Department of Computer Science and Engineering
Islamic University of Technology (IUT)
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Laboratory Report

CSE 4412: Data Communication and Networking Lab

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Section	**:1A**
Semester	**:Summer**
Academic Year	**:2021-2022**
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Lab No	**:07**

Title: Configuration of OSPF in a network topology.

Objective:

1. Understand Link State Routing Protocol
2. Understand OSPF
3. Understand the difference between DV and LS routing

Devices/ software Used:
1.CISCO Packet Tracer

Theory:
Link State (LS) Routing
Link-state routing is a routing protocol that is also known as the shortest path first (SPF) algorithm. In link-state routing, every router in the network maintains a map of the entire network.This map is known as a link state database.
When a change occurs in the network, each router updates its map and calculates the shortest path to every other router in the network by using a shortest path algorithm, such as Dijkstra's algorithm. This information is then flooded throughout the network, so that every router has the most updated map.
Link-state routing is an efficient routing protocol and is used in many large networks including the Internet. Examples of link-state routing protocols include OSPF (Open Shortest Path First).

Link-State Database (LSDB)
A Link-State Database (LSDB) stores the network topology information in a link-state routing protocol. In link-state routing, each node maintains an identical copy of the LSDB. LSDB contains the information about the state and availability of all network links and routers.

Link State Packet
A Link State Packet (LSP) is a data packet used in link-state routing protocols to distribute information about the state and availability of network links and routers.
Each LSP contains a unique identifier called a Link-State ID (LSID) and a sequence number.
In a link-state routing protocol, each node in the network generates an LSP that describes itself and its connected links. The LSP is then flooded to all other nodes in the network so that each node can build and maintain an accurate map of the network topology.
When a node receives an LSP, it compares the LSID and sequence number to the information it already has in its Link-State Database. If the new LSP has a higher sequence number or is from a different node, the node updates its LSDB with the new information and forwards the LSP to all of its neighbors. If the new LSP has a lower sequence number, the node ignores it.

By exchanging LSPs, link-state routing protocols allow each node in the network to build and maintain a complete and accurate map of the network topology which helps the protocol to make reliable routing decisions and determine optimal path for data to travel.

Open Shortest Path First (OSPF)

Open Shortest Path First (OSPF) is a link-state routing protocol commonly used in large networks. It is an Interior Gateway Protocol (IGP) that allows routers to communicate and exchange routing information.

within an autonomous system (AS) unlike BGP(Border Gateway Protocol) which is used to exchange routing information between different autonomous systems.

In OSPF, each router maintains a complete and accurate map of the network topology in its Link-State Database (LSDB). This information is shared with other routers in the AS using Link-State Advertisements (LSAs). When a change occurs in the network, OSPF updates the LSDB and floods the new information to all other routers in the AS.

Metric:

In OSPF, the metric is known as the cost. It is used to determine the shortest path to a destination. The cost is calculated based on the bandwidth of the link, and routers choose the path with the lowest cost to forward packets.By default, OSPF calculates the cost based on the bandwidth of the link.Cost is inversely proportional with bandwidth which means

cost $\propto$ 1/ interface bandwidth.

The reference bandwidth is configurable and is set to 100 Mbps by default.

In addition to the default calculation based on bandwidth, OSPF also supports other methods for calculating the cost, including Delay, reliability, and load.

Areas:

In OSPF, areas are used to divide a large network into smaller networks which are easier to manage. This structure helps to reduce the amount of routing traffic.An OSPF network can be divided into one or more areas. Each area is represented by a 32-bit number called the Area ID. The Area ID is used to identify the area in the network and must be unique within the OSPF domain.

Link State Advertisement (LSA):

An LSA is a packet of information that contains details about the routers, links, and networks in the area. Each router in the area generates and floods LSAs to all other routers in the area to build a complete map of the network topology.

When a router receives an LSA, it updates its own copy of the network topology and floods the LSA to all other routers in the area.

When an LSA is flooded through the network, it is encapsulated in a Link State Packet (LSP). The LSP contains information about the sender of the LSA, the sequence number of the LSA, and the type of the LSA. The LSP is then sent to all other routers in the network using the OSPF flooding algorithm.

