**ATHUL S** **AM.EN.U4ECE22011**

# Computer Network Assignment

**1. Tree Topology:**

**Definition:**
Tree topology is a combination of star and bus topologies. It is structured like a tree, where groups of star-configured networks are connected to a linear bus backbone.

**Advantages:**

- Scalable: Easy to expand by adding new nodes.
- Hierarchical: Allows better management and error detection.
- Fault isolation is easier compared to bus topology.

**Disadvantages:**

- Backbone dependency: If the backbone fails, the entire network is affected.
- Complex wiring compared to simpler topologies.
- Higher maintenance cost.

**Applications:**

- Large organizations like universities and hospitals.
- WAN (Wide Area Network) environments.
- Network structures needing hierarchical control.

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**2. Star Topology:**

**Definition:**
In a star topology, all nodes (computers, printers, etc.) are individually connected to a central hub or switch.

**Advantages:**

- Easy to install and manage.
- Failure of one node does not affect the others.
- Easy to detect faults and remove parts without disturbing the network.

**Disadvantages:**

- Central hub failure will bring down the entire network.
- Requires more cable length than some other topologies.
- Higher installation costs due to more cabling and equipment.

**Applications:**

- Office networks.
- Home networks (using Wi-Fi routers).
- Banking systems and ATM networks.

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**3. Ring Topology:**

**Definition:**
In ring topology, each device is connected to exactly two other devices, forming a circular pathway for signals.

**Advantages:**

- Data flows in one direction, reducing chances of packet collisions.
- Easy to manage and expand (with token-passing protocols like Token Ring).
- Performance is better under heavy load compared to bus topology.

**Disadvantages:**

- A failure in any cable or device can disrupt the entire network.
- Troubleshooting is difficult compared to star topology.
- Adding or removing devices can interrupt the network.

**Applications:**

- Metropolitan Area Networks (MAN).
- FDDI (Fibre Distributed Data Interface) networks.
- Some types of LANs that require predictable performance.

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**4.Bus Topology:**

**Definition:** In a bus network topology, all devices (nodes) are connected to a single central cable, called the "bus," which acts as a shared communication medium. Data sent by one device is broadcast to all devices on the network, but only the intended recipient accepts and processes the data.

- All devices are connected to a single central cable (the bus).
- Data flows along this shared medium in both directions.
- No centralized device like a router is necessary, but terminators are placed at both ends of the bus to prevent data from bouncing back.

**Working Principle:** Each device in the network sends data along the bus. The data travels in both directions and is picked up by every device. Only the device with the matching address processes the data, while others ignore it.

**Advantages:**

- **Simple and Cost-Effective:** Easy to implement with minimal cables and hardware.
- **Easy to Expand:** New devices can be added easily without disturbing the existing setup.
- **Good for Small Networks:** Works well in smaller, low-traffic environments.

**Disadvantages:**

- **Traffic Congestion:** Since all devices share the same communication medium, network traffic can quickly become congested.
- **Single Point of Failure:** If the bus cable breaks or a terminator fails, the whole network goes down.
- **Limited Scalability:** Performance degrades as more devices are added, and the bus becomes more congested.

**Applications:**

- Small office networks or temporary setups.
- Legacy systems still using bus topologies.

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**5.Mesh Topology:**

**Definition:** In a mesh network topology, every device is directly connected to every other device in the network. This creates a redundant and highly fault-tolerant network, as multiple paths are available for data to travel.

- Each device has a point-to-point connection to every other device in the network.
- This creates a fully connected web of devices, where multiple direct paths exist between any two devices.

**Working Principle:** Data can travel across multiple paths, ensuring that even if one link fails, data can still reach its destination via another path. Mesh topology can be fully connected, where every device is linked to every other device, or partially connected, with only some devices directly connected to others.

**Advantages:**

- **Fault Tolerance:** If one link fails, there are always other paths for data to travel.
- **Scalability:** New devices can be added without affecting the existing network too much.
- **High Reliability:** The redundancy of connections ensures continuous communication, making it ideal for mission-critical systems.

**Disadvantages:**

- **Complex and Expensive:** Requires a lot of cabling and hardware to create direct connections between every device.

- **Difficult to Manage:** As the network grows, managing the connections becomes increasingly difficult.
- **High Maintenance:** More devices and connections require more effort to maintain.

**Applications:**

- Large-scale networks requiring high uptime, such as data centers, telecommunications, and military networks.
- Systems that require high fault tolerance and reliability.

**6.Combined Topology with Single Router:**

**Definition:**
In a combined network topology, multiple basic topologies (Tree, Star, and Ring) are interconnected via a central router.
The router acts as the main control unit, handling communication between different parts of the network, regardless of their internal structure.

- **Center:** A single router.
- **Connected to router:**
  - One branch has a **Tree topology** structure.
  - Another branch has a **Star topology** structure.
  - Another branch has a **Ring topology** structure.

(Imagine the router in the center, with three different topology "zones" hanging off it.)

**Working Principle:**
Each topology (Tree, Star, Ring) manages communication within its own structure. The router provides a bridge between them, enabling devices from different topologies to communicate with each other.

