Terna Engineering College

Computer Engineering Department

Program: Sem V

Course: Computer Network Lab

PART A

(PART A: TO BE REFERRED BY STUDENTS)

Experiment No. 08

A.1 Objective:

Configure Network using Link State Vector Routing protocol (OSPF).

A.2 Prerequisite:

Cisco Packet tracer / Physical Cisco Router, Physical Switch, cables

A.3 Outcome:

After successful completion of this experiment students will be able to

Explore various routing algorithms and Protocols of network layer using simulators and Physical devices.

A.4 Theory:

Open Shortest Path First (OSPF) is a link-state routing protocol which is used to find the best path between the source and the destination router using its own Shortest Path First). OSPF is developed by Internet Engineering Task Force (IETF) as one of the Interior Gateway Protocol (IGP), i.e, the protocol which aims at moving the packet within a large autonomous system or routing domain. It is a network layer protocol which works on the protocol number 89 and uses AD value 110. OSPF uses multicast address 224.0.0.5 for normal communication and 224.0.0.6 for update to designated router(DR)/Backup Designated Router (BDR).

OSPF terms –

1. **Router I'd –** It is the highest active IP address present on the router. First, the highest loopback address is considered. If no loopback is configured, then the highest active IP address on the interface of the router is considered.
2. **Router priority –** It is a 8 bit value assigned to a router operating OSPF, used to elect DR and BDR in a broadcast network.
3. **Designated Router (DR) –** It is elected to minimize the number of adjacency formed. DR distributes the LSAs to all the other routers. DR is elected in a broadcast network to which all the other routers share their DBD. In a broadcast network, router requests for an update to DR and DR will respond to that request with an update.

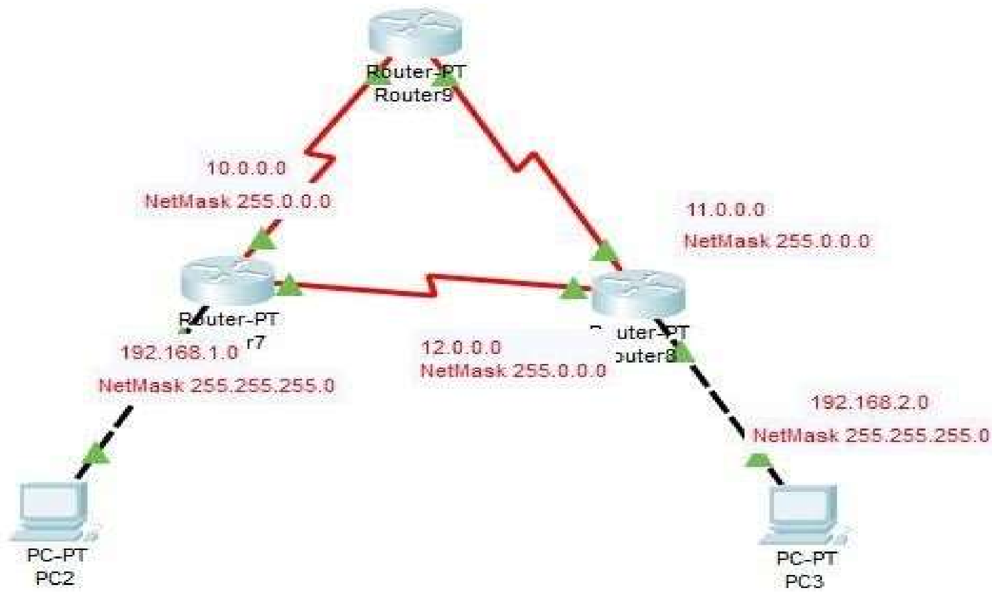
4. **Backup Designated Router (BDR) –** BDR is backup to DR in a broadcast network. When DR goes down, BDR becomes DR and performs its functions.

DR and BDR election – DR and BDR election takes place in broadcast network or multi access network. Here is the criteria for the election:

1. Routers having the highest router priority will be declared as DR.
2. If there is a tie in router priority then highest router Id will be considered. First, the highest loopback address is considered. If no loopback is configured then the highest active IP address on the interface of the router is considered.