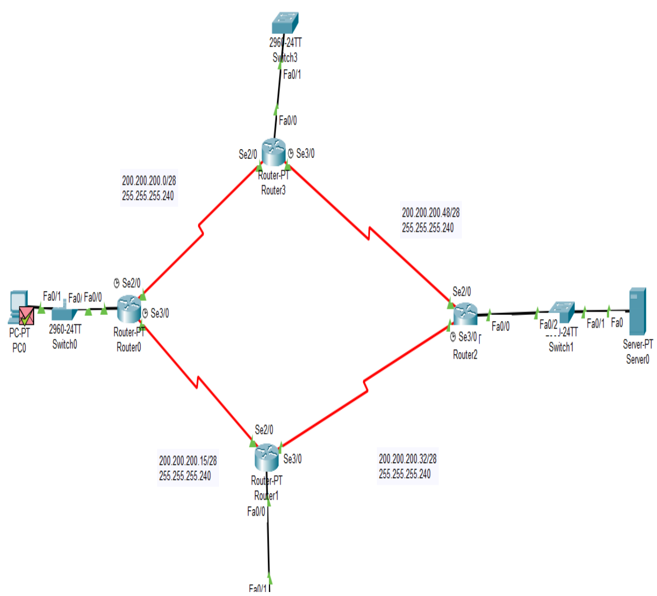
OSPF Implementation:
The first step in implementing OSPF is to design the network topology. This includes identifying the routers, the areas and their interconnections.
OSPF needs to be configured on each router in the network. This involves assigning OSPF router IDs, configuring OSPF interfaces and specifying the areas to which the router belongs.
OSPF divides the network into areas to optimize routing efficiency.
OSPF uses metrics to determine the best path for a destination network. The metrics used by OSPF include the cost of a link and the bandwidth of the link. These metrics are adjusted to optimize network performance.
Then configure OSPF authentication to prevent unauthorized access to the network.
Once OSPF has been configured on all routers, it is important to verify that the configuration is correct.
OSPF requires monitoring to ensure that the network is operating efficiently.

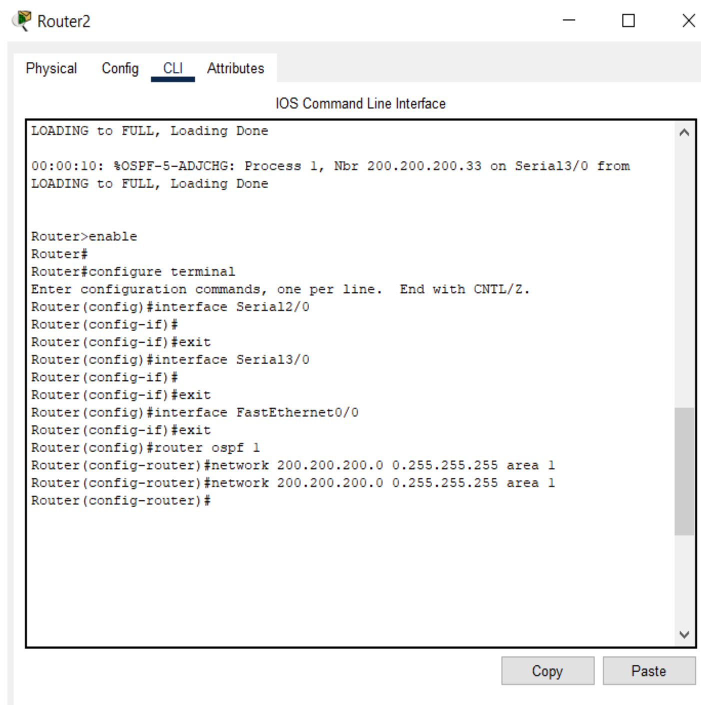
Performance:
OSPF uses a fast convergence algorithm that allows routers to quickly adapt to changes in the network topology to reduce network failures
OSPF is designed to manage large networks with multiple areas and routers. OSPF improves network performance by distributing traffic evenly across the available paths.
OSPF uses a path selection algorithm that takes into account multiple metrics, including link cost, bandwidth, and delay.
OSPF provides several options for securing OSPF messages.
Overall, OSPF is a high-performance routing protocol that provides several benefits for network performance.