**Advantages:**

- **Flexibility:** Different departments or use-cases can choose the most suitable topology while staying connected.
- **Scalability:** New topologies can be added easily through the router.
- **Centralized Control:** Router manages traffic efficiently, supporting complex communication patterns.
- **Optimized Performance:** Each topology can handle specific loads while overall traffic is managed by the router.

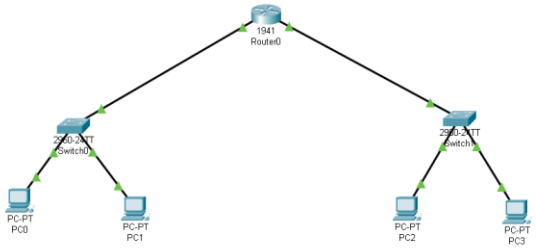
**Disadvantages:**

- **Router Dependency:** Failure of the router affects the entire interconnected system.
- **Higher Cost:** More expensive than single-topology networks due to the router and mixed cabling needs.
- **Complex Management:** Requires careful planning and management to avoid bottlenecks and failures.

## Applications:

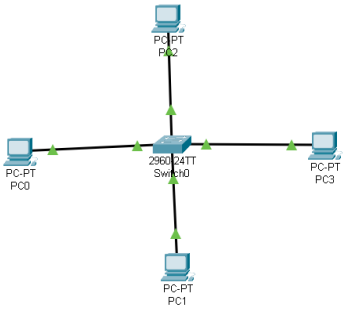
- **University Campuses:** Different departments may use different topologies but stay connected via the central router.
- **Corporate Networks:** Offices with different requirements (data centers, administration, finance) can operate efficiently.
- **Smart Cities:** Where varied systems (traffic lights, security cameras, public Wi-Fi) use different topologies but are managed centrally.

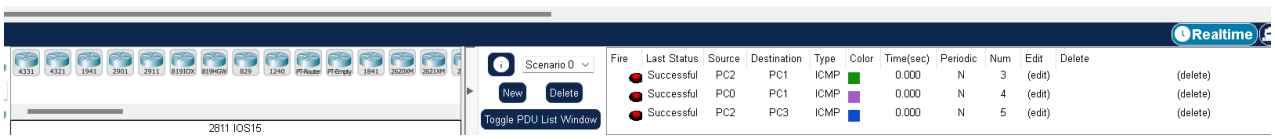
## Tree Topology (Cisco packet diagram):



