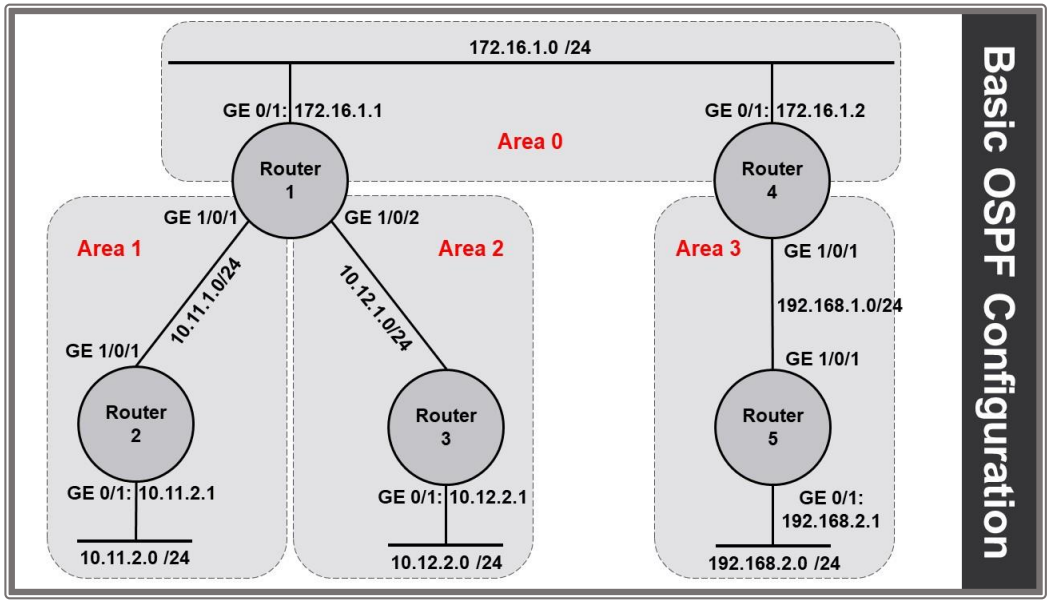
Virtual **Network Laboratory**

A Virtual Experiment on implementation of

OPEN SHORTEST PATH FIRST (OSPF)



Implementation Manual

Prepared by: ***Dr. Rajeev Chatterjee***

National Institute of Technical Teachers' Training & Research

Block-FC, Sec-III, Salt Lake City, Kolkata-700 106, West Bengal, India

www.nitttrkol.ac.in

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SECTION 1

BASIC CONCEPT OF OSPF

1.1 OSPF

Open Shortest Path First (OSPF) is a routing protocol used in the Transmission Control Protocol / Internet Protocol (TCP/IP) suite. It is mainly used for routing operation within a single Autonomous System (AS) and that is why it falls under the category of Interior Gateway Protocols (IGPs). For its operation, it uses a Link State Routing (LSR) algorithm. OSPF is supported in classful Internet Protocol Version 4 (IPv4) networks. It also supports the Classless Inter-Domain Routing (CIDR) addressing model. Further OSPF is also supported in Internet Protocol Version 6 (IPv6) networks.

OSPF gathers link state information from available routers and constructs a topology map of the network. The information related to **routers** are presented in form of Link- State Database (LSDB). As OSPF is generally used in larger networks the entire AS is divided into various areas namely area1, area2 and so on. There is a backbone area known as area 0 which houses the area border routers and backbone routers. Thus, we can say that this protocol uses is hierarchical topology of routers deployed in various areas, which are again based on hierarchical topology.

OSPF is widely used in large enterprise networks. IS-IS, another LSR-based protocol, is more common in large service provider networks. Originally designed in the 1980s, OSPF is defined for IPv4 in protocol version 2 by RFC 2328 (1998).[1] The updates for IPv6 are specified as OSPF Version 3 in RFC 5340 (2008).[2] OSPF supports the Classless Inter-Domain Routing (CIDR) addressing model also.

1.2 Autonomous System (AS)

An autonomous system (AS) is a collection of connected Internet Protocol (IP) routing prefixes under the control of one or more network operators on behalf of a single administrative entity or domain, that presents a common and clearly defined routing policy to the Internet. In other words, an AS is a collection of routers from various network operators or ISPs under one single administrative entity that follows a common routing policy for all the routers as show in the figure 1.

