Data Networking

Networking Concepts:

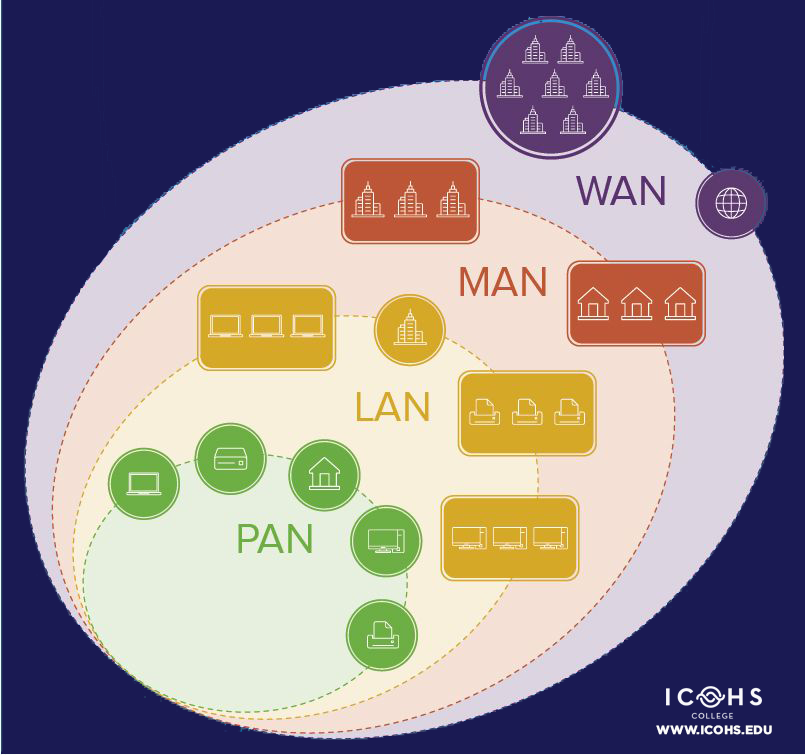
Data is basically any information which is in binary form. A system that transfers data between different nodes through data switching, system control and interconnection transmission lines is what we called as data network. The excahnage of data between 2 devices via a transmission medium and following some kind of a protocol is known as data communication. Data networking and communication is used to transfer data to one or more points called as multipoint. It is of two types namely: Broadcast and Point-to-Point.

Broadcast: when data is transmitted from one point to multipoint then that is known as broadcasting of data. Data broadcasting is again of two types i.e. Independent data broadcasting and linked data broadcasting. Independent data broadcasting is the one which transmits supplementary information directly onto the main television such as news, weather forecast etc. Linked data broadcasting is the one which provides information about the characters of the television drama. For example, in a sports program one can check about the athletes, their information and their progress.

ISDB- T (Integrated Services Digital Broadcasting- Terrestrial) is able to send much more and detailed data through a communication line in order to complement broadcasting of data which has only limited Bandwidth.

Network Types and Topologies:

There are basically 4 types of Networks namely PAN, LAN, MAN, WAN. The figure shown below shows the basic types of data networks:



1. PAN (Personal Area Network) :- It is the smallest network which is personal to the users. It is basically involved with the personal usage of the person that’s why named as personal area network. Its range is around 10 meters. It includes Bluetooth, Zigbee , Smartphones, TV Remotes etc. It ranges generally from 10m to 100m with a speed of upto 250 Kbps in zigbee and 24Mbps in Bluetooth.

Some Standards are shown below;

Bluetooth:- Bluetooth was standardized by the IEEE with a standards

802.15.01

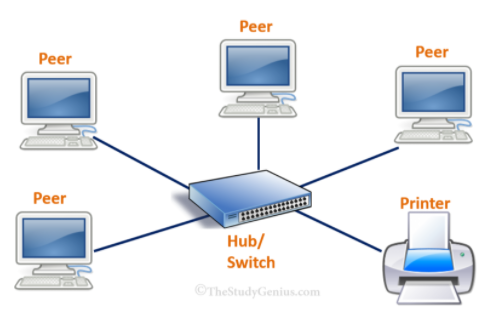
802.15.01B

802.15.1.1 Ratified as [IEEE Standard 802.15.1–2002](https://en.wikipedia.org/wiki/IEEE_802.15#Task_group_1_(WPAN/Bluetooth))

