Computer Networks

- A collection of computing devices that are connected in various ways to communicate and share resources.
- Can share both intangible resources like files and tangible resources like printers.
- Networks are defined not only by physical connections but the ability to communicate.

Computer Networks

- Can contain devices other than computers.
- Networked printers can be used from all computers on the network.
- Also contain variety of devices for handling network traffic.
- Node or host – generic terms for any device on the network.

Computer Networks

- Data transfer rate – speed at which data is moved from one place on the network to another.
- Bandwidth – another name for the data transfer rate.
- Protocol – a set of rules that defines how data is formatted and processed on a network.
- Client/server model – A distributed approach in which a client makes requests to a server and the server responds.

Types of Computer Networks

- Personal Area Networks (PAN)
  - Extremely small networks, often referred to as "piconets" that encompass an area around a single person. These networks, such as Bluetooth, have a range of only 1-5 meters, and tend to have very low power requirements, but also very low datarates.
- Local Area Network (LAN)
  - LAN networks can encompass a building such as a house or an office, or a single floor in a multi-level building.

Types of Computer Networks

- Wide Area Network (WAN)
  - Connects one or more LANs over a potentially large geographic distance.
- Metropolitan Area Network (MAN)
  - A large network which covers a campus or a city – more focused on an organisation or area.
- Sensor Area Networks
  - These networks are low-datarate networks primarily used for embedded computer systems and wireless sensor systems.

LAN Topologies

- Point-to-Point
- Bus
- Star
- Ring
- Mesh
- Tree
- Hybrid

Point-to-Point

- The simplest topology is a permanent link between two endpoints.
  - Switched point-to-point topologies are the basic model of conventional telephony.
  - The value of a permanent point-to-point network is unimpeded communications between the two endpoints.
- Permanent link.
- Switched link – telephone line.

Bus

- Each computer or server is connected to the single bus cable.
- A signal from the source travels in both directions to all machines connected on the bus cable until it finds the intended recipient.
- If the machine address does not match the intended address for the data, the machine ignores the data. Alternatively, if the data matches the machine address, the data is accepted.

Bus

- Linear Bus
  - All the nodes of the network are connected to a common transmission medium which has exactly two endpoints (the 'bus', or backbone, or trunk).
- Distributed Bus
  - All the nodes of the network are connected to a common transmission medium which has more than two endpoints that are created by adding branches to the main section of the transmission medium (physically all nodes share a common transmission medium).

Bus

- Advantages
  - Easy to implement and extend.
  - Well-suited for temporary or small networks not requiring high speeds (quick setup), resulting in faster networks.
  - Less expensive than other topologies.
  - Cost effective; only a single cable is used.
  - Easy identification of cable faults.

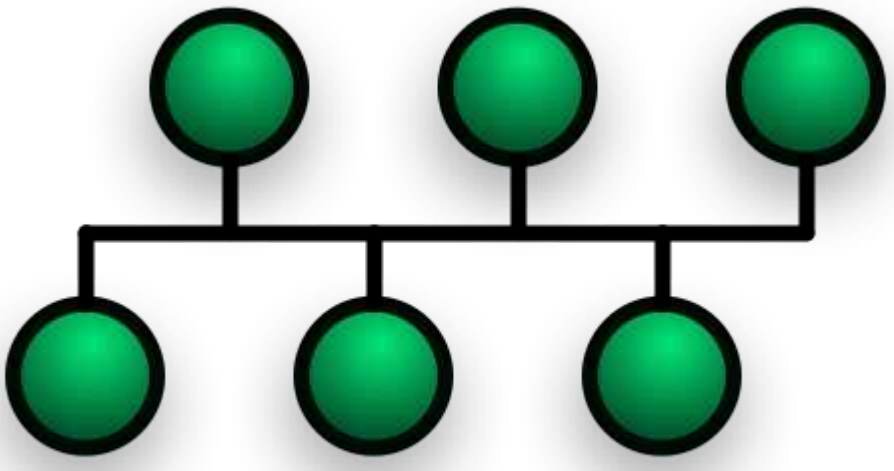
Bus

- Disadvantages
  - Limited cable length and number of stations.
  - If there is a problem with the cable, the entire network breaks down.
  - Maintenance costs may be higher in the long run.
  - Performance degrades as additional computers are added or on heavy traffic (shared bandwidth).
  - Proper termination is required (loop must be in closed path).

Bus

- Disadvantages
  - Significant Capacitive Load (each bus transaction must be able to stretch to most distant link).
  - It works best with limited number of nodes.
  - Commonly has a slower data transfer rate than other topologies.
  - Only one packet can remain on the bus during one clock pulse

Bus network



Star

- Each network host is connected to a central hub with a point-to-point connection.
- The network does not necessarily have to resemble a star to be classified as a star network, but all of the nodes on the network must be connected to one central device.
- All traffic that traverses the network passes through the central hub.
- The hub acts as a signal repeater.