OSPF states – The device operating OSPF goes through certain states. These states are:

1. **Down –** In this state, no hello packet have been received on the interface.
   Note – The Down state doesn't mean that the interface is physically down. Here, it means that the OSPF adjacency process has not started yet.
2. **INIT –** In this state, hello packet have been received from the other router.
3. **2WAY –** In the 2WAY state, both the routers have received the hello packets from other routers. Bidirectional connectivity has been established. **Note –** In between the 2WAY state and Exstart state, the DR and BDR election takes place.
4. **Exstart –** In this state, NULL DBD are exchanged. In this state, master and slave elections take place. The router having the higher router Id becomes the master while the other becomes the slave. This election decides which router will send its DBD first (routers who have formed a neighbor ship will take part in this election).
5. **Exchange –** In this state, the actual DBDs are exchanged.
6. **Loading –** In this state, LSR, LSU and LSA (Link State Acknowledgement) are exchanged.
   Important – When a router receives DBD from another router, it compares its own DBD with the other router DBD. If the received DBD is more updated than its own DBD then the router will send LSR to the other router stating what links are needed. The other router replies with the LSU containing the updates that are needed. In return to this, the router replies with the Link State Acknowledgement.
7. **Full –** In this state, synchronization of all the information takes place. OSPF routing can begin only after the Full state.



Sample Network Design

References:

https://www.youtube.com/watch?v=B7-7RcZCIbM

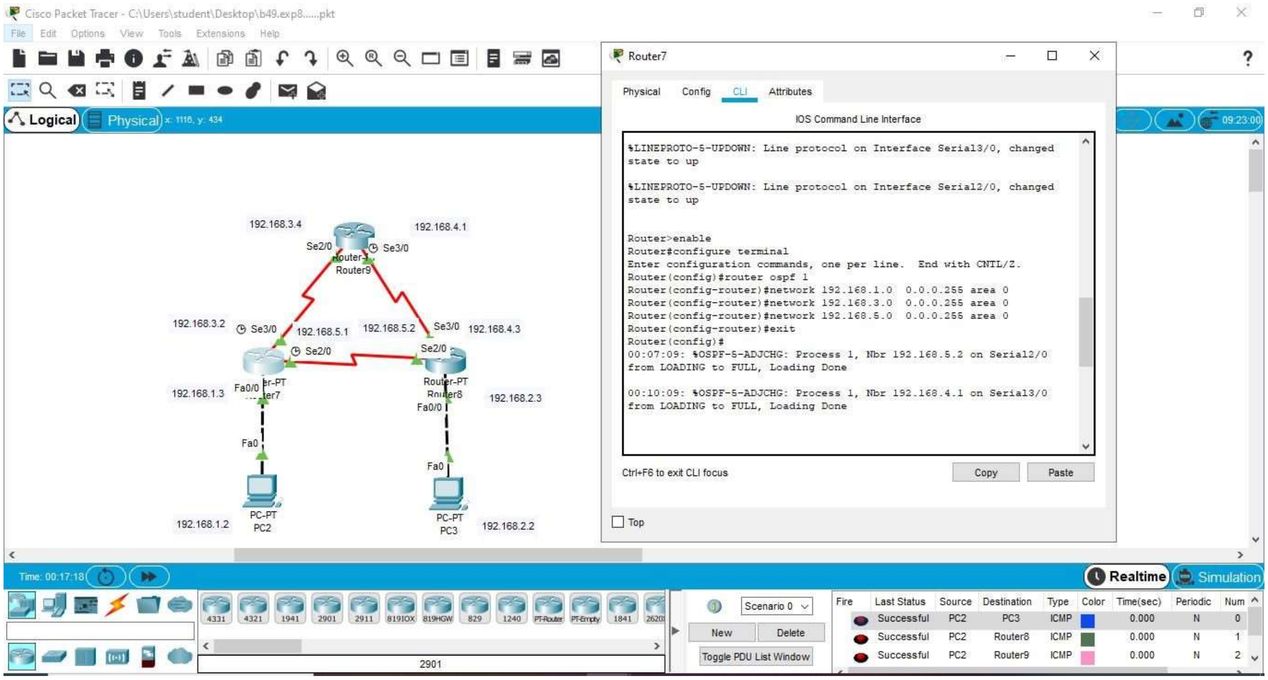
PART B

(PART B : TO BE COMPLETED BY STUDENTS)