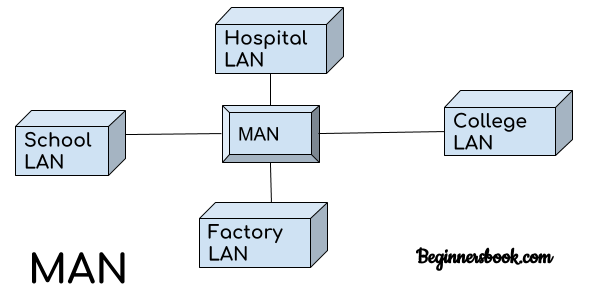
802.15.1.2 Ratified as [IEEE Standard 802.15.1–2005](https://en.wikipedia.org/wiki/IEEE_802.15#Task_group_1_(WPAN/Bluetooth))

And so on

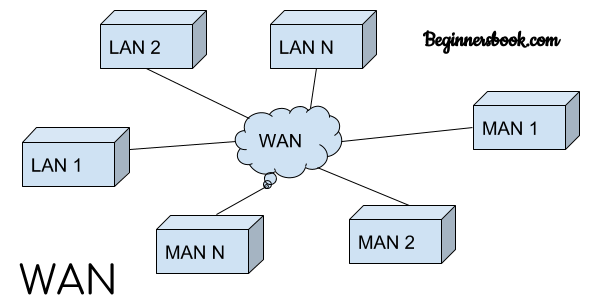
1. LAN (Local Area Network):- It is a network which is local to an area like school, college, office, building etc. It is a privately owned network which can be directly accessed by using an ethernet or a central device like switch or a hub. With Ethernet cables, the speed of data transfer can reach upto 54Mbps and with Gigabit Ethernet, it can reach upto 1Gbps. It ranges from basically 100m to 5km

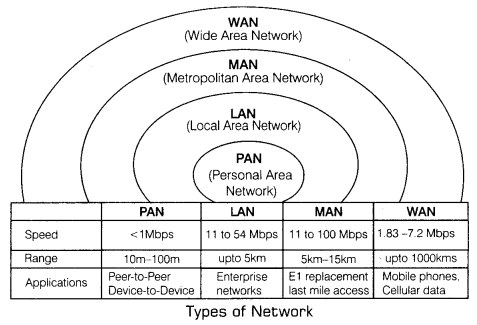


1. MAN (Metropolitan Area Network) :- When two or more LAN are interconnected then a MAN network is formed. It is bigger than LAN but smaller than WAN. For example, an organization has many branches at numerous locations which uses LAN network. So the organization can connect a telephone line over the LAN network to create a MAN network. Its speed is around 100Mbps with a range of upto 15Km.



1. WAN (Wide Area Network) :- It includes a large geographical area like a country or a continent and uses a carrier such as a telephone line or a satellite system etc. It is basically when multiple MANs and LANs are interconnected to form a network then a WAN network is formed. It Speed speed varies from 1.83 to 7.2 Mbps with a range of upto 1000km





The effectiveness of data communication system depends on 5 fundamental characteristics which includes:

Accuracy:- The accuracy of data transfer should be high i.e whatever data is transmitted must be received at the receiver site. The data that has been changed while transmission and useless.

Delivery:- The data must be delivered to the correct destination. The data transmitted, if received by some other receiver other that the intended one is useless.

Jitter:- Any abrupt change in the delay is what is known as jitter. It is basically defined as the variation in the arrival time of the packet.

Timeliness:- It indicates that the system must deliver the data timely. Any data delivered after the allotted time is useless. Such kind of D=delivery is known as rea-time transmission.

Latency:- It is the delay between the transmission time and the reception time. It is less than 10ms in 4G.