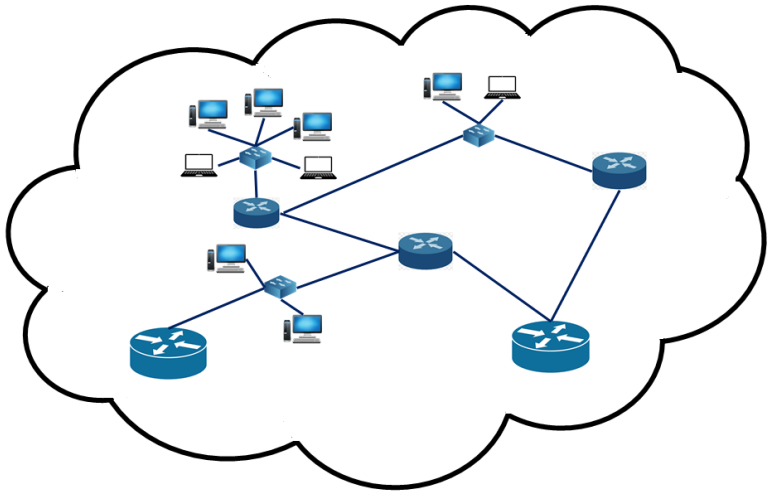

Fig 1: Autonomous system

Each of these AS is identified with a number known as Autonomous System Number or (ASN) having range from 1 to 23455 and then from 23457 to 64495. By Now we have the concept of AS, let us see the interconnection of ASes in the Internet environment. This is shown in figure 2.

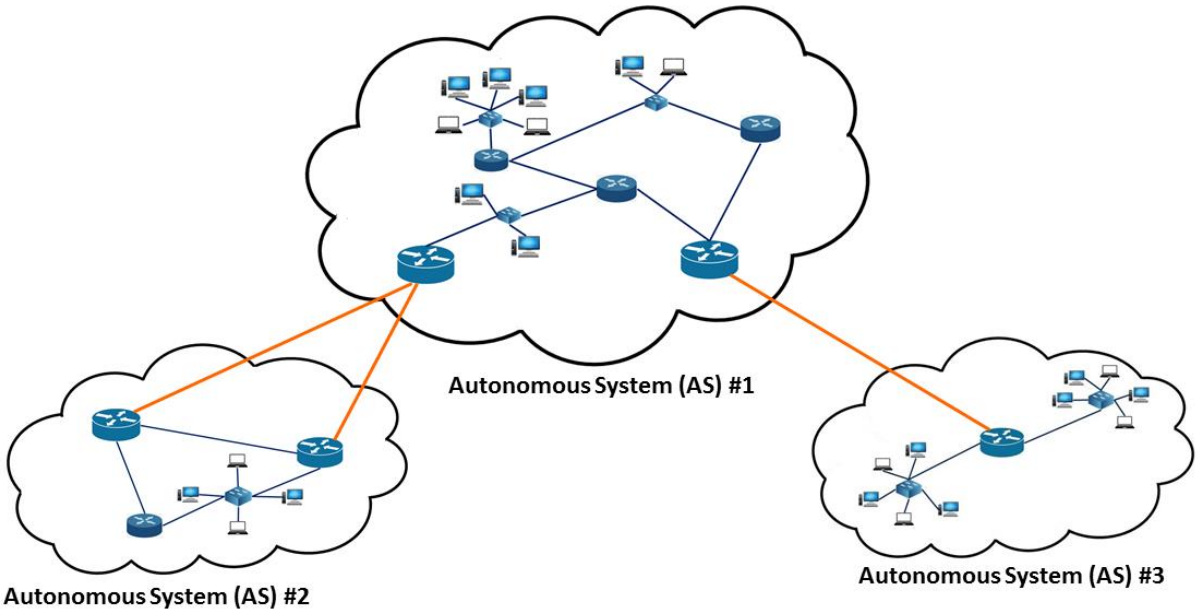

Fig 2: Interconnection of AS in the Internet environment

Here, in this figure you can see an individual AS (AS#1) is connected to two ASes consisting of 3 and 1 routers (AS#2 & AS#3), respectively. AS that are connected to 2 or more ASes is known as multi-homed AS where as if an AS that is connected to only another AS then it is known as Stub AS. Communication within the routers of an individual AS is done by using Interior Routing Protocol (IRP), whereas communication among the external peers of two different ASes is done using Exterior Routing Protocol (ERP). OSPF is a typical example of IRP, generally used in large Autonomous System.

SECTION 2

AIM OF THE EXPERIMENT

- To implement OSPF protocol using 5 routers scenario.

In this set 5 routers are deployed in 4 areas namely AREA 1, AREA2, AREA3 AND of course the designated backbone area, AREA 0. The connections among the routers deployed in various areas are along-with networks are given in figure 3.