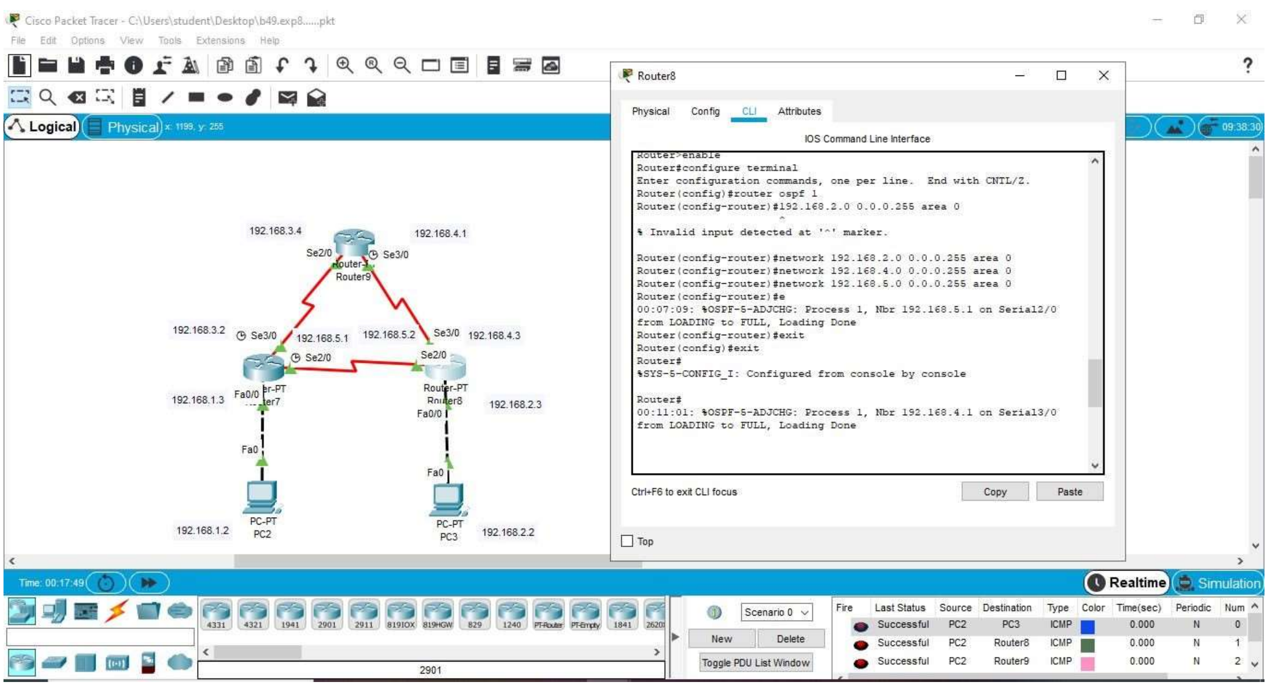
Roll No. A11	Name: Khan Mohammad TAQI Karrar Husain
Class : T.E A	Batch : A1
Date of Experiment:	Date of Submission:
Grade :	

B.1 Document created by the student:

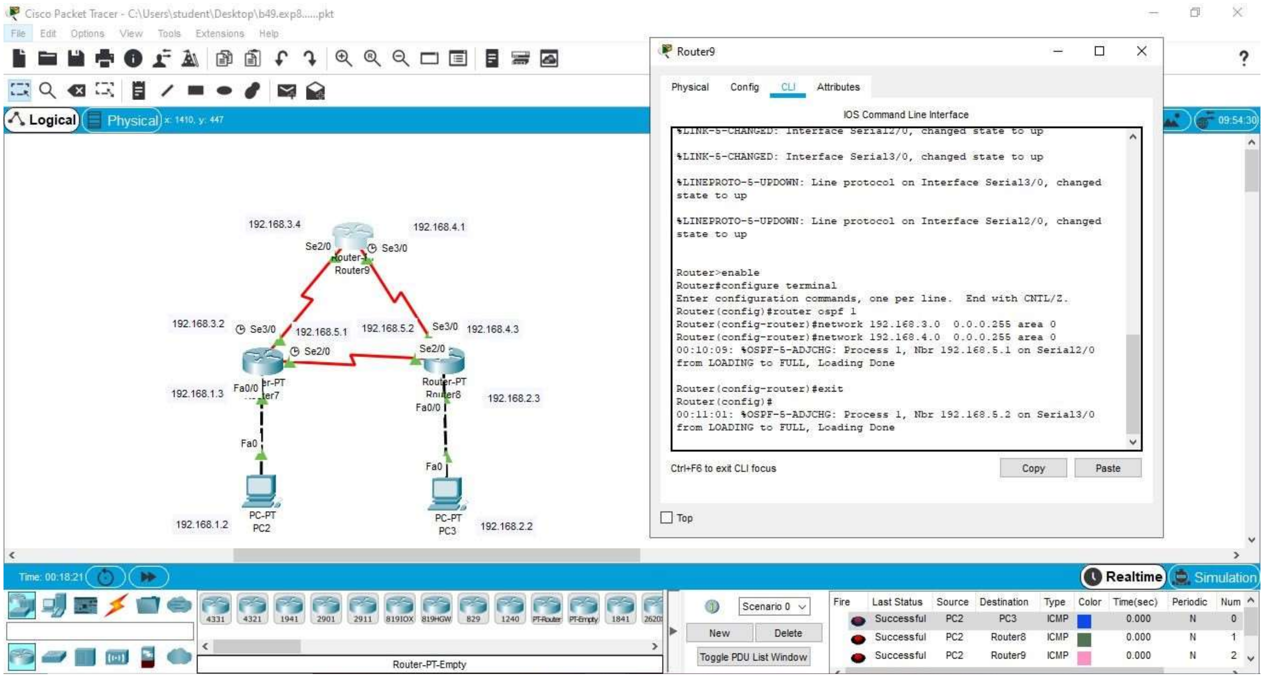
Router 7:



Router 8:



Router 9:

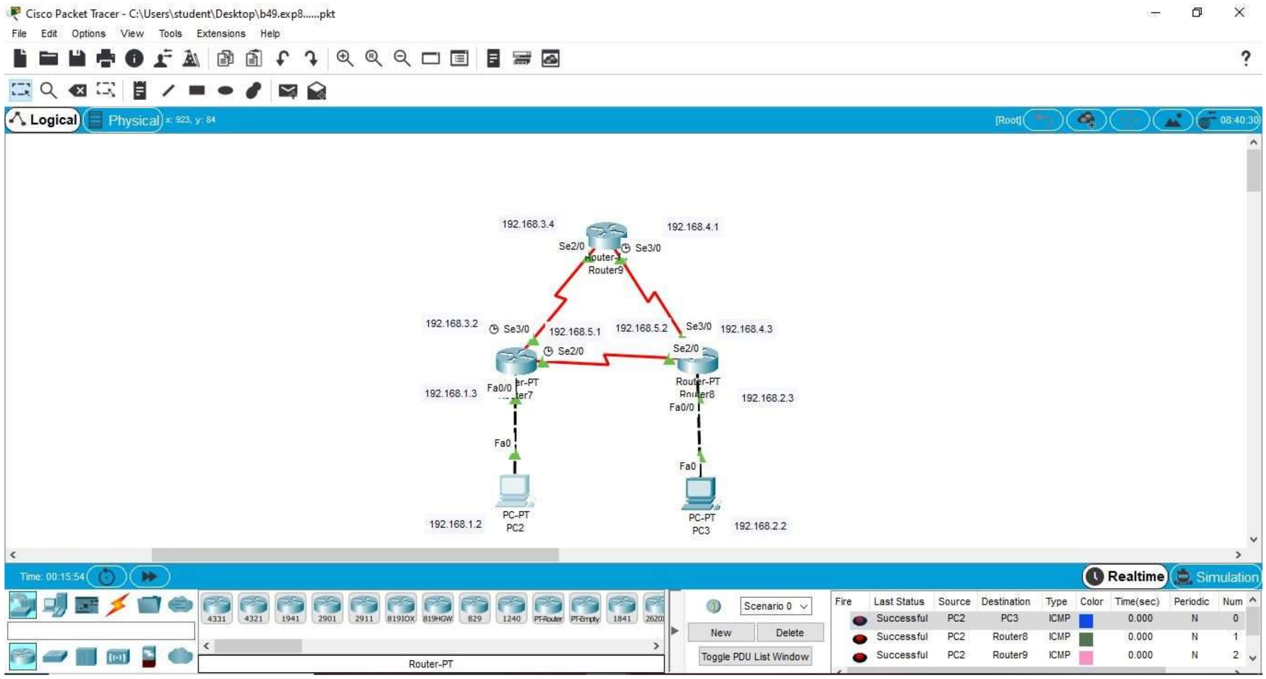


B.3 Observations and learning:

B.3.1 Interface Configuration table:

SNO.	NAME OF THE DEVICE	INTERFACE	IP ADDRESS	SUBNET MASK	DEFAULT GATEWAY
1	PC 2	FastEthernet 0	192.168.1.2	255.255.255.0	192.168.1.3
2	Router 7	FastEthernet 0/0	192.168.1.3	255.255.255.0	N/A
		Serial2/0	192.168.5.1	255.255.255.0	N/A
		Serial3/0	192.168.3.2	255.255.255.0	N/A
3	Router 8	FastEthernet 0/0	192.168.2.3	255.255.255.0	N/A
		Serial2/0	192.168.5.2	255.255.255.0	N/A
		Serial3/0	192.168.4.3	255.255.255.0	N/A
4	Router 9	Serial2/0	192.168.3.4	255.255.255.0	N/A
		Serial3/0	192.168.4.1	255.255.255.0	N/A
5	PC 3	FastEthernet 0	192.168.2.2	255.255.255.0	192.168.2.3

B.3.2 Design:



B.4 Conclusion:

The choice to use a Link State Vector Routing protocol would depend on the specific requirements of the network and its size. These protocols offer advantages in terms of accuracy and convergence but come with increased complexity and resource demands. It's essential to consider the network's size, the availability of resources, and the expertise of the network administrators when selecting a routing protocol.

B.5 Question of Curiosity:

Q1: What is the backbone area?

Answer: In the context of routing protocols like OSPF (Open Shortest Path First), a backbone area, often referred to as Area 0, is a central and essential part of the network topology. OSPF is a link-state routing protocol used in IP networks, and it divides large networks into smaller areas or domains to improve routing efficiency and scalability. The backbone area plays a critical role in OSPF routing:

1. Central Routing Domain: The backbone area, usually denoted as Area 0, is the central routing domain to which all other OSPF areas are connected. It serves as the core of the OSPF network.

2. Interconnecting Areas: OSPF divides a large network into multiple areas, each of which has its own routing information. These areas are interconnected through the backbone area. All traffic between different areas passes through the backbone area, making it the transit area for inter-area routing.

3. Scalability: By using areas and a backbone area, OSPF improves network scalability. Instead of having every router maintain information about every route in the entire network, routers in non-backbone areas only need to know about routes within their own area and the routes to reach the backbone area. This reduces the size of routing tables and the amount of routing information that needs to be exchanged.

4. Hierarchical Routing: The use of a backbone area creates a hierarchical routing structure. This hierarchy simplifies routing calculations and reduces the overhead associated with routing updates. It also enables easier management of the network as it grows.

5. Network Design Flexibility: OSPF allows network administrators to design their networks with multiple areas and choose how they want to connect those areas to the backbone. This flexibility allows for efficient use of resources and optimized routing.

6. Stability: The backbone area is often designed to be highly stable and reliable. It typically contains core routers that are well-maintained and have redundant connections to ensure network stability and minimal downtime.

In summary, a backbone area in OSPF is a central routing domain that connects multiple OSPF areas within a larger network. It provides a hierarchical and scalable structure, improving routing efficiency and simplifying network management. OSPF routers in non-backbone areas route their traffic through the backbone area, which serves as the transit area for inter-area routing.

Q2: What are the different tables maintained by OSPF?

