Experiment No: 2	
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Title	Different types of topologies in computer networks
Theory (short)	The term "topology" typically refers to the arrangement or layout of various elements within a computer network. This includes how different nodes (such as computers, servers, and devices) are interconnected and how they communicate with each other. The main types of network topologies are: 1) **Bus Topology**: In a bus topology, all devices are connected to a single central cable, known as the bus. Data sent by one device is available to all other devices on the network. It's simple and inexpensive but can become slow and inefficient as the network grows. 2) **Star Topology**: This topology features a central hub or switch to which all nodes are connected. The hub acts as a repeater for data flow. Star topology is easy to manage and troubleshoot but relies heavily on the central hub, making it a single point of failure. 3) **Ring Topology**: In a ring topology, each device is connected to two other devices, forming a circular data path. Data travels in one direction (or both directions in a dual ring). This topology can offer good performance but can be disrupted if any single connection fails. 4) **Mesh Topology**: This topology involves each node being connected to every other node in the network. It provides high redundancy and reliability, as there are multiple paths for data to travel. However, it's complex and expensive to implement due to the large number of connections. 5) **Tree Topology**: Also known as a hierarchical topology, this combines characteristics of star and bus topologies. It has a root node and all other nodes are connected in a hierarchical manner. It's scalable and easy to manage but depends on the main bus cable. 6) **Hybrid Topology**: This topology is a combination of two or more different types of topologies. It leverages the strengths of each included topology and is used to meet the specific needs of large and complex networks.

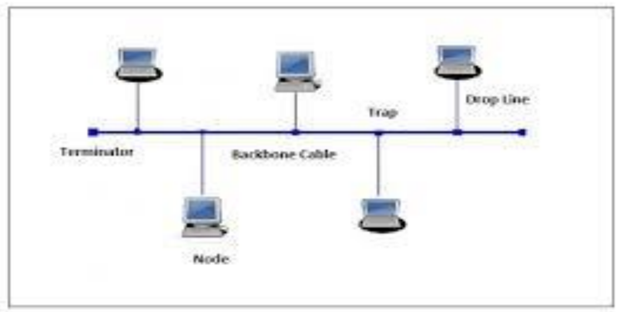

Figure 1: Bus Topology

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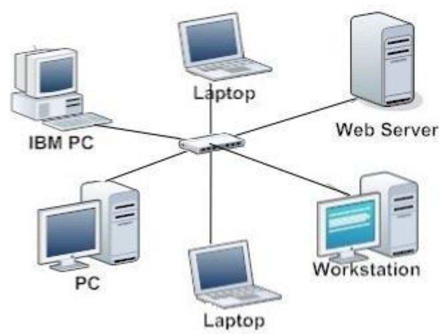