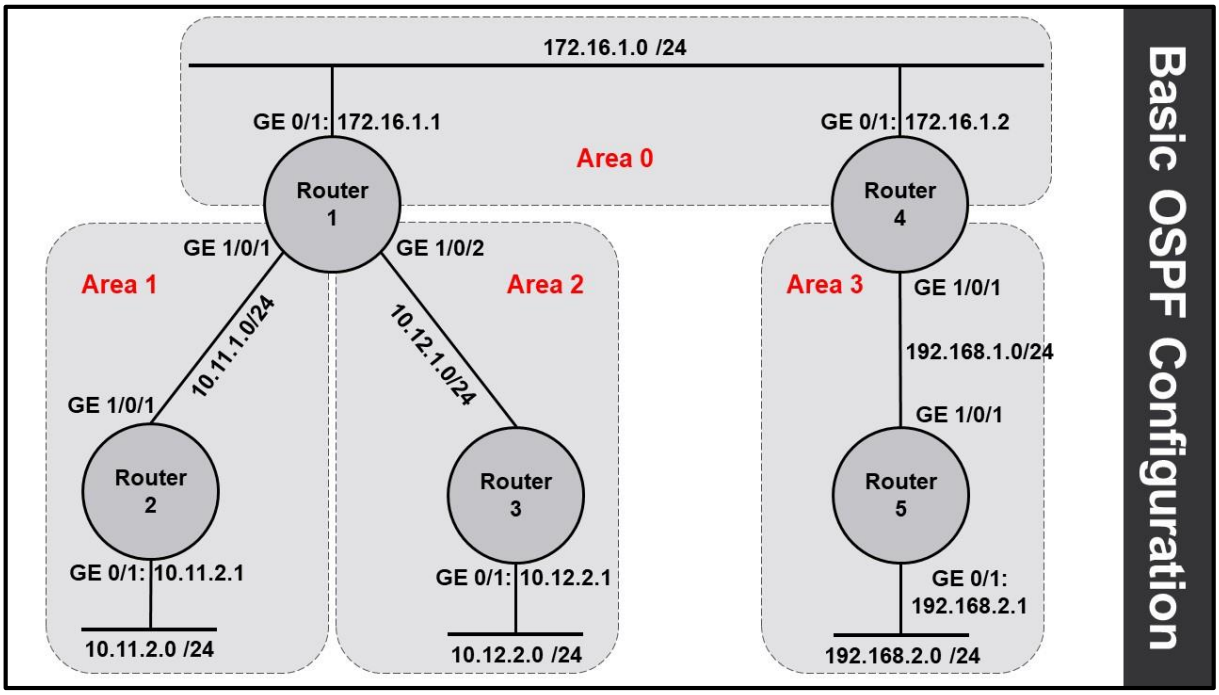

Fig. 3: Deployment of routers in multiple areas using OSPF Protocol.

SECTION 3

ABOUT THE EXPERIMENT

Here we are going to exhibit a virtual experiment on Open Shortest Path First (OSPF) Protocol. This protocol is an Interior Routing Protocol that means OSPF is primarily used for communication among the routers within a single Autonomous System (AS) particularly for Larger AS. In small AS we generally used Routing Information Protocol (RIP)

In this virtual experiment, the instructor has created an AS consisting of 4 areas namely AREA 1, AREA 2, AREA 3 and the most important area i.e. designated backbone area, AREA 0. The details of the routers with models and area assignment is given the table 1.

Table 1: Details of the router for deployment

Sl. No.	Router	Model of Router	Areas
1.	Router 1	Cisco 2800 series	Area 0, Area 1, Area2
2.	Router 2	Cisco 2800 series	Area 1
3.	Router 3	Cisco 1800 series	Area2
4.	Router 4	Cisco 2800 series	Area 0, Area 3
5.	Router 5	Cisco 1800 series	Area5

For configuration of the routers we can either use HyperTerminal or use Putty

The deployment of routers within various areas of an AS is given in figure 4.