Network Topologies:

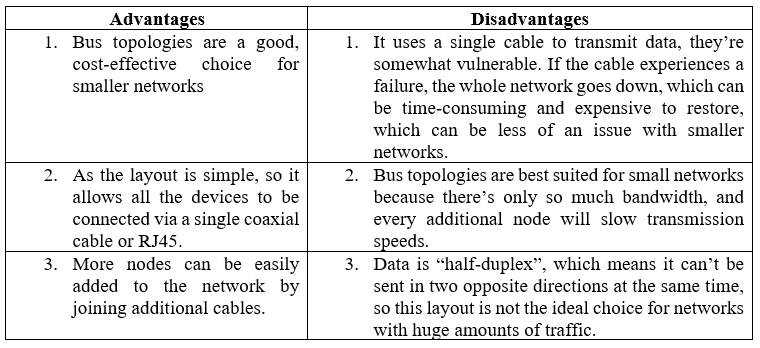
The way a network has been arranged to transfer the data is known as topology. Network topology is basically defines how a connection, device and nodes are interconnected in a network with respect to each other. There are two approaches to the network topology i.e physical and logical.

Physical :- It refers to the actual wired connections of how the networks are arranged.

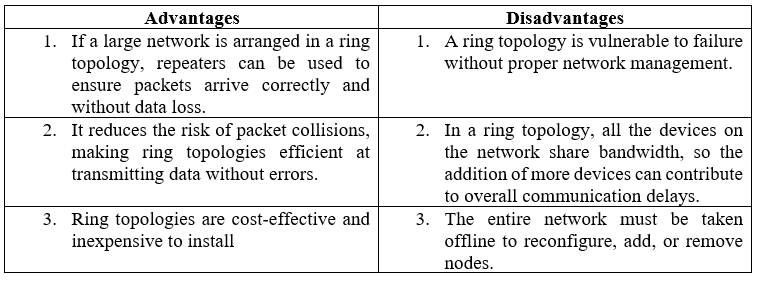
Logical :- The logical topology refers to the high level idea of the interconnection of nodes and devices on the network. It also determines how the data is transmitted over the network.

Types of Topologies: -

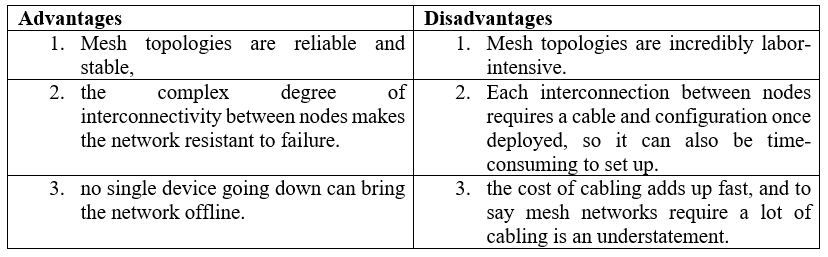
1. Bus Topology: It is responsible for the orientation of all the devices on a single cable from one end to another in a single direction. It is also known as line topology or the backbone topology. Advantages and disadvantages of Bus topology are as follows:



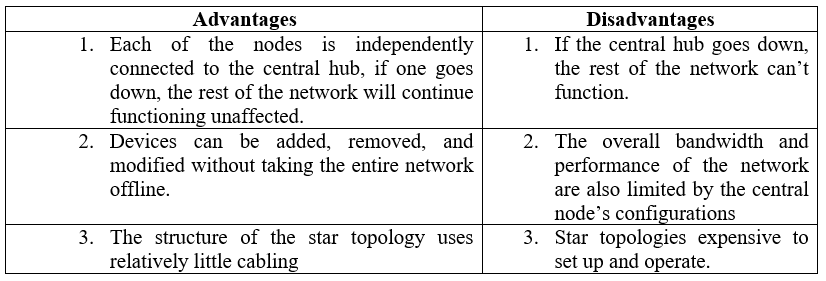
1. Ring Topology: It is a topology where nodes are arranged in rings. The data can travel in one or both direction through a ring network. Advantages and disadvantages of Ring topology are as follows:



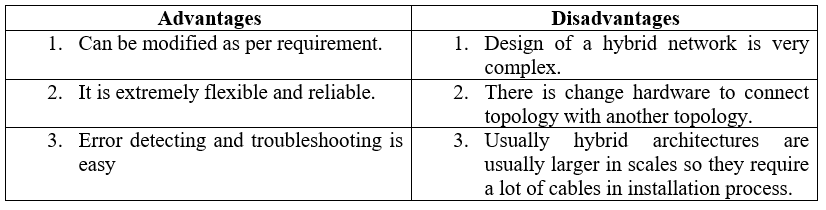
1. Mesh Topology: It is an integrated structure of point to point network. Here each node is connected to all the other nodes. Advantages and disadvantages of Mesh topology are as follows:

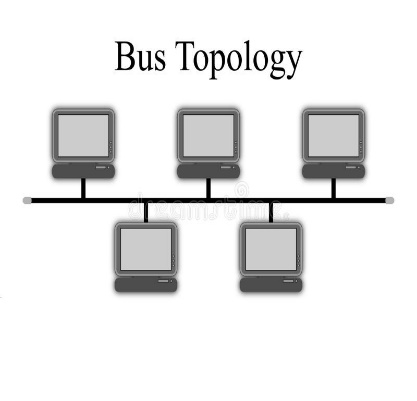
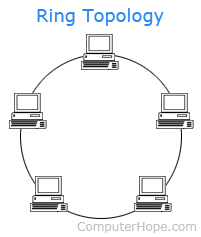
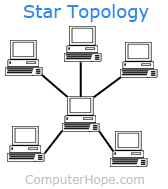
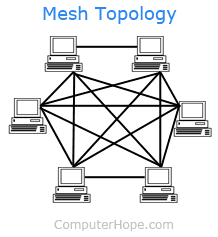
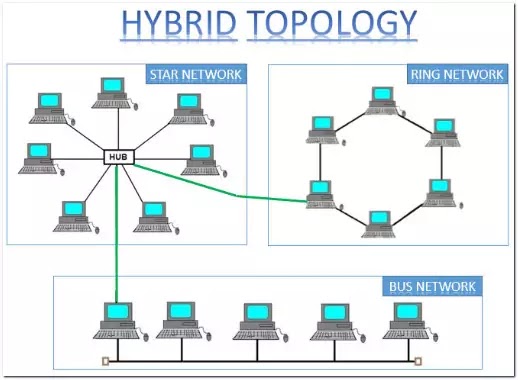


1. Star Topology: It is one of the most common topology in which every node is connected to a central hub via a fiber optic, twisted pair, or coaxial cable. The central hub is responsible for managing data transmission and hence functions as a repeater. Advantages and disadvantages of Star topology are as follows:



1. Hybrid Topology: It combines two or more different topologies. It is mostly used in larger companies where each department is having a personalized network topology as per their need. Advantages and disadvantages of Hybrid topology are as follows:

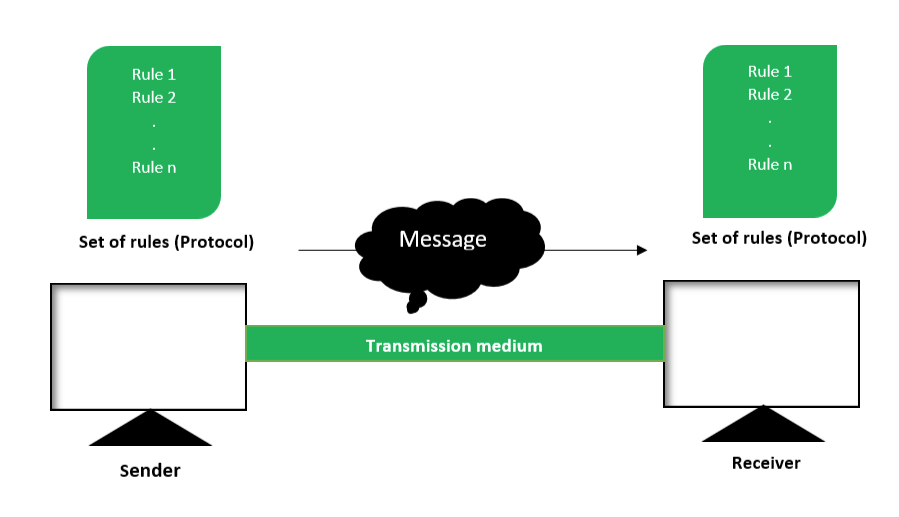


Data Communication system has five components namely:

1. Message: Any piece of data which needs to be communicated is a message. It is the most useful asset of a communication system.
2. Sender: Any device which is responsible for sending the data from transmitter is known as sender.
3. Receiver: It is the destination which receives the data send by the transmitter.
4. Transmission medium: The bridge between transmitter and receiver is known as medium. It could be through twisted pair cable, microwaves, fibre optic cable, radio waves, etc. . It can be simplex, half duplex or full duplex. Transmission medium in detail on wired and wireless is explained later.
5. Protocols: These are the set of rules which governs the transmission of data from transmitter to receiver.

