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**Experiment 1**

**Aim**

To study various hardware tools that are used in networking.

**1. Cable Crimper**

* **Purpose:**  
  To attach connectors (like RJ45 for Ethernet) to the ends of network cables.
* **How It Works:**  
  It crimps (presses) the pins of the connector into the cable's individual wires, creating a strong electrical and mechanical connection.
* **Uses:**
  + Setting up Ethernet cables for local area networks (LANs).
  + Repairing or customizing network cables for specific lengths.

**2. Punch-Down Tool**

* **Purpose:**  
  To insert and secure wires into patch panels, keystone jacks, or punch-down blocks.
* **How It Works:**  
  The tool pushes the wire into the slot while simultaneously cutting off excess wire, ensuring a secure connection.
* **Uses:**
  + Structured cabling installations in data centres and offices.
  + Organizing and terminating network cables for cleaner connections.

**3. Cable Stripper**

* **Purpose:**  
  To remove the outer insulation from network cables (like CAT5, CAT6).
* **How It Works:**  
  The tool cuts through the cable's jacket without damaging the inner wires.
* **Uses:**
  + Preparing cables for crimping or punch-down.
  + Efficiently stripping large volumes of network cables during installation.

**4. Wire Cutter**

* **Purpose:**  
  To cut through various types of network cables cleanly.
* **How It Works:**  
  Sharp blades slice through cables, ensuring a clean edge for easier handling and connections.
* **Uses:**
  + Trimming excess cable during installations.
  + Cutting Ethernet, coaxial, and telephone wires.

**5. Multimeter**

* **Purpose:**  
  To measure electrical properties such as voltage, current, resistance, and continuity in network cables.
* **How It Works:**  
  Connect the probes to the circuit or cable, and the multimeter displays the measurement values.
* **Uses:**
  + Troubleshooting network connections.
  + Checking for breaks, shorts, or incorrect wiring in cables.

**6. Tone Generator**



* **Purpose:**  
  To identify specific cables in a bundle or locate faults in network wiring.
* **How It Works:**  
  The generator sends a distinct tone through the cable, which is detected using a tone probe at the other end.
* **Uses:**
  + Identifying cables in crowded patch panels.
  + Diagnosing breaks or faults in wiring.

**7. Cable Tester**

* **Purpose:**  
  To test the integrity, continuity, and configuration of network cables.
* **How It Works:**  
  The tester checks the wiring of the cable and displays any faults, such as open connections or miswiring.
* **Uses:**
  + Verifying newly crimped cables.
  + Ensuring proper connections in LAN setups.

**8. Loopback Adapter**

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* **Purpose:**  
  To test and diagnose network ports and connections.
* **How It Works:**  
  The adapter loops signal back to the network port to check if data transmission and reception are functioning correctly.
* **Uses:**
  + Diagnosing faulty network cards.
  + Testing switches and routers in network setups.

**9. Time Domain Reflectometer (TDR)**

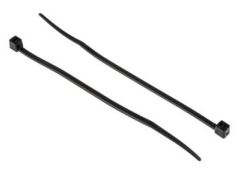
* **Purpose:**  
  To locate faults in copper and fibre optic cables by measuring reflections along the cable length.
* **How It Works:**  
  Sends an electrical pulse through the cable and measures the time it takes for reflections to return.
* **Uses:**
  + Identifying breaks, shorts, or impedance mismatches in network cables.
  + Precise fault location for cable repairs.

**10. Heat Gun for Shrink Tubing**

* **Purpose:**  
  To shrink heat-shrink tubing around cable connections for insulation and protection.
* **How It Works:**  
  The gun blows hot air that causes the tubing to contract tightly around the cables.
* **Uses:**
  + Securing cable splices and connections.
  + Providing insulation in electrical and network wiring.

**11. Screwdriver Set**

* **Purpose:**  
  To assemble and disassemble network hardware like switches, routers, and patch panels.
* **How It Works:**  
  Different screwdriver heads (Phillips, flathead) fit into screws to tighten or loosen them.
* **Uses:**
  + Mounting network equipment in racks.
  + Repairing or upgrading network components.

**12. Cable Tie**

* **Purpose:**  
  To organize and secure bundles of network cables.
* **How It Works:**  
  The tie is wrapped around the cables and tightened to hold them together.
* **Uses:**
  + Reducing cable clutter in data centres.
  + Securing cables to racks or walls.