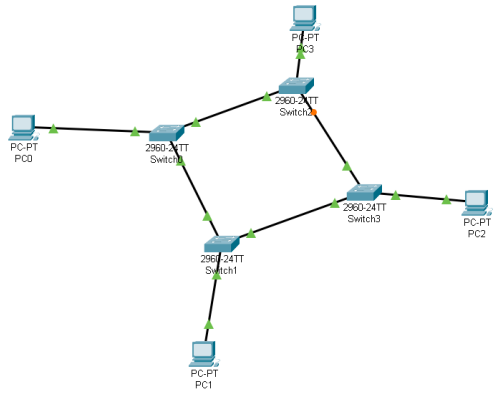


## Star topology (Cisco packet diagram):



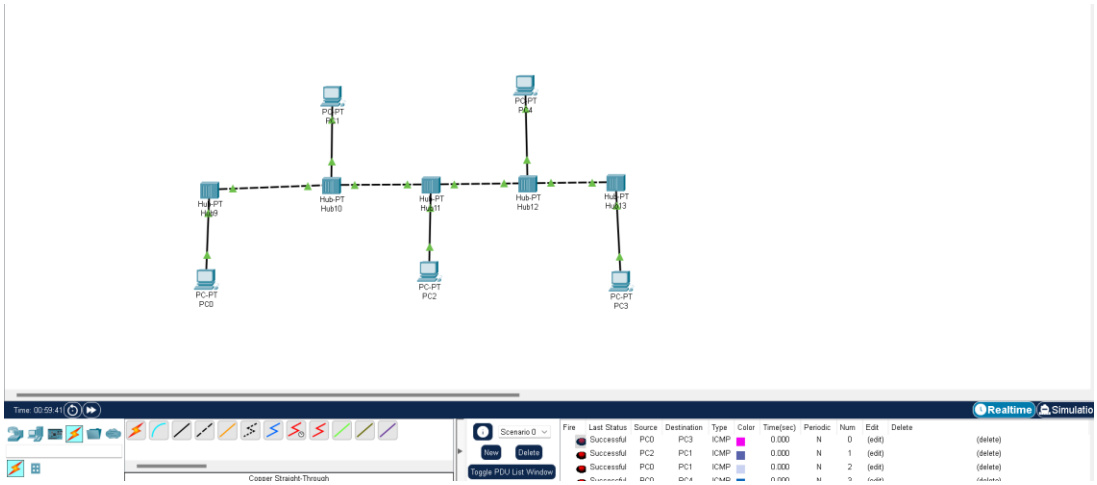



## Ring topology (Cisco packet diagram):

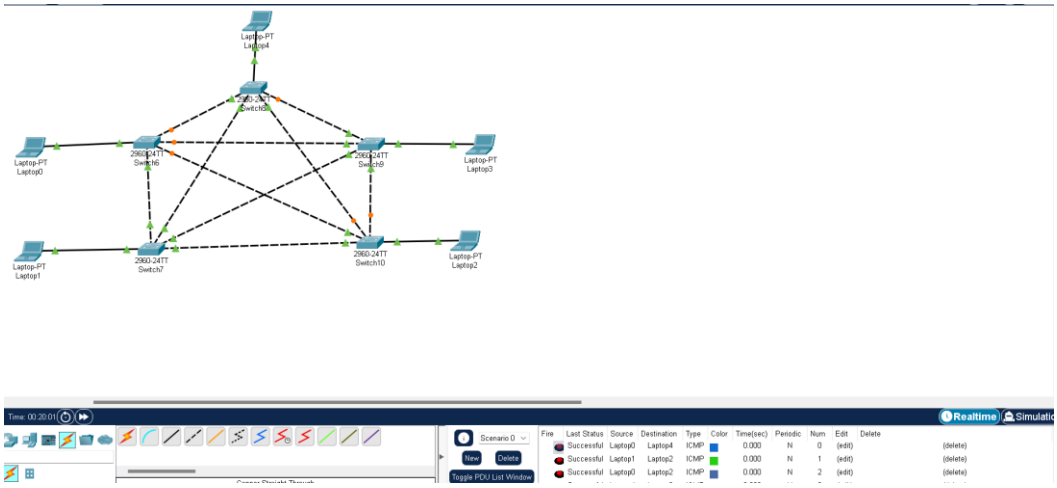




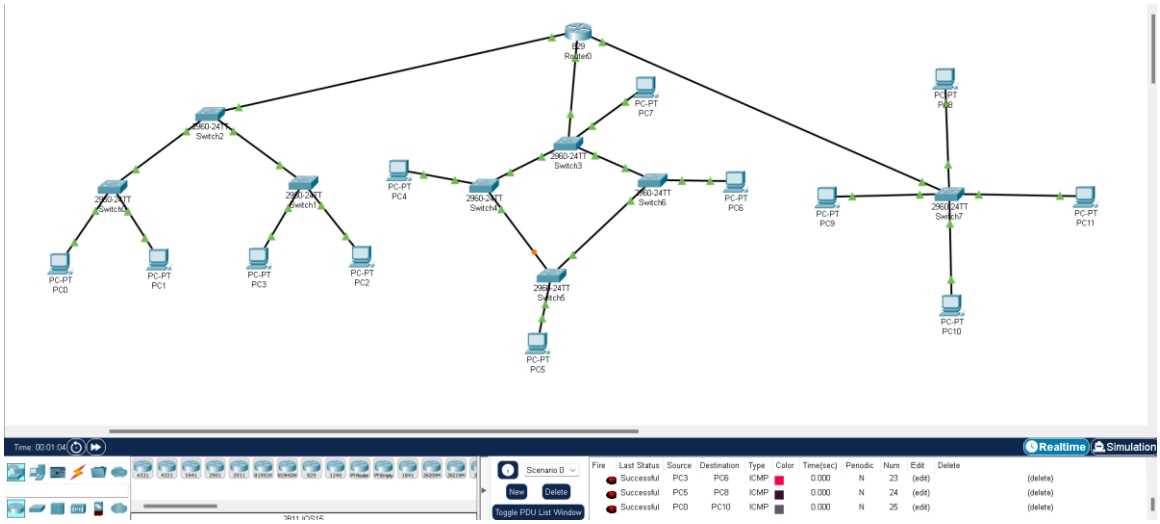
## Bus topology(cisco packet tracer)




## Mesh topology (cisco packet tracer)



**3-topology(tree,star,ring) combined from 1 single router (cisco packet tracer)**




**Inferences:**

1. **Scalability and Flexibility**: Tree and star topologies are superior in environments requiring easy expansion and management, making them well-suited for dynamic organizational structures.

2. **Network Reliability**: The mesh topology stands out as the most reliable for critical applications, as it offers redundant pathways, although at a higher cost and complexity level.

3. **Performance Trade-offs**: As networks grow, trade-offs become apparent—choices between cost, ease of management, and resiliency must be carefully considered based on specific application needs.

4. **Suitability of Topologies**: Each topology serves distinct purposes; for instance, while bus topology may suffice in small, temporary setups, larger infrastructures increasingly benefit from tree configurations to handle diverse user requirements effectively.

**Results:**

**Topological Overview:**

- **Tree Topology**: Combines star and bus structures, allowing for scalable and efficient management across departments, making it suitable for large organizations and WANs.
- **Star Topology**: Promotes simplicity and ease of management, ensuring that failure in one node does not affect others, though it relies heavily on a central hub.
- **Ring Topology**: Enhances data flow efficiency with a unidirectional path, suitable for structured environments but presents challenges in troubleshooting.
- **Bus Topology**: Functions well for small networks due to its simplicity, yet suffers from performance degradation and single points of failure as traffic increases.
- **Mesh Topology**: Every device is interconnected, providing multiple pathways for data transmission, which enhances fault tolerance and reliability.