Figure 2: Star topology

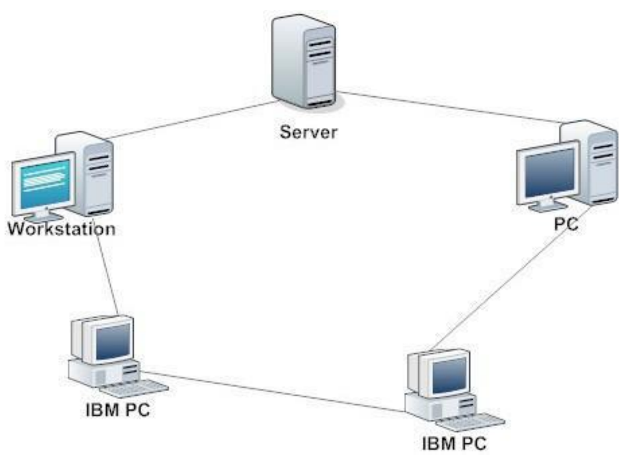


Figure 3: Ring topology

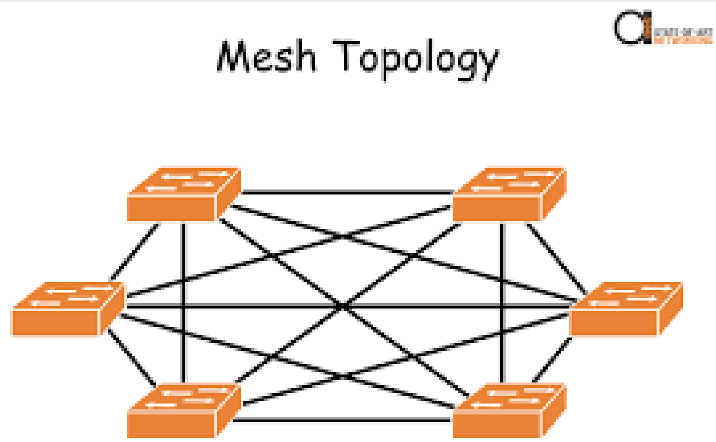


Figure 4: Mesh topology

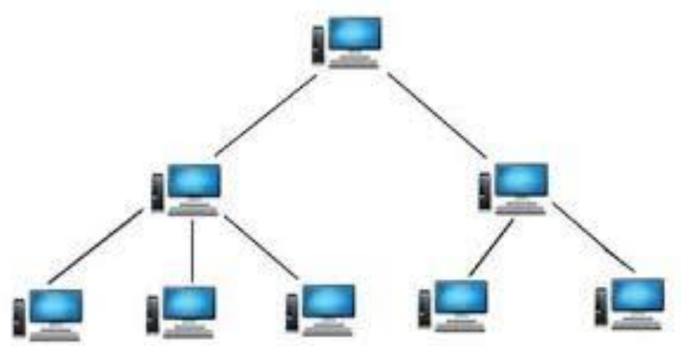


Figure 5: Tree topology