**13. Scissors**

* **Purpose:**  
  To cut network cables, insulation, and other materials during installation.
* **How It Works:**  
  Sharp blades provide clean and precise cuts for easier cable handling.
* **Uses:**
  + Trimming cables during setup.
  + Cutting tape and insulation for cable management.

**Experiment 2**

**Aim**

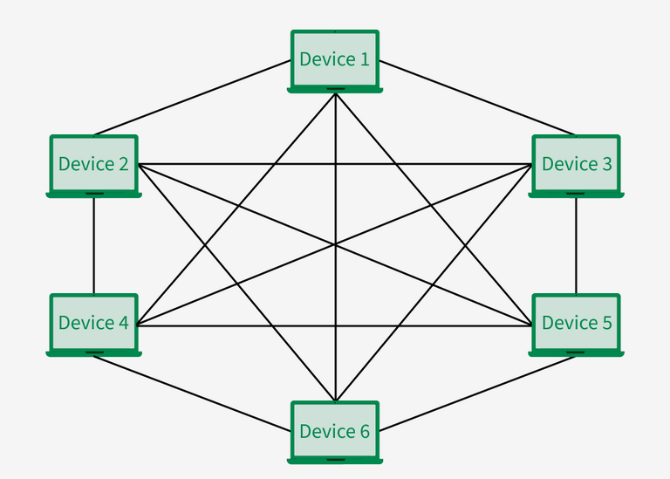
To study various topologies that are used in networking.

**Network Topology**

Network topology is the way devices are connected in a network. It defines how these components are connected and how data transfer between the network. Understanding the different types of network topologies can help in choosing the right design for a specific network.

**Types of Network Topologies**

Common types of network topologies in wired Networks include bus, star, ring, mesh, and hybrid topologies.

**I. Mesh Topology**

**1. Characteristics of Mesh Topology**

* **Network Configuration:** Every device is interconnected with every other device, providing multiple routes for data transmission.
* **Node Connectivity:** Nodes are completely connected via dedicated links, allowing information to travel from node to node.
* **Number of Links:** For N nodes, the number of required links is N(N-1)/2.
* **Data Transmission:** Each computer not only sends its own signals but also transfers data from other computers.
* **Connection Type:** Connections within the mesh can be wired or wireless.
* **IEEE Standards:** Mesh networks often comply with IEEE 802.11s standards for wireless mesh communication, providing efficient routing and connectivity.

**2. Advantages of Mesh Topology**

* In case of failure of a single device, the entire network didn’t break.
* There is no traffic problem as there is a dedicated point to point links for every device.
* Mesh Topology provides high privacy and security.
* Data transmission is more consistent because failure doesn’t disrupt its processes.
* Adding new devices won’t disrupt transmission of data.

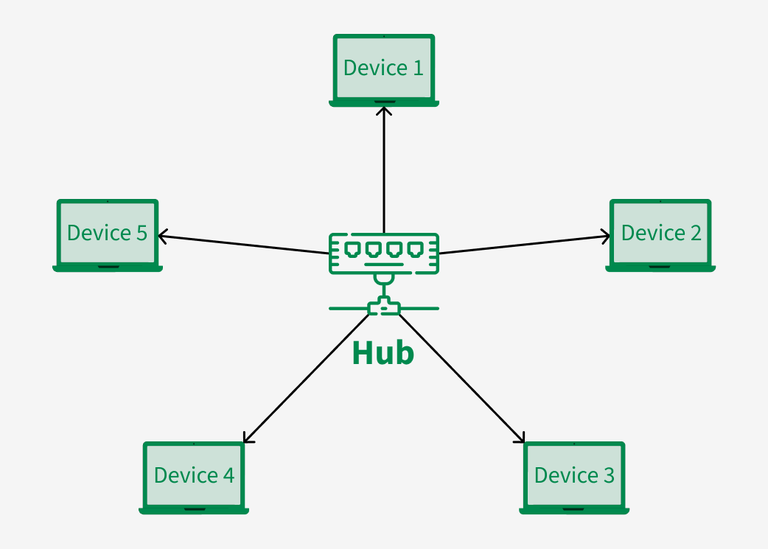
**3. Disadvantages of Mesh Topology**

* Mesh Topology is costly as compared to the other network topologies i.e. star, bus, point to point topology.
* Installation of nodes are difficult in mesh topology.
* Power requirement is higher as all the nodes will need to remain active all the time and share the load.
* Each node requires an extra utility cost.
* More maintenance is required in mesh topology.