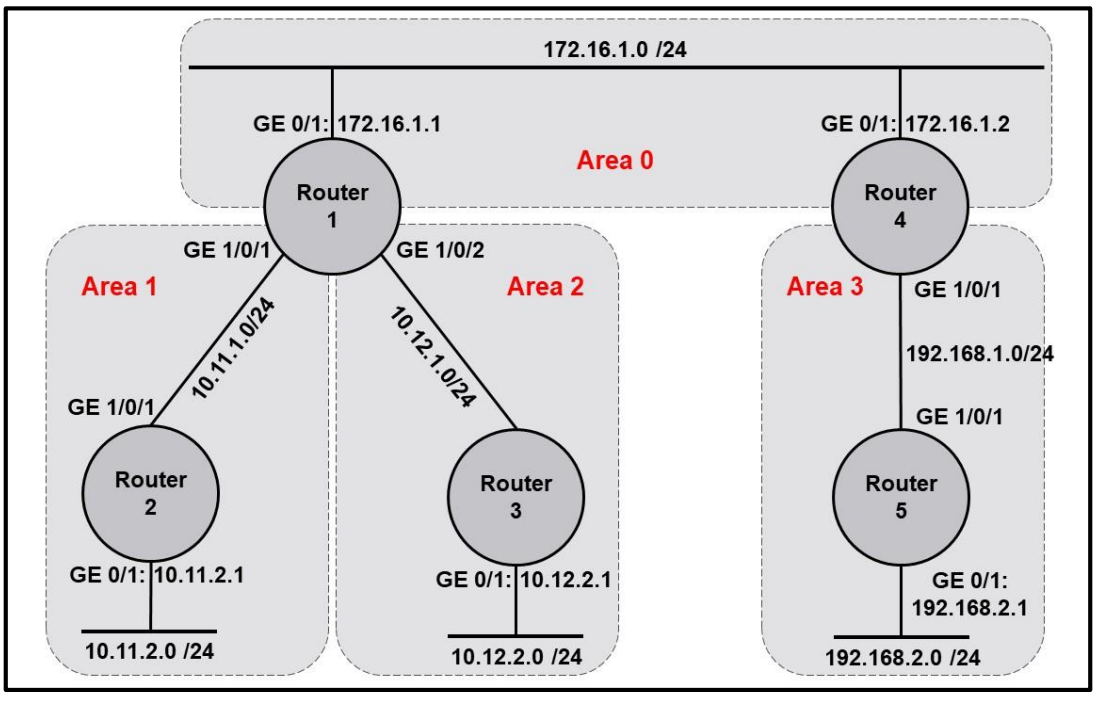

Fig. 4: Deployment of routers in multiple areas of an AS.

SECTION 4

DESCRIPTION OF THE EQUIPMENT

In order to carry out this virtual experiment of implementation of OSPF protocol in the actual laboratory the following equipment are required.

- **Routers (5 Nos.)**
- **Laptop or Desktop (1 No.)**
- **Ethernet Cable (8 Nos.)**
- **Console Cable (1 No.)**
- **Comm. to USB converter in case you are using a Laptop.**

Here in this experiment we are using 2 different types of routers. The first category of router is Cisco make 2800 series router consisting of 3 Gigabit Ethernet port with 1 console port and 1 mini console port. The router contains one power supply. The second type of router that is used here is Cisco make 1800 series router. It contains 2 Fast Ethernet port, with 1 console port. This has been clearly shown in the description of video. For configuration of the router a Laptop or desktop computer can be used. Here in this experiment we have used an intel i5 Core laptop for the procedure. HyperTerminal or Putty software can be used for configuration of the various routers. Putty software can be downloaded from the internet. The routers Cisco 2800 series and Cisco 1800 series are given in figure 5 and 6 respectively.

Fig. 5: Cisco 2800 Series Router

Fig. 6: Cisco 1800 Series Router

SECTION 5

CONFIGURATION OF THE ROUTERS

5.1 Accessing the router through Command Line interface (CLI)

In order to configure the routers available here, first of all we have to procure HyperTerminal software or we can use putty software. You can download putty.exe from the internet. The webpage along with URL is given in figure 7.