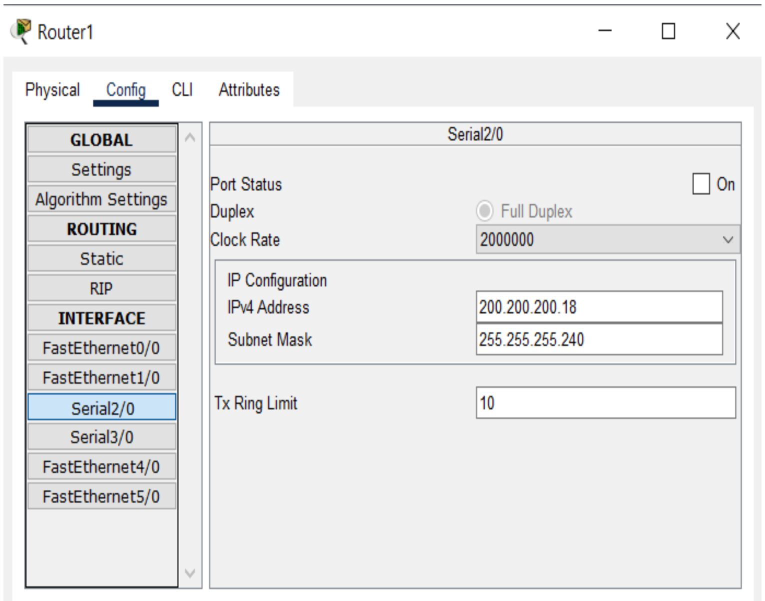
Update Message:
In OSPF, routers exchange information about the network topology using OSPF Update messages. An OSPF Update message contains a list of LSAs that describe the current state of the network topology. Each LSA contains information about a portion of the network. When a router receives an OSPF Update message, it updates its own copy of the network topology.
OSPF Update messages are sent only to routers that need to receive the updates. This helps to reduce the amount of OSPF traffic on the network and to improve network performance. OSPF uses a reliable flooding mechanism to ensure that all routers in the network receive the updates.
OSPF Update messages are also used to acknowledge the receipt of OSPF messages. When a router receives an OSPF message, it sends an acknowledgement in the form of an OSPF Update message back to the sender.

Convergence of Forwarding Tables:
The convergence of forwarding tables is the process by which routers in a network adjust their forwarding tables to reflect changes in the network topology.
In OSPF, when a router detects a change in the network it sends out an OSPF Update message to inform all the other routers in the network. Each router then recalculates its shortest path based on the new information and updates its forwarding table accordingly. Once all routers have updated their forwarding tables, convergence is said to have occurred.
The convergence time in OSPF is influenced by a number of factors such as the size of the network, the number of routers, the complexity of the network and the configuration of the OSPF protocol parameters.
The convergence of forwarding tables ensures that packets are forwarded in the most optimal path.

Diagram of the experiment:






Router1
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
Serial2/0
Port Status
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Clock Rate
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IP Configuration
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Subnet Mask
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Tx Ring Limit
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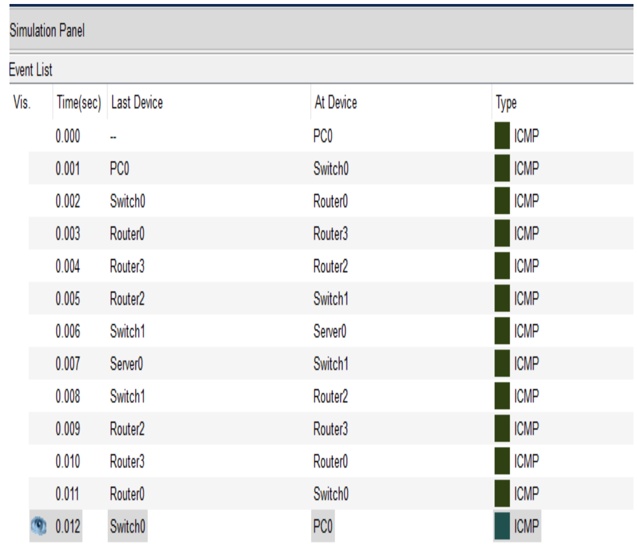
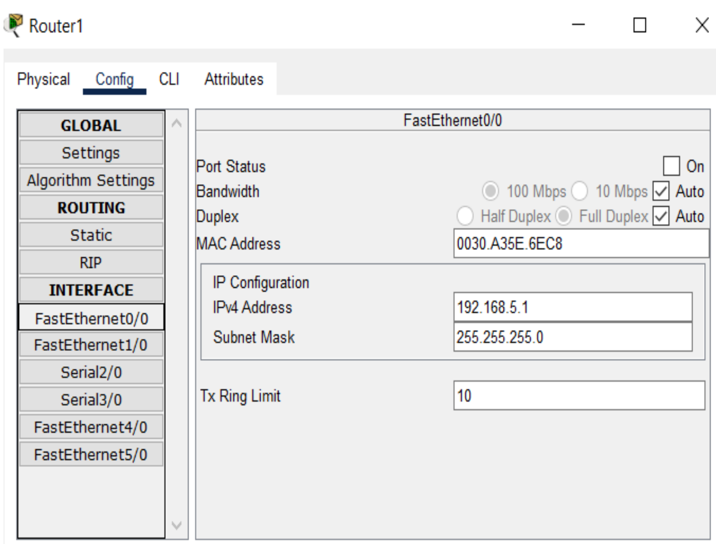