**4. Applications of Mesh Topology**

* **Wireless Networks:** Many homes and small office spaces uses Mesh Wi-Fi System for better internet coverage and connectivity.
* **Industrial and Manufacturing Networks:** Many industries uses mesh topology to control machinery, ensuring better productivity.
* **Smart Homes:** Some advanced homes also use mesh topology for connecting home appliances like smart lights, security systems, etc.
* **Military Communication:** Mesh Topology are used in Military Purposes as if one connection fails, then there is always a chance of another connection.

**II. Star Topology**



**1. Characteristics of Star Topology**

* + **Central Hub:** Each device is connected to a central node called a hub or switch, which manages data flow.
  + **Data Transmission:** Devices communicate by sending data to the hub, which then forwards it to the target device.
  + **Topology Type:** Commonly used in Local Area Networks (LAN).
  + **Number of Links:** Requires **N** links to connect **N** devices to the hub.
  + **Network Management:** The hub or switch controls and manages all network functions.
  + **IEEE Standards:** Star topology networks often follow IEEE 802.3 (Ethernet) and IEEE 802.11 (Wi-Fi) standards for wired and wireless communication, respectively.

**2. Advantages of Star Topology**

* It is very reliable as if one cable or device fails then all the others will still work.
* It is high performing as no data collisions can occur.
* It is less expensive because each device only needs one I/O port and wishes to be connected to the hub with one link.
* Easy fault detection because the links are often easily identified.
* If N devices are connected to each other in star, then the number of cables required to attach them is N. So, it’s easy to line up.

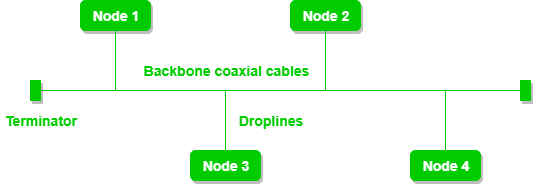
**3. Disadvantages of Star Topology**

* If the connecting network device (network switch) fails, the nodes attached are disabled and can’t participate in network communication.
* More expensive than linear bus topology due to the value of the connecting devices (network switches).
* If the hub goes down everything goes down, none of the devices can work without the hub.
* Extra hardware is required (hubs or switches) which adds to the cost.
* Performance is predicated on the one concentrator i.e. hub.

**4. Applications of Star Topology**

* **Home Networks:** Star Topology is used in a home network where all devices connect to a connected to a central router that manages the Internet.
* **ATM Networks:** In banks, ATMs are also connected in as a star network, as it helps in managing data efficiently.
* **Hospital Networks:**Hospital devices, medicinal equipment are connected in the star topology. It helps in easily accessing data records.
* **CCTV Networks:** Star Topology are also used in CCTV Networks where multiple cameras are connected to central video recorder.

**III. Bus Topology**



**1. Characteristics of Bus Topology**

* + **Data Transmission:** Data is transmitted through a single main cable that reaches every node in the network.
* **Address Checking:** Each node checks the destination address (MAC/IP) in the transmitted data.
* **Address Match:** If the address matches, the node processes the data.
* **Address Mismatch:** If the address does not match, the node ignores the data.
* **Communication:** All communication between nodes occurs through the main network cable.
* **IEEE Standards:** Bus topology networks commonly follow IEEE 802.3 standards for Ethernet communication.

**2. Advantages of Bus Topology**

* It is the easiest network topology for linearly connecting peripherals or computers.
* It works very efficiently well when there is a small network.
* The length of cable required is less than a star topology.
* It is easy to connect or remove devices in this network without affecting any other device.
* Very cost-effective as compared to another network topology i.e. mesh and star

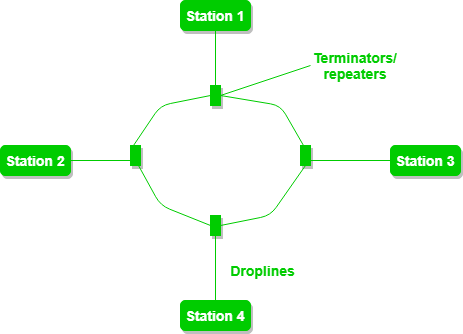
**3. Disadvantages of Bus Topology**

* Bus topology is not good for large networks.
* Identification of problems becomes difficult if the whole network goes down.
* Troubleshooting individual device issues is very hard.
* Need terminators are required at both ends of the main cable.
* Additional devices slow the network down.
* If the main cable is damaged, the whole network fails or splits into two.