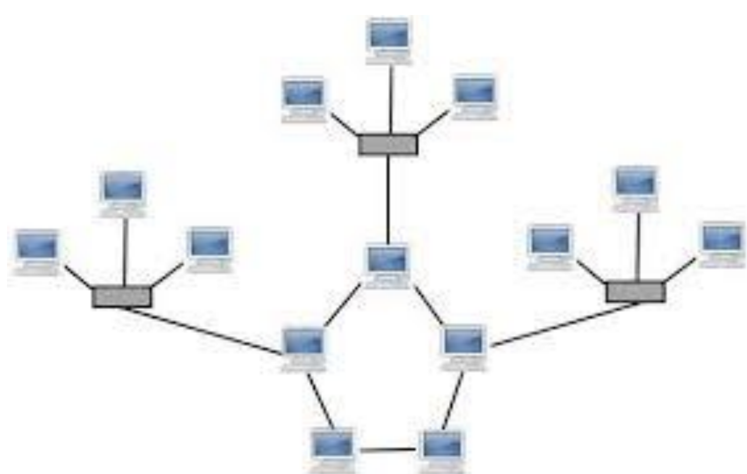
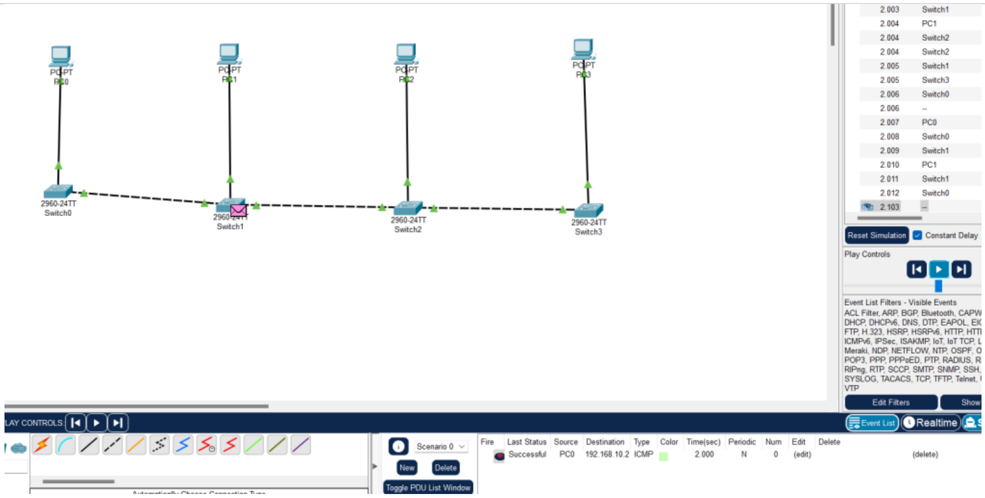
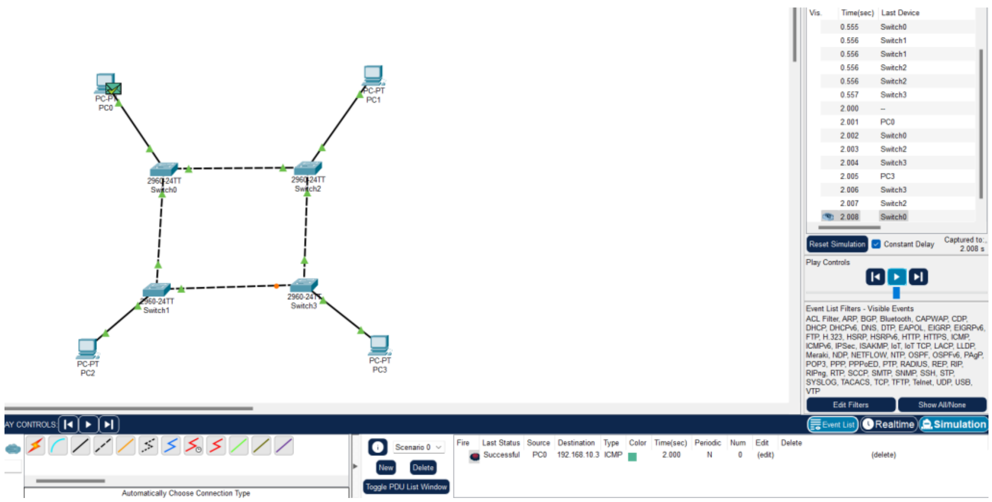
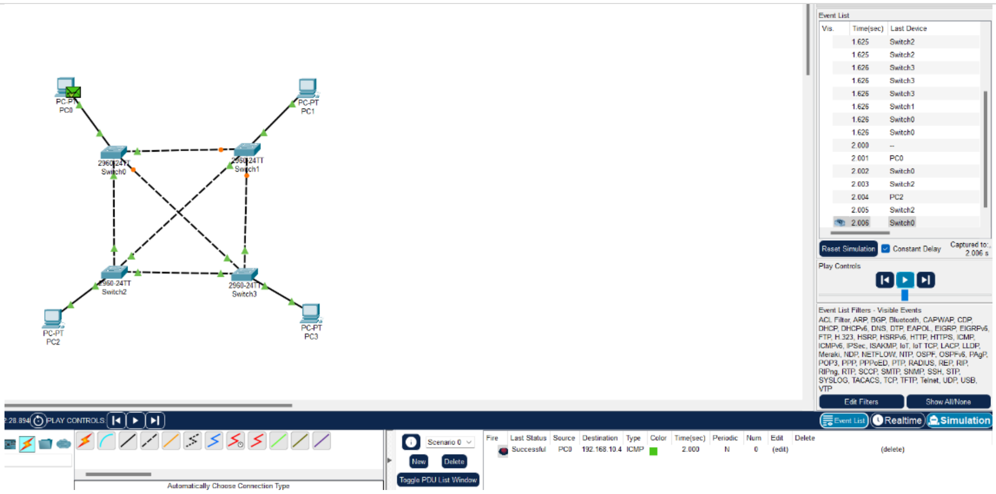
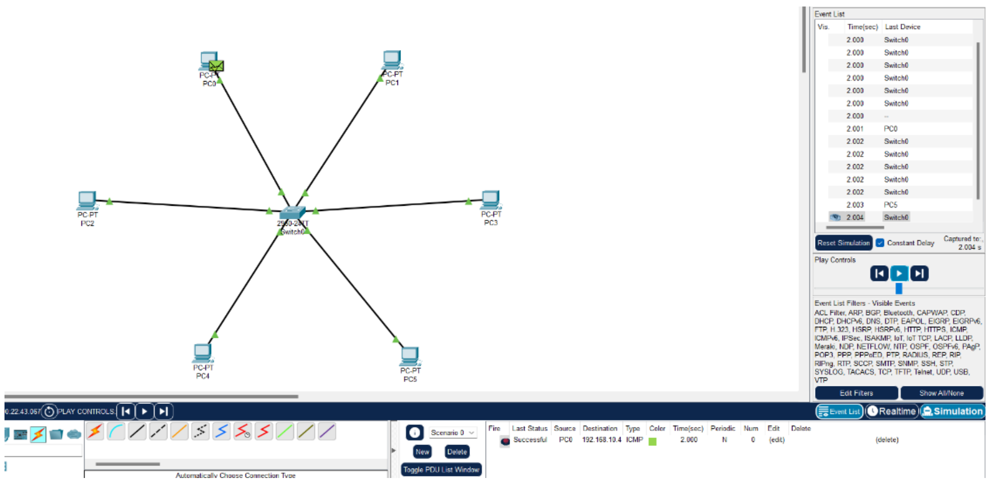


