## Data Communication:

The term "Data Communication" comprises two words: Data and Communication. Data can be any text, image, audio, video, and multimedia files. Communication is an act of sending or receiving data. Thus, data communication refers to the exchange of data between two or more networked or connected devices.

Components of Data Communication

A communication system is made up of the following components:

1. **Message:** A message is a piece of information that is to be transmitted from one person to another. It could be a text file, an audio file, a video file, etc.
2. **Sender:** It is simply a device that sends data messages. It can be a computer, mobile, telephone, laptop, video camera, or workstation, etc.
3. **Receiver:** It is a device that receives messages. It can be a computer, telephone mobile, workstation, etc.
4. **Transmission Medium / Communication Channels:** Communication channels are the medium that connect two or more workstations. Workstations can be connected by either wired media or wireless media.
5. **Set of rules (Protocol):** When someone sends the data (The sender), it should be understandable to the receiver also otherwise it is meaningless. For example, Sonali sends a message to Chetan. If Sonali writes in Hindi and Chetan cannot understand Hindi, it is a meaningless conversation.
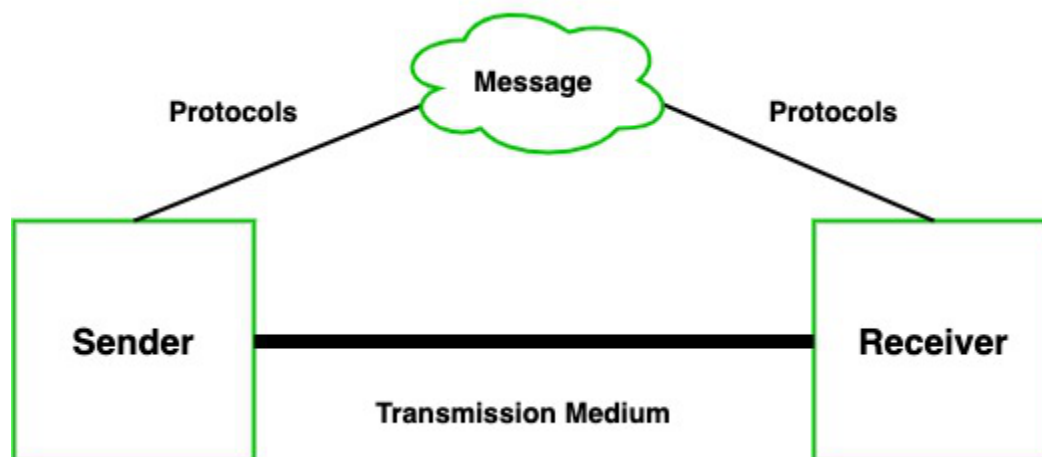

Therefore, there are some set of rules (protocols) that is followed by every computer connected to the internet and they are:

- **TCP(Transmission Control Protocol)**: It is responsible for dividing messages into packets on the source computer and reassembling the received packet at the destination or recipient computer. It also makes sure that the packets have the information about the source of the message data, the destination of the message data, the sequence in which the message data should be re-assembled, and checks if the message has been sent correctly to the specific destination.
- **IP(Internet Protocol)**: Do You ever wonder how does computer determine which packet belongs to which device. What happens if the message you sent to your friend is received by your father? Scary Right. Well! IP is responsible for handling the address of the destination computer so that each packet is sent to its proper destination.

Type of data communication

As we know that data communication is communication in which we can send or receive data from one device to another. The data communication is divided into three types:

1. **Simplex Communication:** It is one-way communication or we can say that unidirectional communication in which one device only receives and another device only sends data and devices uses their entire capacity in transmission. For example, IoT, entering data using a keyboard, listing music using a speaker, etc.
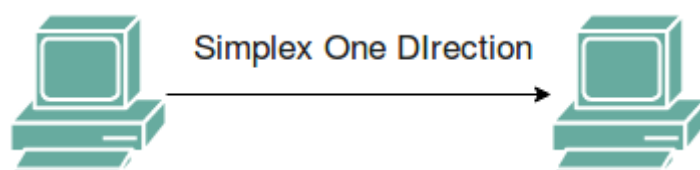
2. **Half Duplex communication:** It is a two-way communication or we can say that it is a bidirectional communication in which both the devices can send and receive data but not at the same time. When one device is sending data then another device is only receiving and vice-versa. For example, walkie-talkie.
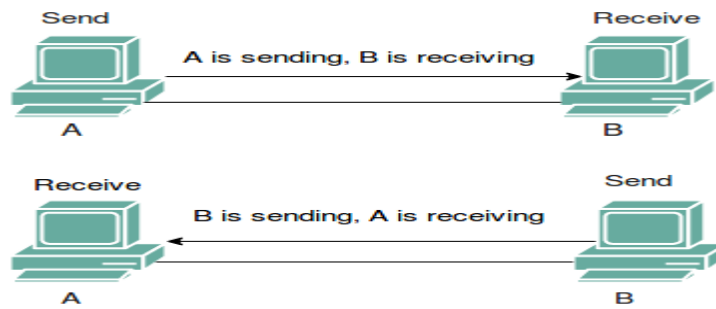
3. **Full-duplex communication:** It is a two-way communication or we can say that it is a bidirectional communication in which both the devices can send and receive data at the same time. For example, mobile phones, landlines, etc.
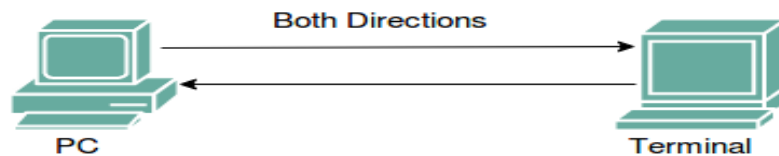
Communication Channels

