choosing that route.  As there are 4 networks in this topology, it is able to observe 4 paths.  There’s not a lot of differences to be observed here.  **Run “show ip route” on all routers and discuss the findings:**  **On R1:**    **On R2:**    **On R3:**    **FINDINGS:**  Unlike previously, there are clear differences. We are seeing new “letters” infront of “O” symbol which is “IA”. What this effectively means is that our router was able to learn new networks **OUTSIDE** the area or in a different area which it is not “immediately” able to see by itself.  **Run below commands, attach its screenshot and discuss the results:**  **Run “show ip ospf neighbor” on R1, R2 and R3:**  **On R1:**    **On R2:**    **On R3:**    **Findings:**  Not alot of differences to be observed here. It simply tells the Router IDs of the immediate neighbors each router sees and the “port interface” through which it learns.  **Run “show ip ospf interface” on any one Router**  **I am choosing R1 as an example:**    **Interpreting this:**  When we learn about the information from each interface is it the IP-address, OSPF Area, OSPF Process, OSPF Router ID, Network Type, OSPF Cost, The state of our router, DR ID, if there is a backup designated router, OSPF Timers (Hello time, Dead time, wait time, retransmit) , If there are neighbors on this networks or not.  **Observation and differences from the Task1:**  The main differences lies in the existence of different areas which I discussed under “show ip protocol” which tells the network belonging to different areas in R2, and in R1, with show ip routes, existence of “O LA” which is different from “O” meaning that it exists in different areas  Aside of that, running the “show ip ospf database” command, we will learn that the routers that exists in a single same area share the same database! |
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**Lab Evaluation Assessment Rubric**

**EE-424 Lab 12**

| **#** | **Assessment Elements** | **Level 1: Unsatisfactory**  **Points 0-1** | **Level 2: Developing**  **Points 2** | **Level 3: Good**  **Points 3** | **Level 4: Exemplary**  **Points 4** |
| --- | --- | --- | --- | --- | --- |
| **LR2** | **Program/Code/ Simulation Model/ Network Model** | Program/code/simulation model/network model does not implement the required functionality and has several errors. The student is not able to utilize even the basic tools of the software. | Program/code/simulation model/network model has some errors and does not produce completely accurate results. Student has limited command on the basic tools of the software. | Program/code/simulation model/network model gives correct output but not efficiently implemented or implemented by computationally complex routine. | Program/code/simulation /network model is efficiently implemented and gives correct output. Student has full command on the basic tools of the software. |
| **LR4** | **Data Collection** | Measurements are incomplete, inaccurate and imprecise. Observations are incomplete or not included. Symbols, units and significant figures are not included. | Measurements are somewhat inaccurate and imprecise. Observations are incomplete or vague. Major errors are there in using symbols, units and significant digits. | Measurements are mostly accurate. Observations are generally complete. Minor errors are present in using symbols, units and significant digits. | Measurements are both accurate and precise. Data collection is systematic. Observations are very thorough and include appropriate symbols, units and significant digits and task completed in due time. |
| **LR5** | **Results & Plots** | Figures/ graphs / tables are not developed or are poorly constructed with erroneous results. Titles, captions, units are not mentioned. Data is presented in an obscure manner. | Figures, graphs and tables are drawn but contain errors. Titles, captions, units are not accurate. Data presentation is not too clear. | All figures, graphs, tables are correctly drawn but contain minor errors or some of the details are missing. | Figures / graphs / tables are correctly drawn and appropriate titles/captions and proper units are mentioned. Data presentation is systematic. |
| **AR4** | **\*Report Submission** | Late submission after 1 week and in between 2 weeks. | Late submission after 2 days and within a week. | Late submission after the lab timing and within 2 days of the due date. | Timely submission of the report and in the lab time. |

**\*Report:** Report will not be accepted after due date