Lets take an example of data communication system in sending an email. Here the user who sends an email acts as a sender, the receiver of email is the reciver and message is the data. Email is an example of application layer where SMTP protocol is used. However there are many protocols involved in the whole process. Below is the explainationof whole OSI action in sending an email.



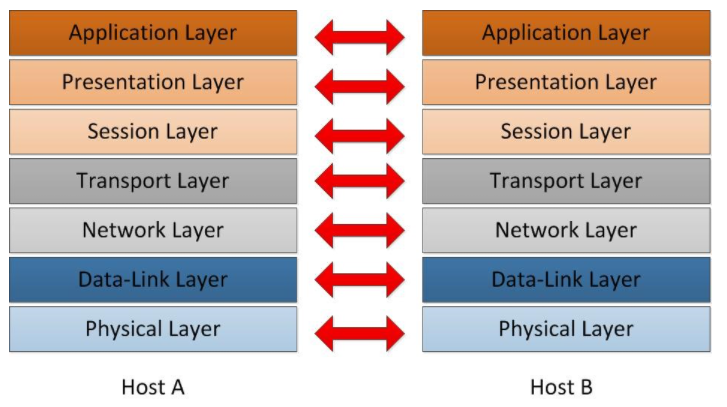
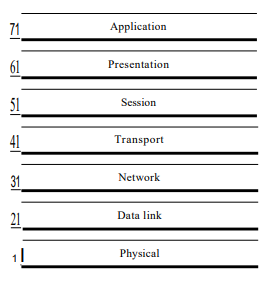
Wired and Wireless Networks:

1. Wired Networks: It is also known as guided media. Guided media are those which

OSI Model: **. Data (Packet) transmission over the internet :-**

When data is send from one server to another, it goes through all the 7 layers of the transmission model from top to bottom and bottom to top. At one side these layers talk to its upper layer and at the other side they talk to their lower layers. There is also side to side communication i.e each layer talks to their corresponding layer in the other side eg. application layer of one side communicates with only the application layer of the other side, it cannot talk to the presentation layer of the other side.

The communication between different layers for passing of the data and the network information is made possible by interfaces existing between each pair of adjacent layers. Layered functions and well defined interfaces provides modularity to the network. The OSI model is a layered framework for the designing of a network system that is establishes connection between all types of computer system.



Data is transmitted over the internet not in its actual form but rather they are subdivided into smaller packets and the transmission between computers (or server) across the internet is featured by different protocols [7]. It is a seven layered model consisting of physical, data link, internet (network), transport, session, presentation and application layer. When an email is send from one server to another, it goes to the application layer of the OSI model. It provides interface to the user in order to tell the computer how to handle the data. Gradually, the data and information moves to different layers using different protocols and reaches to its destination. The protocols has been discussed in the latter sections.

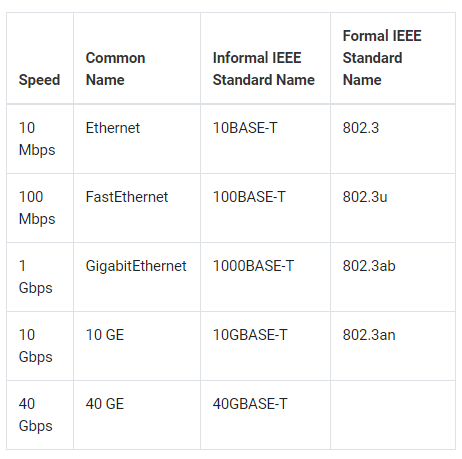
**Physical layer :-**

* It coordinates function required to carry a bit stream over physical layer.
* It is a peer-to-peer communication.
* It provides physical and electrical specification for device and medium.
* It is responsible for representation of bits and synchronization of sender and receivers clock.