Simulation Panel
Event List
Vis. Time(sec) Last Device At Device Type
0.000 -- PC0 ICMP
0.001 PC0 Switch0 ICMP
0.002 Switch0 Router0 ICMP
0.003 Router0 Router3 ICMP
0.004 Router3 Router2 ICMP
0.005 Router2 Switch1 ICMP
0.006 Switch1 Server0 ICMP
0.007 Server0 Switch1 ICMP
0.008 Switch1 Router2 ICMP
0.009 Router2 Router3 ICMP
0.010 Router3 Router0 ICMP
0.011 Router0 Switch0 ICMP
0.012 Switch0 PC0 ICMP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FastEthernet0/0
Port Status
On
Bandwidth
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
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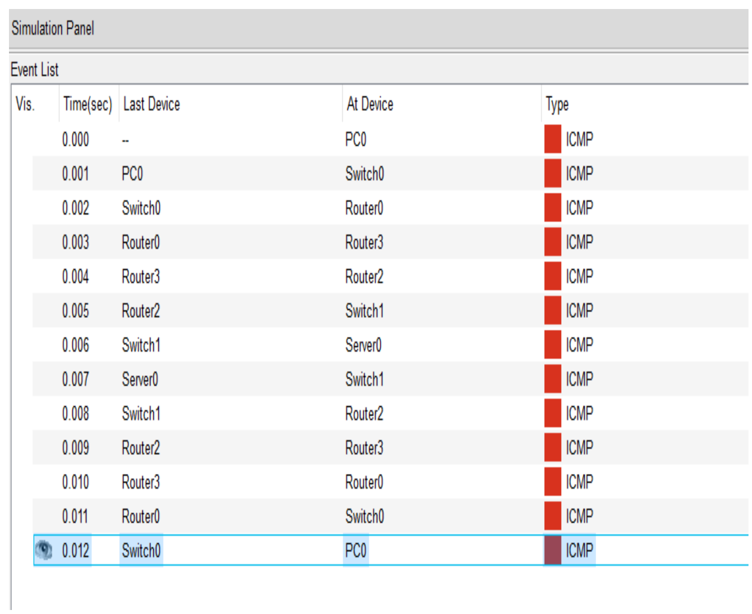
255.255.255.0
Tx Ring Limit
10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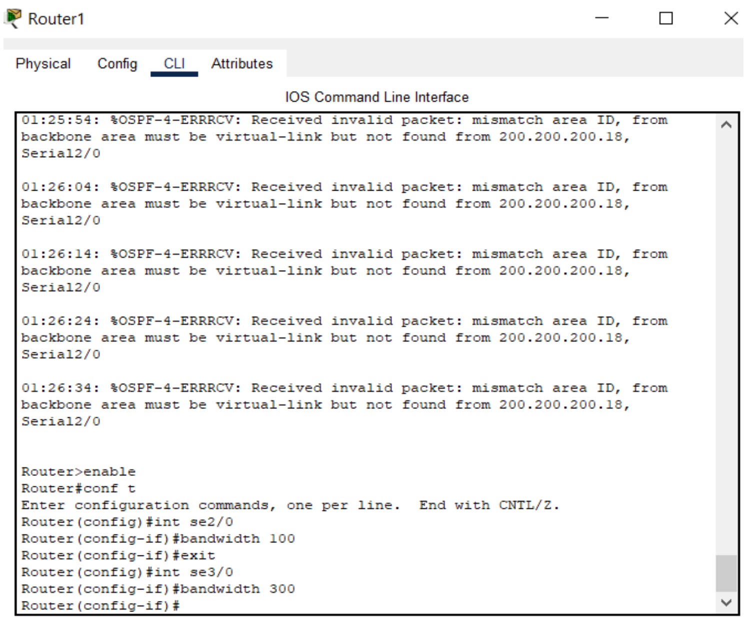
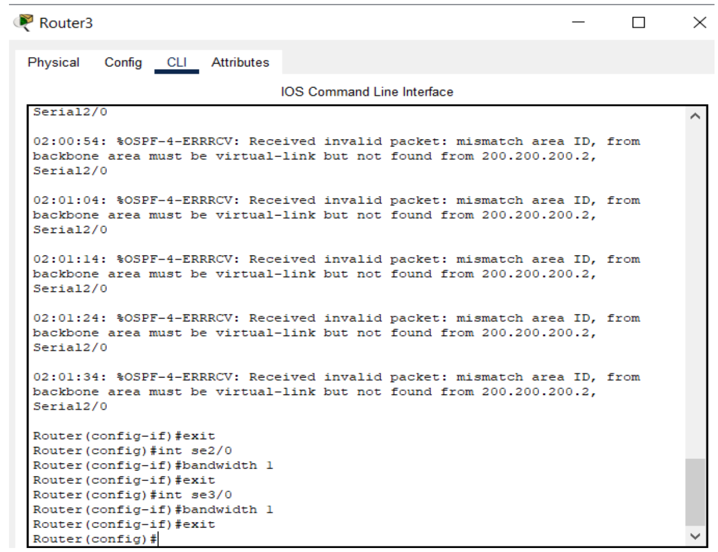
0.004 Router3 Router2 ICMP
0.005 Router2 Switch1 ICMP
0.006 Switch1 Server0 ICMP
0.007 Server0 Switch1 ICMP
0.008 Switch1 Router2 ICMP
0.009 Router2 Router3 ICMP
0.010 Router3 Router0 ICMP
0.011 Router0 Switch0 ICMP
0.012 Switch0 PC0 ICMP