Star

- Extended Star
  - A network that is based upon the physical star topology has one or more repeaters between the central node and the peripheral nodes, the repeaters being used to extend the maximum transmission distance of the point-to-point links between the central node and the peripheral nodes.
- Distributed Star
  - Individual networks that are based upon the physical star topology connected together in a linear fashion – i.e., 'daisy-chained' – with no central or top level connection point.

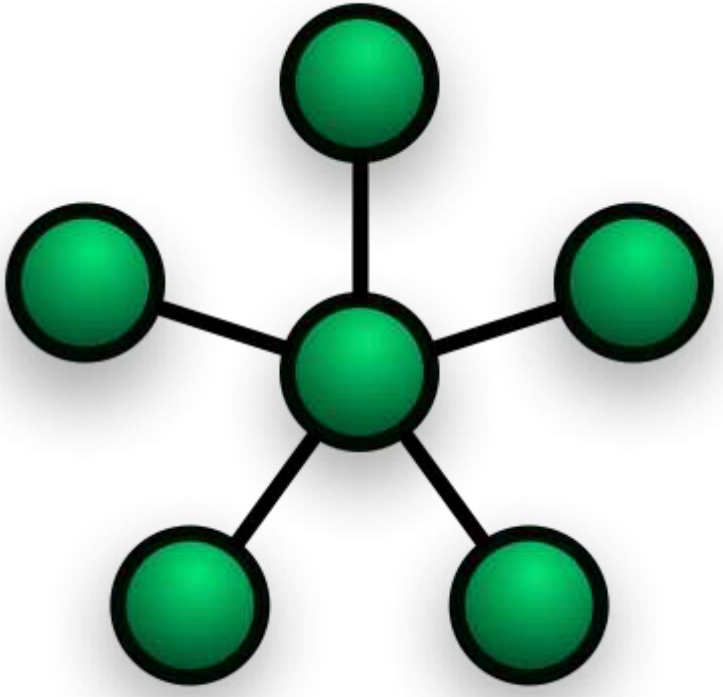
Star

- Advantages
  - Better performance: star topology prevents the passing of data packets through an excessive number of nodes.
  - Isolation of devices: Each device is inherently isolated by the link that connects it to the hub.
  - Benefits from centralization: As the central hub is the bottleneck, increasing its capacity, or connecting additional devices to it, increases the size of the network very easily.
  - Easy to detect faults and to remove parts.
  - No disruptions to the network when connecting or removing devices.

Star

- Disadvantages
  - High dependence of the system on the functioning of the central hub
  - Failure of the central hub renders the network inoperable

Star Network



Ring

- A network topology that is set up in a circular fashion in which data travels around the ring in one direction and each device on the right acts as a repeater to keep the signal strong as it travels.
- Each device incorporates a receiver for the incoming signal and a transmitter to send the data on to the next device in the ring.
- The network is dependent on the ability of the signal to travel around the ring.

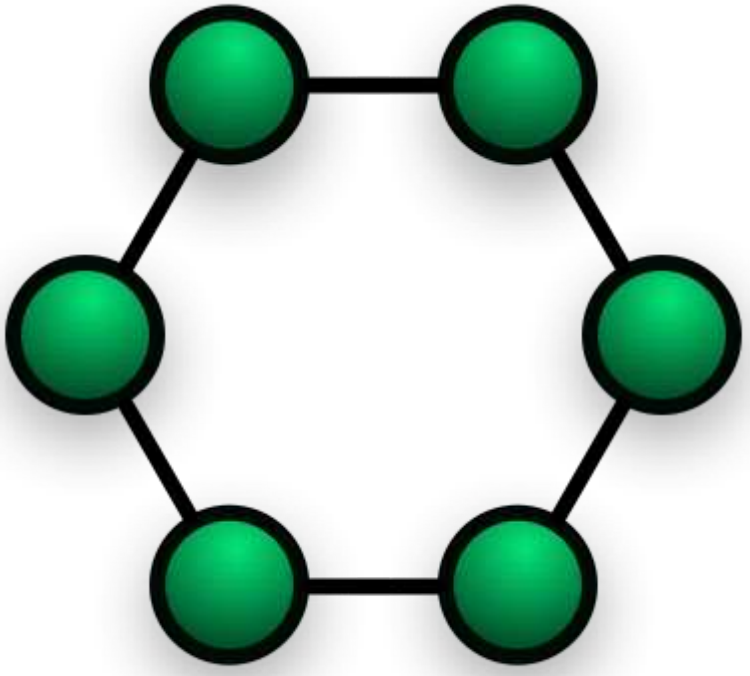
Ring

- Advantages
  - Very orderly network where every device has access to the token and the opportunity to transmit
  - Performs better than a bus topology under heavy network load
  - Does not require a central node to manage the connectivity between the computers