**Data link layer:-**

* It makes the unliable physical layer to a reliable link.
* It converts bit streams into manageable units called frames.
* It provides physical addressing to the frames and responsible for node-to-node delivery.
* It is also responsible for error control and detection of damaged, duplicate or lost frames.
* Protocols at this layer includes:

1. Ethernet:- Ethernet is not a single thing, it refers to a family of standards. The main purpose of Ethernet is to act as a single LAN technology even if the data can pass through different types of connections (visible and copper cables, wireless connectors) at different speeds (from 10Mbps trough 100Gbps), because it uses the same data- various media and technologies. However, the network engineer should be aware of the names of at least the most commonly used Ethernet standards such as FastEthernet and GigabitEthernet.



IEEE standards include:

Logic Link Layer (LLC): 802.2

Wired Network or ethernet: 802.3

Wifi: 802.11

Bluetooth: 802.15

WiMax: 802.16

1. Token Ring :- It is a protocol used in communication of LAN Network. This topology is used to define the order in which the stations send. The connections of stations are shown below. Token is a three byte single frame. It travels around the ring. Token passing is the mechanism which is used here. Data packets are also transmitted in the same direction as that of the token. The station that carries the token is the one which transmits the data packets.
2. RS 232:- RS 232 is the communication protocol used for serial communication. It allows the connected servers to and its peripheral devices to allow serial exchange of data between them. RS 232 is used for connecting DTE i.e. data transmission equipment and DCE i.e data communication equipment.
3. FDDI/ FTTH :- It is Fiber distributed data interface/ Fiber to the home which is a set of ANSI and ISO standards for data transmission over LAN via fiber optics cable. It is applicable only to the LAN which is over the range of 200 km in diameters.

**Network layer:-**

* It is responsible for host to host delivery i.e source to destination delivery of the packets across multiple networks.
* It is responsible for providing logical address and also performs the function of routing.

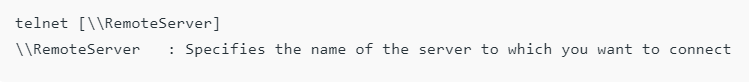
**Transport Layer:-**

* It is responsible for process to process delivery of the packets.
* It is also responsible for segmentation, sequencing and service-point addressing known as port address wich is used to achieve multiplexing.

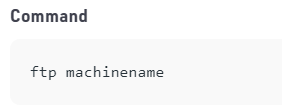
**Application Layer:-**

* It is the top most layer of the OSI model through which the user interacts. It is responsible for the services provided to the users. For example :- E-mail services, file transfer etc.
* This layer contains many protocols which includes,

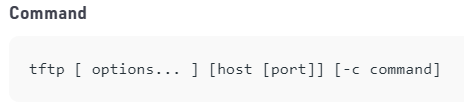
1. TELNET (TELecommunication NETwork): It allows the client to access the resources of the server It is responsible for file management and set up devices like switches. Port number is 23. Command is:



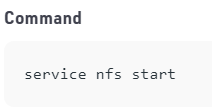
1. FTP (File Transfer Protocol): It is actually responsible for transfer of files. It promotes reliable and efficient data transfer via remote computers. Port number is 20 for data and 21 for control.



1. TFTP (Trivial File Transfer): It is a simplified version of FTP. If we know exactly what to find and where to find then TFTP is the protocol.



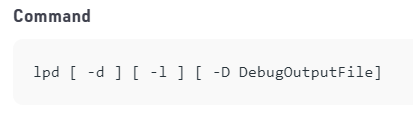
1. NFS (Network File Transfer): It allows the remote host to mount the file systems over the network and interact with those file systems as though they are mounted locally.



1. SMTP (Simple Mail Transfer Protocol): It is responsible for the movement of the emails on and across the networks. It works closely with MTA (Mail Transfer Protocol) to send data to the right email box. SMTP port number is 25.



1. LPD (Line Printer Daemon): It is responsible for printer sharing. Daemon is an agent or a server.



1. X-Windows :- It is responsible for writing the GUI based applications. It allows a program(client) to run on one server.
2. POP3 (Post Office Protocol version 3) : It is a mailing protocol which is used to receive emails to local email client from remote server. It works on two ports i.e.

Port 995 – It is used to connect using POP3 securely.

Port 110 – It is default non-encrypted port of POP3.

1. IMAP ( Internet Message Access Protocol): It is a mailing protocol which is used to receive emails to remote server from local client. It has two ports:

Port 993 – It is responsible for secure connection using IMAP securely.

Port 143 – It is default non-encrypted IMAP port.