Simulation Panel

Event List

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	0.001	PC0	Switch0	ICMP
	0.002	Switch0	Router0	ICMP
	0.003	Router0	Router1	ICMP
	0.004	Router1	Router2	ICMP
	0.005	Router2	Switch1	ICMP
	0.006	Switch1	Server0	ICMP
	0.007	Server0	Switch1	ICMP
	0.008	Switch1	Router2	ICMP
	0.009	Router2	Router1	ICMP
	0.010	Router1	Router0	ICMP
	0.011	Router0	Switch0	ICMP
	0.012	Switch0	PC0	ICMP

Configuration of Routers:

Router(config)#router ospf 1

Router(config-router)#network <network ID> <wildcard mask>area <area ID>

Here network id is the first three octets of the ip addresses assigned to the router's serial ports wildcard mask is the opposite of subnet mask.

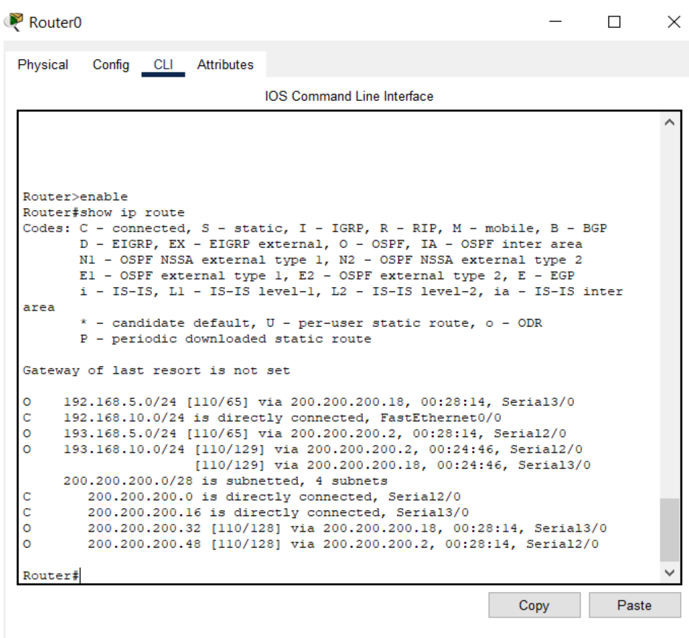
Observation:

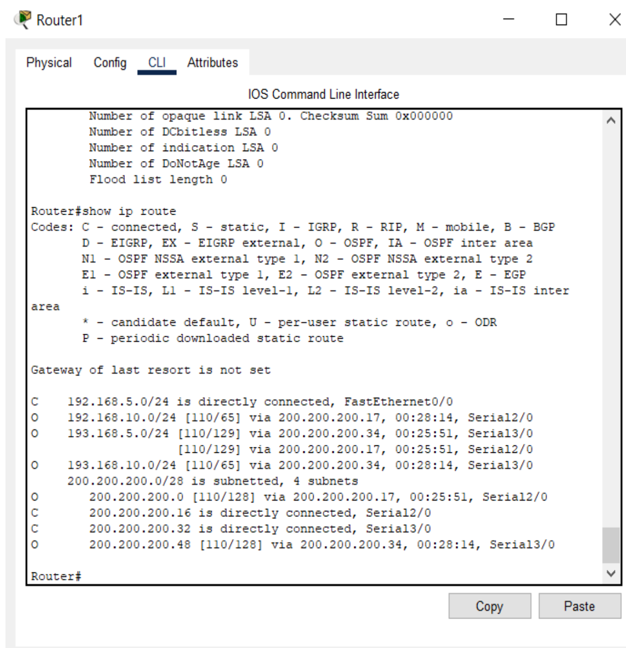
After configuring the routers and implementing OSPF, I observed that the packets sent from PC to the server were going through router1 from router 0 to router 2.

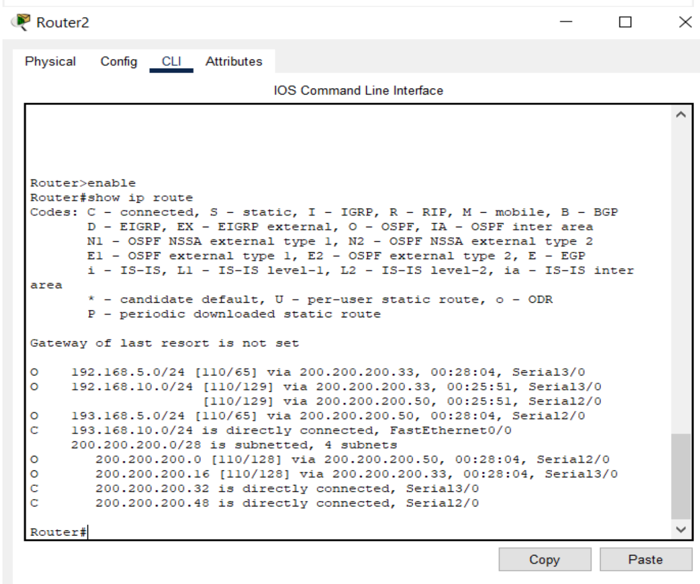
But if I shut down the fast ethernet port of router 1 or shutdown the serial ports of router 1, then the packets would go through router 3.This is the reflection of dynamic routing.

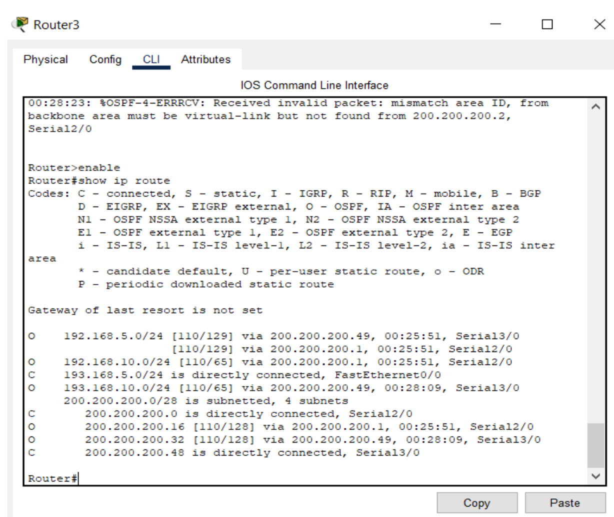
Also in OSPF, the packets take the route with lower costs. Cost is inversely proportional with bandwidth. So, reducing the bandwidth increases the costs. I turned on all the fast ethernet ports and serial ports of all the routers. Set the bandwidth of serial ports of router 3 to 1 and that of router 1 to 100 and 300. After that I observed that the packets were going through router 1 which was the route with minimum cost.

The screenshots of routing table of each router is shown below:









Challenges:

I faced some challenges while implementing OSPF as it was the first time I was implementing so. It took me a bit of time to set the bandwidth of the ports also.