Figure 6: Hybrid topology

Procedure	**Step-by-Step Procedure:**
	1. **Open Cisco Packet Tracer:**
	    o Launch Cisco Packet Tracer on your computer.
	2. **Add Devices:**
	    o Drag and drop the required number of PCs from the Device-Type Selection box to the workspace. For example, add five PCs.
	3. **Add a Switch:**
	    o From the Device-Type Selection box, drag and drop a switch to the workspace. The switch will act as the central bus in this simulation.
	4. **Connect Devices:**
	    o Use the "Copper Straight-Through" cable to connect each PC to the switch. Click on a PC, select the "FastEthernet" port, and then click on the switch to connect it to one of the switch's ports.
	    o Repeat this step for all PCs.
	5. **Assign IP Addresses:**
	    o Click on each PC, go to the "Desktop" tab, and then click on "IP Configuration."
	    o Assign a unique IP address to each PC within the same subnet. For example:
	        ▪ PC1: IP Address: 192.168.1.1, Subnet Mask: 255.255.255.0
	        ▪ PC2: IP Address: 192.168.1.2, Subnet Mask: 255.255.255.0
	        ▪ PC3: IP Address: 192.168.1.3, Subnet Mask: 255.255.255.0
	        ▪ PC4: IP Address: 192.168.1.4, Subnet Mask: 255.255.255.0
	        ▪ PC5: IP Address: 192.168.1.5, Subnet Mask: 255.255.255.0
	6. **Test Connectivity:**

	- Use the "Add Simple PDU" tool to send a ping from one PC to another to ensure connectivity. - Click on the "Add Simple PDU" icon (the envelope icon), then click on the source PC and the destination PC to send a ping. - Verify that the ping is successful by checking the response in the simulation window. 7. **Simulation Mode:** - Switch to "Simulation Mode" to view the data packets being sent between the PCs. - Click on "Auto Capture / Play" to observe how packets travel from one PC to another through the switch. Now this is to be done for every connection. Make sure to refer to the images given in the theory section to see how all the end devices are connected to each other in different topologies. However for this assignment, only bus, ring, star and mesh are to be used.

Output Screenshots	 

	 
Observation	In all the screenshots, we noticed that all the topologies have given a green signal for successful connections. This means the messages sent from one end device to another in all topologies are valid connections.
Self-assessment Q&A	Answer 1: The possible reasons would include wrong connection type or the wrong port which is used to connect the routers or switches. Its also quite possible if 2 end devices have the same IP address. Its better to check the IPv4 address of every device in the topology to ensure that there is no issue with the delivery of the messages Answer 2: In a bus topology, all devices are connected to a single central cable (the bus). The characteristics of fault tolerance in a bus topology include:

	1. **Single Point of Failure:**
	    o The central bus cable is a single point of failure. If the bus cable fails, the entire network becomes inoperable, and all devices lose connectivity.
	2. **Device Failure:**
	    o If a device connected to the bus fails, it generally does not affect the connectivity of other devices. However, a fault in the bus itself will disrupt communication for all connected devices.
	3. **Troubleshooting:**
	    o Troubleshooting can be challenging because identifying the exact point of failure in the bus can be difficult. If the bus cable has an issue, all devices connected to it are affected.
	