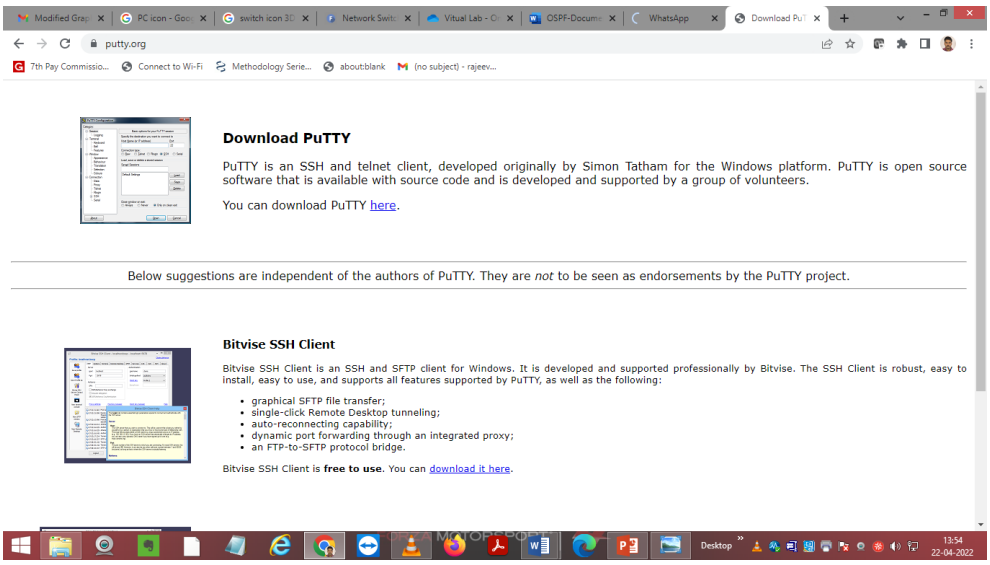

Fig 7: Webpage from where putty can be downloaded (www.putty.org)

Once the putty is downloaded from the Internet click on the putty and select the serial option. Make serial line as COM1 and speed as 9600 bytes as shown in figure 8.

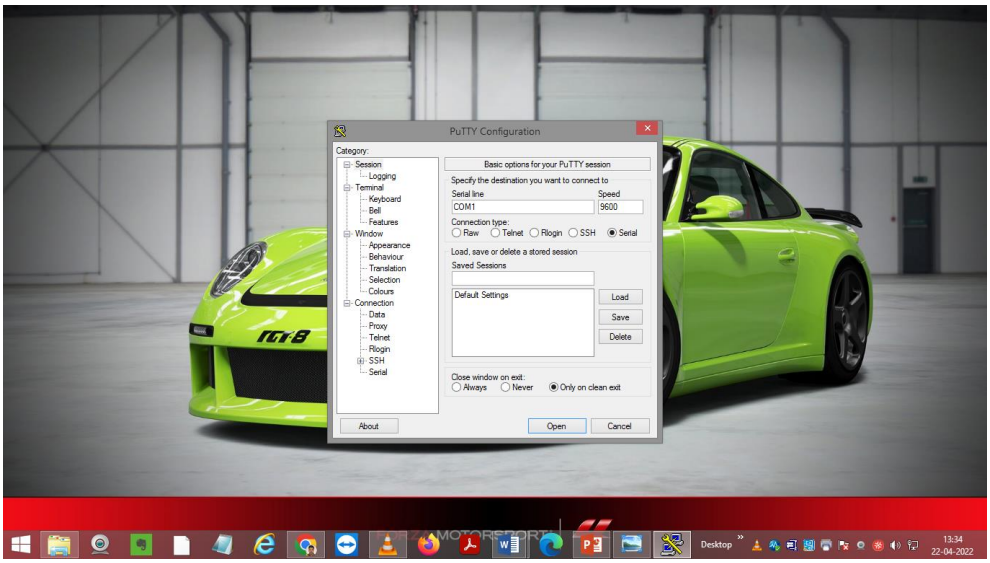

Fig 8: Interface of PUTTY software

After that the Command Line Interface (CLI) of the putty will be available as given in figure 9.

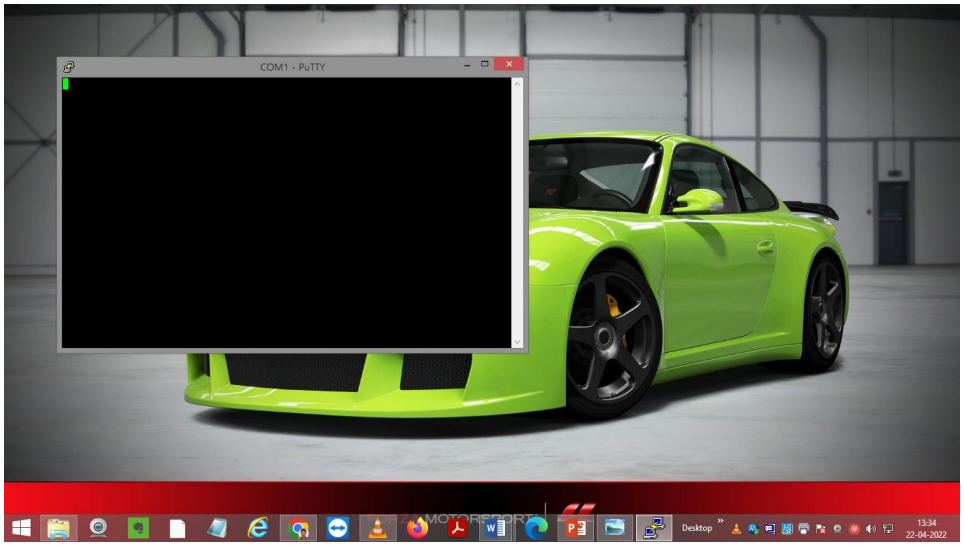

Fig 9: Command Line Interface (CLI) of PUTTY (putty.exe)

Press enter 2 times to get connected to the network device. Here in this case it is a router with its name TRG-Router given in figure 10.

