Network Fundamentals

Network Topology

- **Network Topology** refers to the layout of a network and how different nodes in a network are connected and how they communicate.
- **Topologies** are either physical (the physical layout of devices on a network) or logical (the way that the signals act on the network media, or the way that the data passes through the network from one [1] device to the next).
- The volume of data that can be transferred across a network at a given time is called **bandwidth**. An expensive, high bandwidth network can transfer data much quicker than a low bandwidth one. The bandwidth is affected by the types of network cards and modems used as well as the amount and type of cable used. The way in which computers are connected to form a network also has a large effect on its speed and efficiency.
- Network Topology is the schematic description of a network arrangement, which connects various nodes (sender and receiver) through lines of connection.

Client, Servers, and Peers

- In networks where one (1) computer is more important than the others, the controlling computer is called a **server**, and the other computers on the networks are called **clients**.
- This type of network is called a client/server network.

Types of Network Topology

Network Topologies are categorized into the following basic types:

- **Bus**
  - Bus topology is a network type in which every computer and network device is connected to a single cable. When it has exactly two (2) endpoints, then it is called Linear Bus Topology.
  - *Linear Bus Topology* is a type of network topology in which each device is connected one (1) after the other in a sequential chain. It works well for small networks because it is simple to set up and utilizes shorter cables since each device is connected to the next. It is a poor solution for larger networks, however, since the entire network relies on each connection and network speed is reduced as more devices are added.
- **Ring**
  - It is called Ring Topology because it forms a ring as each computer connects to another computer, with the last one (1) connecting to the first and exactly two (2) neighbors for each device.
  - All messages travel through a ring in the same direction—either "clockwise" or "counterclockwise". A failure in any cable or device breaks the loop and can take down the entire network.
  - To implement a ring network, one (1) computer typically uses FDDI, SONET, or Token Ring technology.
  - Ring Topologies are found in some office buildings or school campuses.
- **Star**
  - In this type of topology, a single hub connects all the computers through a cable. This hub is the central node, and all other nodes are connected to the central node.
- **Mesh**
  - This topology is a point-to-point connection to other nodes or devices. All the network nodes are connected. Mesh has $n(n-1) / 2$ physical channels to link n devices.

- There are two (2) techniques to transmit data over the Mesh Topology. These are the following:
  - *Routing.* In routing, the nodes have a routing logic as per the network requirements. An example of this would be to direct the data to reach the destination using the shortest distance, or routing logic which has information about the broken links to avoid those nodes, etc. We can even have routing logic to re-configure the failed nodes.
  - *Flooding.* In flooding, all the network nodes transmit the same data. Hence, no routing logic is required. The network is robust, and it's unlikely to lose the data, but it leads to unwanted load over the network.
- **Types of Mesh Topology**
  - *Partial Mesh Topology.* In this topology, some of the systems are connected in the same fashion as mesh topology, but some devices are only connected to two (2) or three (3) devices.
  - *Full Mesh Topology.* Every node or device is connected to each other.

- **Tree**
  - This topology, also called hierarchical topology, has a root node and all other nodes are connected to it forming a hierarchy. It should at least have three (3) levels to the hierarchy.
- **Hybrid Topology**
  - It is two (2) different types of topologies, which is a mixture of two (2) or more topologies.

Network Topology	Features	Advantages	Disadvantages
Bus	▪ It transmits data in one (1) direction only. ▪ Every device is connected to a single cable.	▪ It is cost effective. ▪ The cable required is least compared to other network topology. ▪ It is used in small networks. ▪ It is easy to understand. ▪ It is easy to expand joining two (2) cables together.	▪ If the cables fail, then the whole network fails. ▪ If the network traffic is heavy or there are more nodes, the performance of the network decreases. ▪ The cable has a limited length. ▪ It is slower than the ring topology.
Ring	▪ Some repeaters are used for Ring Topology with a large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, the data will have to pass through 99 nodes to reach the 100th node. Hence, to prevent data loss, repeaters are used in the network. ▪ The transmission is unidirectional, but it can be	▪ Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data. ▪ Cheap to install and expand	▪ Troubleshooting is difficult. ▪ Adding or deleting the computers disturbs the network activity. ▪ Failure of one (1) computer disturbs the whole network.