Answer: OSPF (Open Shortest Path First) is a link-state routing protocol that maintains several tables to facilitate efficient routing and decision-making. The primary tables maintained by OSPF include:

1. Neighbor Table (Neighbor Database): This table maintains information about neighboring OSPF routers. It includes details such as the router's ID, IP address, and the state of the OSPF relationship. The Neighbor Table helps OSPF routers establish and monitor adjacencies with their neighbors.

2. Topology Database (Link-State Database): The Topology Database stores all the Link-State Advertisements (LSAs) received from OSPF routers within the same area. LSAs contain information about the state of links and routers in the OSPF network. The Topology Database is used to calculate the SPF (Shortest Path First) tree, which forms the basis for OSPF routing calculations.

3. Routing Table (Forwarding Database): The Routing Table contains the best routes to reach various destinations within the OSPF routing domain. OSPF routers use the SPF tree calculation to determine the best paths to reach these destinations, and the results are stored in the Routing Table. It is sometimes referred to as the Forwarding Database because it is used for forwarding packets.

4. Neighbor State Table (Adjacency Table): This table maintains the state information for OSPF neighbor relationships. It tracks the state transitions of OSPF neighbors as they progress from initialization to full adjacency. Common states include Down, Init, Exstart, Exchange, Loading, and Full.

5. Area Table (Area Database): OSPF routers maintain a table that contains information about the OSPF areas they belong to. This table helps routers determine which LSAs to flood within their area and which LSAs to advertise to routers in other areas. The Area Table is essential for maintaining area-specific LSAs.

6. Virtual Link Table: In cases where the OSPF backbone area (Area 0) is not contiguous, OSPF routers may use virtual links to connect disjoint parts of the backbone. The Virtual Link Table contains information about these virtual links, including their configuration and status.

7. External Routing Table (AS-External Database): OSPF routers that participate in OSPF's AS-External (Type 5) LSAs maintain a table to store information about routes external to the OSPF domain, such as routes learned from other routing protocols or redistributed routes. The External Routing Table helps routers determine how to reach external destinations.

Q 3: How are DR and BR elected?

Answer: In OSPF (Open Shortest Path First) networks, the terms DR (Designated Router) and BDR (Backup Designated Router) are used in multi-access network segments (such as Ethernet LANs) to reduce the amount of routing overhead and control the flooding of Link-State Advertisements (LSAs). The DR and BDR are elected through a process to ensure network stability and efficiency. Here's how they are elected:

1. Neighbor Discovery: When OSPF routers on a multi-access network segment first come up or detect a change in the network, they form OSPF neighbor adjacencies with each other. These routers become neighbors.

2. Router Priority: Each router on the segment is assigned a priority value. The default priority is 1, but it can be configured to a higher value (up to 255) on routers that should have a better chance of becoming the DR or BDR. Routers with higher priorities have a greater chance of winning the elections.

3. Router ID: OSPF routers use their Router IDs to identify themselves. The Router ID can be manually configured or automatically assigned. The Router ID is a 32- bit number that uniquely identifies each router in the OSPF domain.

4. Election Process:

- **DR Election:** Initially, all routers on the segment compete to become the DR. The router with the highest priority wins. If two or more routers have the same priority, the router with the highest Router ID becomes the DR. The DR is responsible for generating and forwarding LSAs on behalf of the segment.
- **BDR Election:** After the DR is elected, the routers that didn't become the DR compete to become the BDR. The BDR serves as a backup to the DR and takes over if the DR fails. The BDR is selected using the same criteria as the DR— priority first and then Router ID.

5. DR and BDR Functions:

- **DR:** The Designated Router is responsible for originating LSAs and forwarding them to all other routers on the segment. This reduces the amount of LSA flooding and minimizes the control traffic on the segment.
- **BDR:** The Backup Designated Router is ready to take over as the DR if the current DR fails. The BDR receives all LSAs and ensures it has an up-to-date copy of the LSDB (Link-State Database) so that it can quickly assume the role of the DR in case of failure.

In summary, the DR and BDR in OSPF are elected based on priority values and, if necessary, Router IDs. The DR and BDR reduce the amount of routing overhead on multi-access network segments and help maintain network stability by ensuring that only a select few routers participate actively in generating LSAs and controlling network changes.

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