**4. Applications of Bus Topology**

* **Local Area Networks (LANs):** Bus topology was traditionally utilized in Ethernet LANs, mainly in older implementations wherein coaxial cables have been daisy-chained to connect computer systems.
* **Industrial Control Systems:** In industrial control system, bus topology is frequently used for connecting sensors, actuators, and different devices in distributed manipulate systems.
* **Instrumentation Networks:** Bus topology is appropriate for connecting devices, meters, and records acquisition gadgets in laboratory or commercial environments.
* **Building Automation Systems:** Bus topology is employed in building automation and HVAC (heating, ventilation, and air conditioning) structures to attach sensors, thermostats, actuators, and other manage devices.

**IV. Ring Topology**



**1. Characteristics of Ring Topology**

* + **Network Configuration:** Devices are connected in a circular data path, forming a ring structure.
  + **Node Connectivity:** Each device is connected to exactly two neighbouring devices.
  + **Repeaters Usage:** Repeaters are used in networks with a large number of nodes to prevent data loss and ensure smooth data transmission.
  + **Data Transmission:** Packets travel from one device to another in a circular manner until they reach the desired destination.
  + **Network Terminology:** Devices connected in this setup are collectively referred to as a **ring network**.
  + **IEEE Standards:** Ring topology networks often comply with IEEE 802.5 standards for token ring communication.

**2. Advantages of Ring topology**

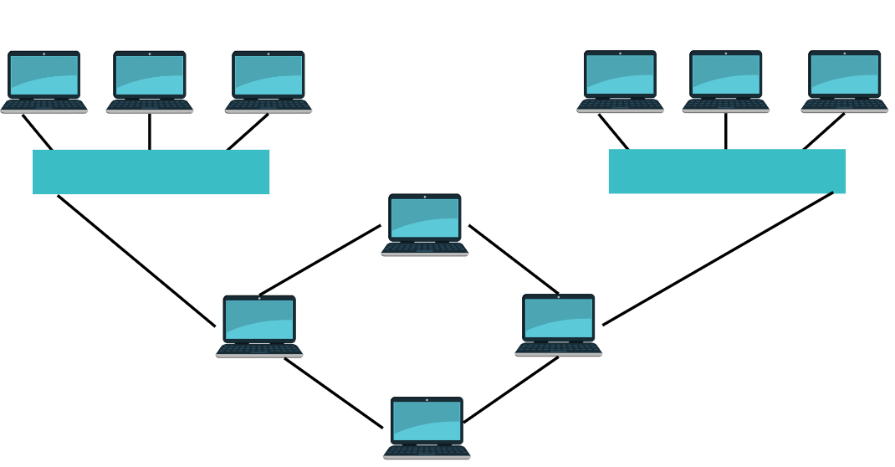
* In this data flows in one direction which reduces the chance of packet collisions.
* In this topology additional workstations can be added after without impacting performance of the network.
* Equal access to the resources.
* There is no need of server to control the connectivity among the nodes in the topology.
* It is cheap to install and expand.
* Minimum collision.
* Speed to transfer the data is very high in this type of topology.
* Ring network is extremely orderly organized where every device has access to the token and therefore the opportunity to transmit.

**3. Disadvantages of Ring topology**

* Due to the Uni-directional Ring, a data packet (token) must have to pass through all the nodes.
* If one workstation shuts down, it affects whole network or if a node goes down entire network goes down.
* It is slower in performance as compared to the bus topology
* It is Expensive.
* Addition and removal of any node during a network is difficult and may cause issue in network activity.
* Difficult to troubleshoot the ring.
* In order for all the computer to communicate with each other, all computer must be turned on.

**4. Applications of Ring Topology**

* + **Telecommunication Networks:** Used in telephone networks and broadband communication systems to maintain consistent data flow.
  + **Campus and Metropolitan Area Networks (MANs):** Ideal for connecting buildings in campuses and for MANs due to its structured data routing.
  + **Industrial Control Systems:** Common in factories and industrial setups where continuous data transmission is crucial for machine coordination.
  + **Token Ring Networks:** Implemented in legacy systems following the IEEE 802.5 standard to manage traffic and avoid collisions.

**V. Hybrid Topology**

**1. Characteristics of Hybrid Topology**

* + **Definition:** A network topology that combines two or more different types of network topologies (e.g., bus, ring, and mesh).
  + **Flexible Design:** The choice of topologies depends on factors like the number of computers, their location, and required network performance.
  + **Custom Configuration:** Network sections consist of configurations tailored to specific needs.
  + **Scalability:** Easily scalable by incorporating additional topologies as required.
  + Performance Optimization: Combines the strengths of different topologies to optimize network performance.
  + **IEEE Standards:** Hybrid topologies may follow various IEEE standards such as IEEE 802.3 (Ethernet) and IEEE 802.11 (Wi-Fi) depending on the topologies used.