	In a mesh topology, every device is connected to every other device. The characteristics of fault tolerance in a mesh topology include:
	1. **Redundancy:**
	    o Mesh topology offers high redundancy. Each device has multiple paths to communicate with any other device, so the failure of one connection or device does not necessarily disrupt the entire network.
	2. **Resilience to Failures:**
	    o The network can continue to operate even if multiple connections fail. The multiple paths ensure that data can be rerouted through other available connections, making the network highly resilient to failures.
	3. **Troubleshooting:**
	    o Identifying and resolving issues in a mesh network can be complex due to the many interconnections. However, the impact of a failure is localized, and the network as a whole remains operational.
	
	Resilience to Failures:
	Bus Topology:
	• **Resilience Level:** Low
	• **Reason:** The bus topology is not resilient to failures due to its single point of failure, the central bus cable. Any fault in this cable can bring down the entire network, affecting all connected devices.
	Mesh Topology:
	• **Resilience Level:** High
	• **Reason:** The mesh topology is highly resilient to failures. With multiple paths between devices, the network can withstand multiple connection failures without significant impact on

overall connectivity. Data can always find an alternate route to reach its destination.

Answer 3:

Bus Topology:

In a bus topology, all devices are connected to a single central cable (the bus). The scalability characteristics of a bus topology include:

1. **Adding Devices:**
   - Adding new devices to a bus topology involves connecting them to the central bus cable.
   - As more devices are added, the bus cable can become a bottleneck because it has a finite capacity for handling traffic.
2. **Signal Degradation:**
   - With an increasing number of devices, the signal on the bus cable may degrade, leading to increased collisions and network inefficiency.
   - The maximum length of the bus cable is limited by signal attenuation, which restricts the number of devices and the physical distance they can be spread over.
3. **Network Performance:**
   - As the number of devices increases, the likelihood of data collisions on the bus increases, which can significantly reduce network performance.
   - The bus topology's performance deteriorates with high traffic because all devices share the same communication medium.
4. **Maintenance and Troubleshooting:**
   - With more devices, maintenance and troubleshooting become more challenging as each additional device increases the complexity of identifying faults in the bus cable.

Mesh Topology:

In a mesh topology, each device is connected to every other device. The scalability characteristics of a mesh topology include:

1. **Adding Devices:**
   - Adding a new device to a mesh topology involves creating connections to all other devices in the network.
   - This ensures that the network maintains its redundancy and fault tolerance but also increases the number of connections exponentially.
2. **Network Complexity:**
   - The number of connections required in a full mesh topology grows quadratically with the number of devices. Specifically, for nnn devices, the number of connections needed is n(n−1)2\frac{n(n-1)}{2}2n(n−1).

- This exponential growth in connections can lead to significant complexity in terms of cabling, configuration, and management.

3. **Hardware and Cost:**
    - Each device in a mesh topology requires multiple network interfaces to handle all the connections, increasing hardware costs.
    - The cost and effort to install and maintain a mesh topology rise significantly as more devices are added.
4. **Performance and Load Balancing:**
    - Despite the complexity, a mesh topology can handle high traffic loads effectively due to its multiple pathways for data transmission.
    - Load balancing can be optimized because data can take various paths to reach its destination, reducing the likelihood of congestion.

Factors Limiting Scalability:
Bus Topology:

1. **Signal Attenuation:**
    - The length of the bus cable is limited by signal attenuation, which affects the distance over which devices can be spread and the total number of devices that can be connected.
2. **Data Collisions:**
    - With more devices, data collisions become more frequent, reducing network efficiency and performance.
3. **Cable Limitations:**
    - The physical and practical limits of the bus cable, such as maximum length and signal degradation, restrict scalability.
4. **Centralized Medium:**
    - Since all devices share the same communication medium, the bus topology becomes increasingly inefficient with higher traffic volumes.