	made bidirectional by having two (2) connections between each network node. It is called **Dual Ring Topology**. ▪ Two (2) ring networks form in a dual ring topology, and the data flow is in the opposite direction. If one (1) ring fails, the second ring can also act as a backup to keep the network up. ▪ The data is sequentially transferred, bit by bit. The data transmitted has to pass through each node of the network until the destination node.		
Star	▪ Every node has its own dedicated connection to the hub. ▪ The hub acts as a repeater for data flow. ▪ It can be used with twisted pair, optical fiber, or coaxial cable.	▪ Fast performance with few nodes and low network traffic. ▪ The hub can easily upgrade. ▪ It is easy to troubleshoot, set up, and modify. ▪ Only the node that has failed is affected, while the rest of the nodes can work smoothly.	▪ The cost of installation is high. ▪ It is expensive to use. ▪ If the hub fails, then the whole network is stopped because all the nodes depend on the hub. ▪ Performance is based on the hub that it depends on its capacity.
Mesh	▪ It is fully connected and robust, but it is not flexible.	▪ Each connection can carry its own data load. ▪ It is robust. ▪ The fault is diagnosed easily. ▪ It provides security and privacy.	▪ Installation and configuration is difficult. ▪ Cabling cost is more. ▪ Bulk wiring is required.
Tree	▪ It is ideal if the workstation is located in groups. ▪ This is used in Wide Area Network.	▪ Extension of bus and star topologies ▪ Expansion of nodes is possible and easy. ▪ Easily managed and maintained ▪ Error detection is easily done.	▪ Heavily cabled ▪ Costly ▪ If more nodes are added, maintenance will be difficult. ▪ If the central hub fails, the network fails.
Hybrid	▪ It is a combination of two (2) or more topologies.	▪ Reliable as error detecting and troubleshooting is easy.	▪ Complex in design ▪ Costly

	▪ It inherits the advantages and disadvantages of the topologies included.	▪ Effective ▪ Scalable as size can be increased easily. ▪ Flexible	

Network Devices

- **Repeater** is an electronic device that amplifies the signal it receives. You can think of repeater as a device which receives a signal and retransmits it at a higher level or higher power so that the signal can cover longer distances.
- **Hub** is the passive central bus connection. It is a networking device which connects multiple network hosts. A network hub is also used to do data transfer. The data is transferred in terms of packets on a computer network.
- **Bridge** routes packets based on MAC addresses. If a router connects two (2) different types of networks, then the bridge connects two (2) subnetworks as a part of the same network. You can think of two (2) different laboratories or two (2) different floors connected by a bridge.
- **Switch** routes packets based on IP addresses. Like a hub, the switch also works at the layer of Local Area Network (LAN), but it is more intelligent than a hub. While the hub does the work of data forwarding, a switch does 'filter and forwarding' which is the more intelligent way of dealing with data packets.
- **Router** routes packets between networks. It is responsible for routing traffic from one (1) network to another. These two (2) networks could be a private company network to a public network. You can think of a router as a traffic police who directs different network traffics to different directions.
- **Gateway** converts between protocols and networks. It is a network node that connects two (2) networks using different protocols together. While a bridge joins two (2) similar types of networks, a gateway joins two (2) dissimilar networks.

Types of Networks

- **Local Area Network (LAN)**
  - This is one of the original categories of network and one of the simplest. LAN networks connect computers together over relatively small distances, such as within a single building or a small group of buildings.
  - Homes often have LAN networks, too, especially if there is more than one (1) device at home. Often they do not contain more than one (1) subnet, if any, and are usually controlled by a single administrator. They do not have to be connected to the Internet to work, although they can be.
- **Wide Area Network (WAN)**
  - This is another of the original categories of network, and slightly more complex in nature. WAN networks connect computers over vast physical distances, remotely connecting them over one (1) huge network and allowing them to communicate even when apart. The Internet is a WAN and connects computers all around the world.
- **Metropolitan Area Network (MAN)**
  - This network is larger than a LAN but smaller than a WAN and incorporates elements of both. It typically spans a town or city and is owned by a single person or company, such as a local council or a large company.
- **Campus Area Network (CAN)**
  - This network is larger than a LAN but smaller than a MAN. This is typical in areas such as a university, large school, or small business. It is typically spread over a collection of buildings

which are reasonably local to each other. It may have an internal Ethernet as well as the capability of connecting to the Internet.

- **Wireless Local Area Network (WLAN)**
  - This is a LAN which works using wireless network technology like Wi-Fi. This type of network is becoming more popular as wireless technology is further developed and is used more at home and by small businesses. This means that devices do not need to rely on physical cables and wires as much and can organize their spaces more effectively.
- **System Area Network**
  - This network connects computers on an especially high-speed connection, in a configuration known as a cluster. This means that computers are connected to work as a single system and can be done as a result of very high-speed computers and new low-cost microprocessors. They usually improve performance and are used for cost efficiency.
- **Storage Area Network**
  - This network connects servers directly to devices which store amounts of data without relying on a LAN or WAN to do so. This can involve another type of connection known as Fiber Channel, a system similar to Ethernet that handles high-performance disk storage for applications on some professional networks.

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