**2. Advantages of Hybrid Topology**

* Adding a new node or deleting the existing node is easy in hybrid topologies.
* Hybrid topology is more secure, reliable, and scalable as compared to individual star, ring and mesh topology.
* Error detection and troubleshooting is easier in hybrid topology.
* When an organization has a large geographical area utilizing hybrid topology is considered as better option.
* Traffic with large volume is handled easily by the hybrid topology.
* The overall performance and speed are greater in hybrid topology.

**3. Disadvantages of Hybrid Topology**

* The design and implementation of hybrid network topology is difficult.
* More number of cables and other physical devices are required for hybrid topology.
* The process of installation of hybrid topology is difficult.
* The overall implementation, setup and process of hybrid topology is much costlier.

**4. Applications of Hybrid Topology**

* + **Enterprise Networks:** Suitable for large organizations to efficiently manage diverse departments with varying network requirements.
  + **Data Centres:** Used to handle complex networking demands and provide fault tolerance.
  + **Telecommunication Systems:** Ideal for building reliable and scalable communication infrastructure.
  + **Campus Networks:** Combines different topologies for connecting multiple buildings and departments.

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| **Features** | **Mesh Topology** | **Star Topology** | **Bus Topology** | **Ring Topology** | **Hybrid Topology** |
| **Structure** | Every device is connected to every other device | All devices are connected to a central hub | Single main cable connects all devices | Devices form a circular data path | Combination of two or more topologies |
| **Data Transmission** | Multiple routes for data | Data passes through the central hub | Data travels along the main cable | Data travels in one direction or both | Depends on combined topologies |
| **Reliability** | Highly reliable (multiple paths) | Moderately reliable (depends on hub) | Less reliable (main cable failure affects the network) | Moderately reliable (repeater required for large networks) | Highly reliable (flexibility to choose fault-tolerant paths) |
| **Scalability** | Difficult to scale | Easy to scale by adding devices | Limited scalability | Difficult to scale | Highly scalable |

**Experiment 3**

**Aim**

To chart out various characteristics of IPv4 and IPv6.

**What is an IP Address?**

An IP (Internet Protocol) address is a unique identifier assigned to each device connected to a network. It enables communication between devices by specifying source and destination addresses. The two major versions in use today are **IPv4 (Internet Protocol Version 4)** and **IPv6 (Internet Protocol Version 6)**.

**Comparison Table: IPv4 vs. IPv6**

|  |  |  |
| --- | --- | --- |
| **Feature** | **IPv4** | **IPv6** |
| **Address Length** | |  | | --- | | 32-bit (4 octets) |  |  | | --- | |  | | 128-bit (8 groups of hexadecimals) |
| **Address Format** | Decimal (e.g., 192.168.1.1) | Hexadecimal (e.g., 2001:0db8:85a3::8a2e:0370:7334) |
| **Total Addresses** | ~4.3 billion | ~340 undecillion (2^128) |
| **Header Size** | 20 bytes | 40 bytes (simplified for efficiency) |
| **Address Configuration** | Manual or DHCP | Auto-configuration (SLAAC) and DHCPv6 |
| **Security** | IPsec optional | IPsec mandatory |
| **Broadcast Support** | Yes | No (replaced with multicast & anycast) |
| **Fragmentation** | Done by sender & routers | Done only by sender |
| **Quality of Service (QoS)** | Limited | Built-in support |
| **Adoption** | Widely Used | Gradually increasing |

**Key Findings**

* IPv6 addresses are longer and more complex than IPv4.
* IPv6 supports auto-configuration, eliminating the need for DHCP in many cases.
* IPv6 eliminates NAT (Network Address Translation), allowing direct communication between devices.
* Packet headers in IPv6 are optimized for faster processing.
* IPv6 has built-in support for security features like IPsec.

**Advantages and Challenges of IPv6**

|  |  |  |
| --- | --- | --- |
| **Feature** | **Advantages** | **Challenges** |
| **Address Space** | 128-bit, practically unlimited | Complex to remember |
| **Security** | Built-in IPsec for encryption | Not fully enforced globally |
| **Efficiency** | Simpler packet headers, faster routing | Requires network upgrades |
| **Auto-configuration** | No need for DHCP in many cases | Some legacy systems don’t support it |

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