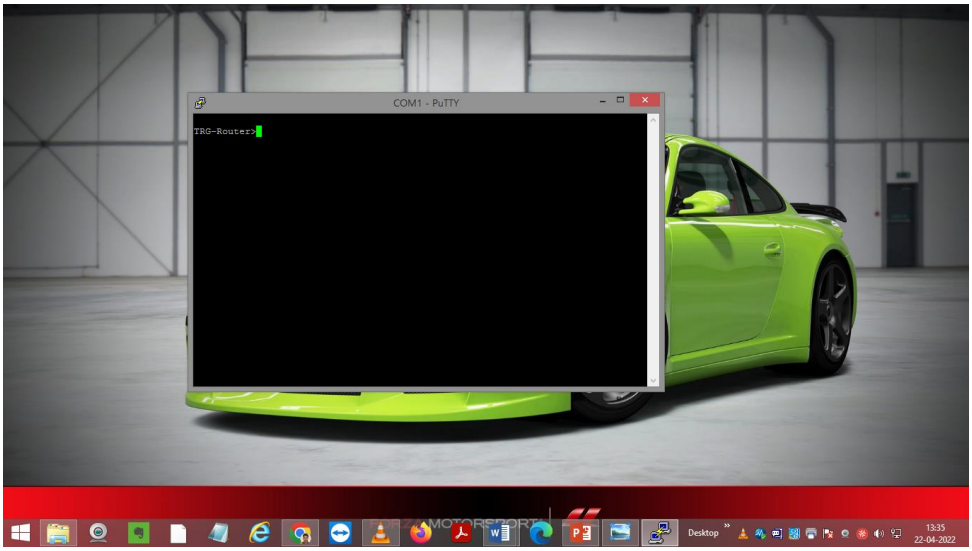

Fig 10: Command Line Interface (CLI) of PUTTY (putty.exe).

Now, we can access the router through the software (putty.exe). In the next section we will see the basic configuration command for the routers.

5.2 Configuring the router through CLI mode

Once we login into the router we will check the current privilege level using the command ***show privilege*** as given in figure 11.

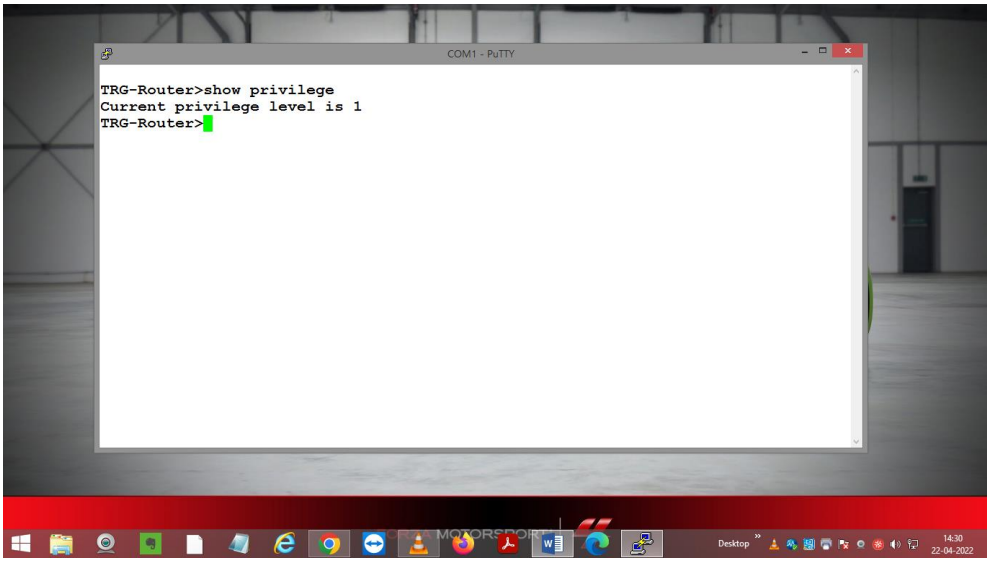

Fig 11: Shows the current privilege in the CLI

Use the command ***enable*** followed by ***password*** to reach to enable level access (i.e. Privilege Level 15). This level is required for ***configuration mode*** shown in figure 12.