Ring

- Disadvantages
  - One malfunctioning workstation can create problems for the entire network
  - Moves, adds and changes of devices can affect the network
  - Communication delay is directly proportional to number of nodes in the network
  - Bandwidth is shared on all links between devices

Ring Network



Mesh

- Is a type of networking where each node must not only capture and disseminate its own data, but also serve as a relay for other nodes, that is, it must collaborate to propagate the data in the network.
- There is often more than one path between a source and a destination in the network.
- Although mostly used in wireless scenarios, this concept is also applicable to wired networks and software interaction.

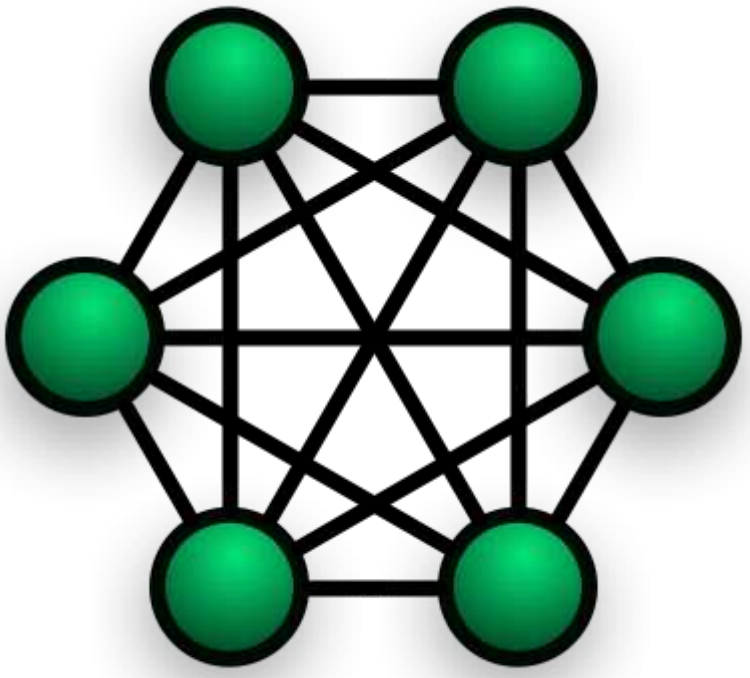
Mesh

- Fully Connected Mesh
  - A fully connected network is a communication network in which each of the nodes is connected to each other.
  - A fully connected network doesn't need to use switching nor broadcasting.
  - However, its major disadvantage is that the number of connections grows quadratically with the number of nodes.
  - A two-node network is technically a fully connected network.