Mesh Topology:

1. **Connection Complexity:**
    - The requirement to connect each device to every other device leads to an exponential increase in connections, making the network difficult to manage as it grows.
2. **Cost:**
    - The cost of additional hardware, cabling, and maintenance increases significantly with the number of devices.
3. **Configuration and Management:**

- Managing a large number of connections and ensuring proper configuration can become overwhelming as the network expands.

4. **Physical Space:**
    - The physical space required to accommodate all the connections and cabling can become impractical in very large networks.

Answer 4:

Star Topology:

In a star topology, all devices are connected to a central hub or switch. The scalability characteristics of a star topology include:

1. **Adding Devices:**
    - Adding new devices is straightforward. Each new device is connected to the central hub or switch via a dedicated cable.
    - The hub or switch must have enough ports to accommodate new devices.
2. **Central Hub Dependency:**
    - The central hub or switch is a single point of failure. If it fails, the entire network goes down.
    - However, this dependency also means that network management is centralized, making it easier to monitor and troubleshoot.
3. **Network Performance:**
    - The performance of the network can be high since each device has a dedicated connection to the hub or switch, minimizing collisions.
    - Performance can degrade if the central hub or switch is overwhelmed by the traffic.
4. **Expansion Limits:**
    - The scalability is limited by the number of available ports on the hub or switch.
    - Upgrading to a larger hub or switch can mitigate this limitation but involves additional cost and effort.

Ring Topology:

In a ring topology, each device is connected to two other devices, forming a circular data path. The scalability characteristics of a ring topology include:

1. **Adding Devices:**
    - Adding new devices involves breaking the ring temporarily and inserting the new device into the ring.
    - This can be disruptive and requires careful management to ensure the ring is re-established correctly.
2. **Data Transmission:**

- Data travels in one direction (or both directions in a dual ring). The time it takes for data to travel increases with the number of devices, which can affect performance.
- Each device acts as a repeater, regenerating the signal as it passes through, which can help maintain signal strength.

3. **Network Performance:**
   - Performance can degrade as more devices are added due to increased transmission times and the potential for more collisions if multiple devices attempt to send data simultaneously.
   - Dual ring topologies can improve performance and fault tolerance but add complexity.
4. **Fault Tolerance:**
   - A single break in the ring can disrupt the entire network. Dual ring configurations can provide redundancy, allowing data to be rerouted in the opposite direction if a break occurs.

Factors Limiting Scalability:
Star Topology:

1. **Port Availability:**
   - The number of available ports on the central hub or switch is a primary limiting factor.
   - Once all ports are used, additional hubs or switches are needed, which can complicate network management.
2. **Central Hub Capacity:**
   - The central hub or switch must be capable of handling the increased traffic as more devices are added.
   - High traffic can lead to congestion and degraded performance if the hub or switch is not powerful enough.
3. **Physical Cable Length:**
   - The length of the cables connecting devices to the hub or switch is limited by the maximum allowable distance for the chosen cabling standard (e.g., Ethernet).
4. **Cost:**
   - Upgrading to larger hubs or switches and managing more extensive cabling can increase costs.

Ring Topology:

1. **Latency and Transmission Time:**
   - As the number of devices increases, the time it takes for data to travel around the ring increases, which can impact performance.
   - Increased latency can be problematic for time-sensitive applications.
2. **Complexity of Adding Devices:**

	◦ Adding or removing devices requires breaking and re-establishing the ring, which can be disruptive and complex to manage. 3. **Single Point of Failure:** ◦ A single break in the ring can disrupt the entire network. Dual ring configurations can mitigate this but add complexity and cost. 4. **Cost:** ◦ Implementing dual ring topologies to improve fault tolerance increases the cost and complexity of the network.
Conclusion	This experiment shows us the different types of topologies being used and how they can be beneficial in different connection scenarios. It also gives us practical training in Cisco packet tracer where we make the connections on our own and try to debug the problems if any.