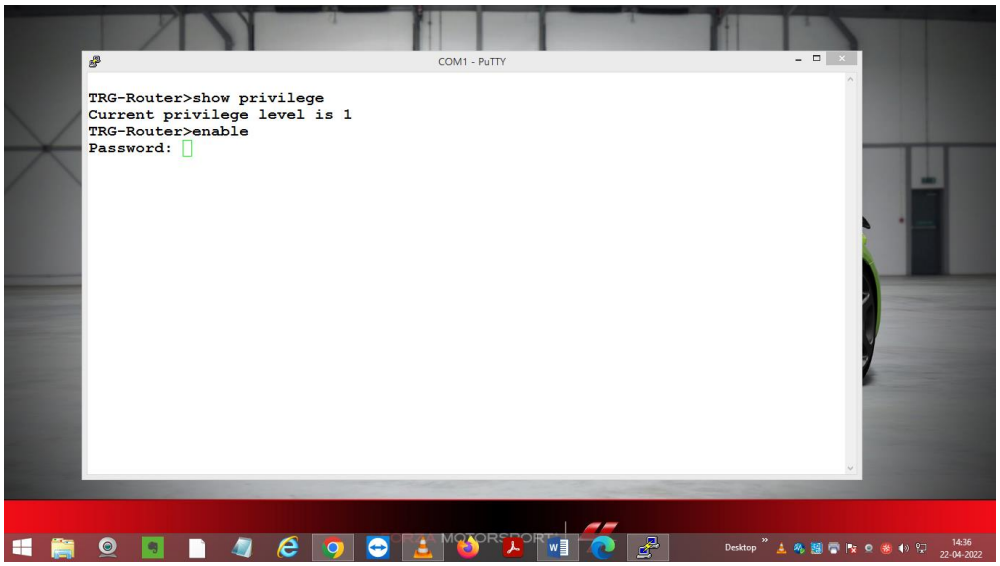

Fig 12: Shows how to enter into Enable Level using appropriate password.

Use the command show privilege to check the current privilege level. If the Current privilege level is 15, then enter the command configure terminal to switch the router into Configure Terminal Mode as given in figure 13.

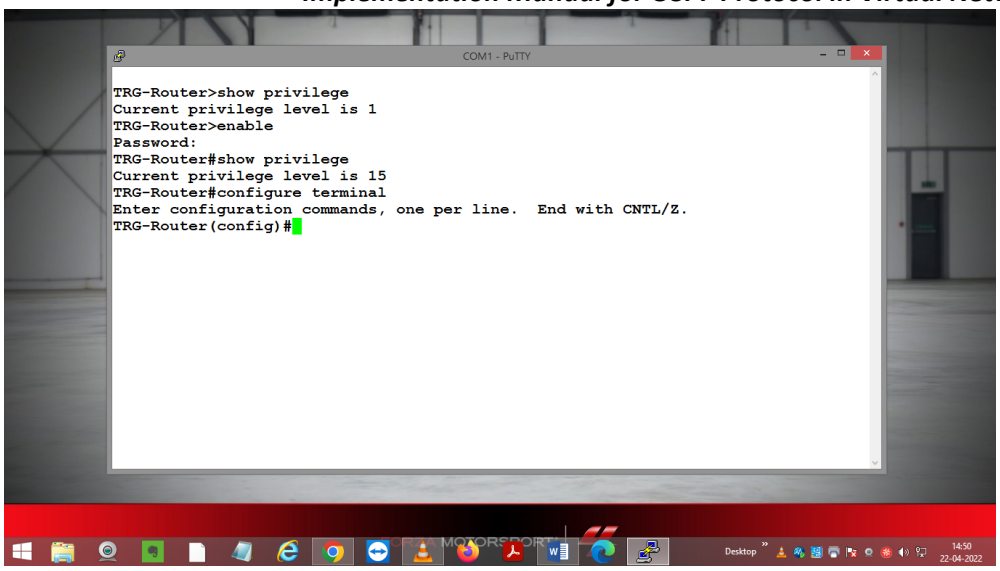

Fig 13: Shows how to enter into Configuration mode.

Now you can enter OSPF Configuration Command for each router. The entire configuration for Router 1 to Router 5 is given below.