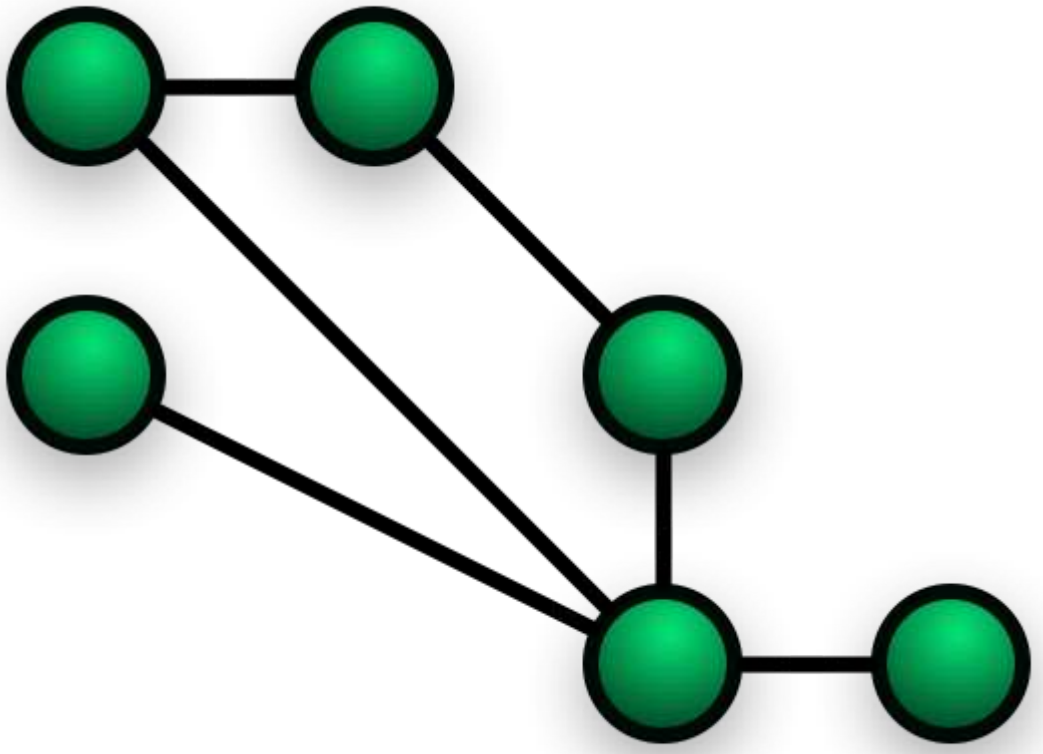
Mesh

- Partially Connected Mesh
  - The type of network topology in which some of the nodes of the network are connected to more than one other node in the network with a point-to-point link
  - This makes it possible to take advantage of some of the redundancy that is provided by a physical fully connected mesh topology without the expense and complexity required for a connection between every node in the network.

Fully Connected Mesh



Partially Connected Mesh



Tree

- Tree topology is a combination of Bus and Star topology.
- The type of network topology in which a top level central 'root' node is connected to one or more other nodes that are one level lower in the hierarchy with a point-to-point link, while each of the second level nodes will also have one or more other nodes that are one level lower in the hierarchy connected to it with a point-to-point link.
- The top level central 'root' node being the only node that has no other node above it in the hierarchy.

Tree

- Each node in the network having a specific fixed number of nodes connected to it at the next lower level in the hierarchy, the number, being referred to as the 'branching factor' of the hierarchical tree.
- This tree has individual peripheral nodes.

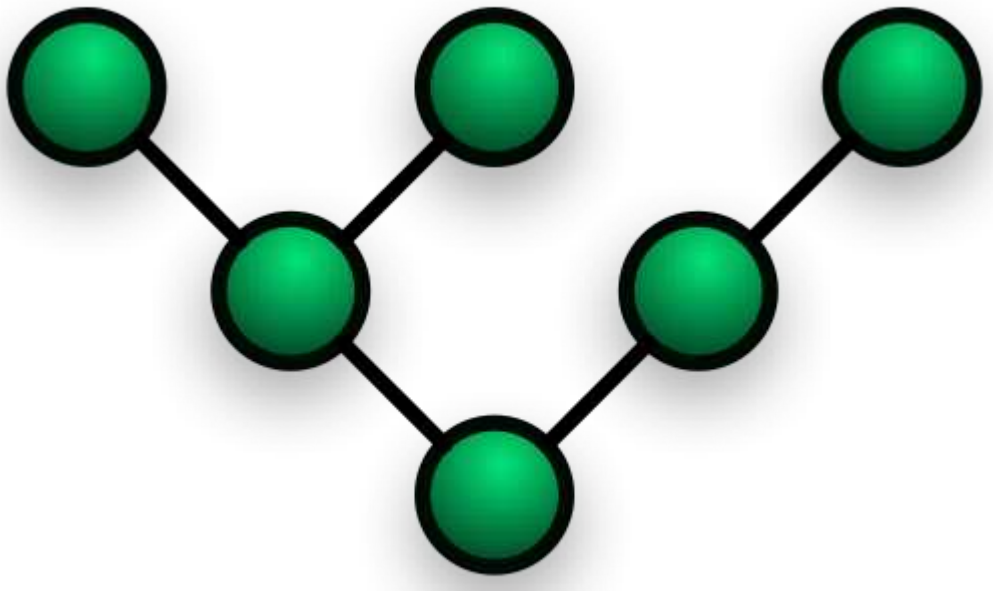
Tree

- A network that is based upon the physical hierarchical topology must have at least three levels in the hierarchy of the tree.
- A network that is based upon the physical hierarchical topology and with a branching factor of 1 would be classified as a physical linear topology.
- The branching factor is independent of the total number of nodes in the network.

Tree

- The total number of point-to-point links in a network that is based upon the physical hierarchical topology will be one less than the total number of nodes in the network.
- If the nodes in a tree network are required to perform any processing upon the data that is transmitted between nodes in the network, the nodes that are at higher levels in the hierarchy will be required to perform more processing operations on behalf of other nodes than the nodes that are lower in the hierarchy.

Tree



Hybrid

- Hybrid networks use a combination of any two or more topologies in such a way that the resulting network does not exhibit one of the standard topologies (e.g., bus, star, ring, etc.).
- For example, a tree network connected to a tree network is still a tree network topology.
- A hybrid topology is always produced when two different basic network topologies are connected.

Hybrid

- A Star ring network consists of two or more star topologies connected using a multistation access unit (MAU) as a centralized hub.
- A Star Bus network consists of two or more star topologies connected using a bus trunk (the bus trunk serves as the network's backbone).
- A Snowflake topology is really a "Star of Stars" network, with characteristics of a hybrid network topology.