5.3 OSPF Configuration for all the 5 routers

OSPF Configuration Command for Router 1

COM1-Putty
Router# configure terminal **Router(config)#hostname Router1** **Router1(config)# interface ge 0/1** **Router1(config-if)# ip address 172.16.1.1 255.255.255.0** **Router1(config-if)# exit** **Router1(config)# interface ge 1/0/1** **Router1(config-subif)# ip address 10.11.1.1 255.255.255.0** **Router1(config-subif)# exit** **Router1(config)# interface ge 1/0/2** **Router1(config-subif)# ip address 10.12.1.1 255.255.255.0** **Router1(config-subif)# exit** Router1(config)# router ospf 100 **Router1(config-router)# network 10.11.0.0 0.0.255.255 area 1** **Router1(config-router)# network 10.12.0.0 0.0.255.255 area 2** **Router1(config-router)# network 172.16.1.0 0.0.0.255 area 0** **Router1(config-router)# exit** **Router1# write** **Router1#**

OSPF Configuration Command for Router 2

COM1-Putty

```
Router# configure terminal
Router(config)#hostname Router2
Router2(config)# interface ge 0/1
Router2(config-if)# ip address 10.11.2.1 255.255.255.0
Router2(config-if)# exit
Router2(config)# interface ge 1/0/1
Router2(config-subif)# ip address 10.11.1.2  255.255.255.0
Router2(config-subif)# exit
Router2(config)# router ospf 100
Router2(config-router)# network 10.11.0.0  0.0.255.255 area 1
Router2(config-router)# exit
Router2# write
Router2#
```

OSPF Configuration Command for Router 3

COM1-Putty

```
Router# configure terminal
Router(config)#hostname Router3
Router3(config)# interface ge 0/1
Router3(config-if)# ip address 10.12.2.1 255.255.255.0
Router3(config-if)# exit
Router3(config)# interface ge 1/0/1
Router3(config-subif)# ip address 10.12.1.2  255.255.255.0
Router3(config-subif)# exit
Router3(config)# router ospf 100
Router3(config-router)# network 10.12.0.0  0.0.255.255 area 2
Router3# write
Router3#
```

OSPF Configuration Command for Router 4

COM1-Putty
Router# configure terminal **Router(config)#hostname Router4** **Router4(config)# interface ge 0/1** **Router4(config-if)# ip address 172.16.1.2 255.255.255.0** **Router4(config-if)# exit** **Router4(config)# interface ge 1/0/1** **Router4(config-subif)# ip address 192.168.1.1 255.255.255.0** **Router4(config-subif)# exit** **Router4(config)# router ospf 100** **Router4(config-router)# network 192.168.0.0 0.0.255.255 area 3** **Router4(config-router)# network 172.16.1.0 0.0.0.255 area 0** **Router4(config-router)# end** **Router4# write** **Router4#**

OSPF Configuration Command for Router 5

COM1-Putty
Router# configure terminal **Router(config)#hostname Router5** **Router5(config)# interface ge 0/1** **Router5(config-if)# ip address 192.168.2.1 255.255.255.0** **Router5(config-if)# exit** **Router5(config)# interface ge 1/0/1** **Router5(config-subif)# ip address 192.168.1.2 255.255.255.0** **Router5(config-subif)# exit** **Router5(config)# router ospf 100** **Router5(config-router)# network 192.168.0.0 0.0.255.255 area 3** **Router5# write** **Router5#**

Disclaimer: The configuration for OSPF shown in this document is based on the connection layout and deployment laid down by the Instructor. There can be different way of connecting the devices and accordingly the Configuration, IP Addresses and Networks may change. Learners' cooperation is solicited.

SECTION 6

REFERENCES

A. Reference Books

Sl. No.	Title of the Book	Author(s)	Publisher	Edition
1)	The TCP/IP Guide: A Comprehensive, Illustrated Internet Protocols Reference	Charles M. Kozierok	No Starch Press Inc.	1st Edition, 2005
2)	OSPF Complete Implementation	John T Moy	Addision Wesley	1st Edition Sep 2000
3)	OSPF anatomy of Internet Routing Protocol	John T Moy	Addision Wesley	8th Printing March 2004
4)	Cisco IOS in a Nutshell : A Desktop Quick Reference for IOS on IP Networks	James Boney	O' Reilly	2nd Edition August 2005
5)	Cisco Cookbook: Field-Tested Solutions to Cisco Router Problems	Kevin Dooley & Ian J. Brown	O' Reilly	1st Edition July 2003

B. Configuration Handbook

Sl. No.	Title of the Book	Author(s)	Publisher	Edition
1)	Cisco OSPF Command and Configuration Handbook: The comprehensive hands-on guide to all Cisco IOS Software OSPF Commands	William R. Parkhurst	Cisco Press	1st Edition April 2002

C. IETF Documents

1) **RFC 1247:** https://datatracker.ietf.org/doc/html/rfc1247
2) **RFC 1583:** https://datatracker.ietf.org/doc/html/rfc1583
3) **RFC 2178:** https://datatracker.ietf.org/doc/html/rfc2178
4) **RFC 2328:** https://datatracker.ietf.org/doc/html/rfc2328
5) **RFC 3101:** https://datatracker.ietf.org/doc/html/rfc3101