Communication channels are the medium that connects two or more workstations. Workstations can be connected by either wired media or wireless media. It is also known as a transmission medium. The transmission medium or channel is a link that carries messages between two or more devices. We can group the communication media into two categories:

- Guided media transmission
- Unguided media transmission

1. Guided Media: In this transmission medium, the physical link is created using wires or cables between two or more computers or devices, and then the data is transmitted using these cables in terms of signals. Guided media transmission of the following types:

1. Twisted pair cable: It is the most common form of wire used in communication. In a twisted-pair cable, two identical wires are wrapped together in a double helix. The twisting of the wire reduces the crosstalk. It is known as the leaking of a signal from one wire to another due to which signal can corrupt and can cause network errors. The twisting protects the wire from internal crosstalk as well as external forms of signal interference. Types of Twisted Pair Cable :

- **Unshielded Twisted Pair (UTP):** It is used in computers and telephones widely. As the name suggests, there is no external shielding so it does not protects from external interference. It is cheaper than STP.
- **Shielded Twisted Pair (STP):** It offers greater protection from crosstalk due to shield. Due to shielding, it protects from external interference. It is heavier and costlier as compare to UTP.

2. Coaxial Cable: It consists of a solid wire core that is surrounded by one or more foil or wire shields. The inner core of the coaxial cable carries the signal and the outer shield provides the ground. It is widely used for television signals and also used by large corporations in building security systems. Data transmission of this cable is better but expensive as compared to twisted pair.

3. Optical fibers: Optical fiber is an important technology. It transmits large amounts of data at very high speeds due to which it is widely used in internet cables. It carries data as a light that travels inside a thin glass fiber. The fiber optic cable is made up of three pieces:

1. **Core:** Core is the piece through which light travels. It is generally created using glass or plastic.
2. **Cladding:** It is the covering of the core and reflects the light back to the core.
3. **Sheath:** It is the protective covering that protects fiber cable from the environment.

2. Unguided Media: The unguided transmission media is a transmission mode in which the signals are propagated from one device to another device wirelessly. Signals can wave through the air, water, or vacuum. It is generally used to transmit signals in all directions. Unguided Media is further divided into various parts :

1. Microwave: Microwave offers communication without the use of cables. Microwave signals are just like radio and television signals. It is used in long-distance communication. Microwave transmission consists of a transmitter, receiver, and atmosphere. In microwave communication, there are parabolic antennas that are mounted on the towers to send a beam to another antenna. The higher the tower, the greater the range.

2. Radio wave: When communication is carried out by radio frequencies, then it is termed radio waves transmission. It offers mobility. It is consists of the transmitter and the receiver. Both use antennas to radiate and capture the radio signal.

3. Infrared: It is short-distance communication and can pass through any object. It is generally used in TV remotes, wireless mouse, etc.

Computer Network

A computer network is a group of computers linked to each other that enables the computer to communicate with another computer and share their resources, data, and applications.

A computer network is a cluster of computers over a shared communication path that works to share resources from one computer to another, provided by or located on the network nodes.
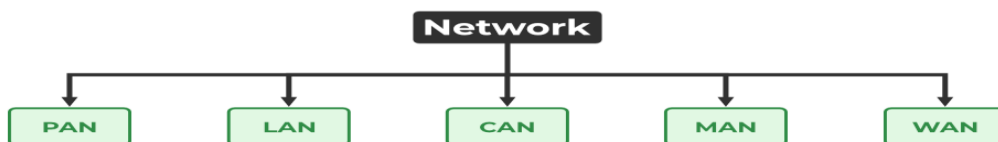
Uses of Computer Networks

- Communicating using email, video, instant messaging, etc.
- Sharing devices such as printers, scanners, etc.
- Sharing files.
- Sharing software and operating programs on remote systems.
- Allowing network users to easily access and maintain information.

Types of Computer Networks

There are mainly five types of Computer Networks
1. Personal Area Network (PAN)
2. Local Area Network (LAN)
3. Campus Area Network (CAN)
4. Metropolitan Area Network (MAN)
5. Wide Area Network (WAN)

Types of Computer Networks

These are explained below.

1. Personal Area Network (PAN)

PAN is the most basic type of computer network. This network is restrained to a single person, that is, communication between the computer devices is centered only on an individual's workspace. PAN offers a network range of 1 to 100 meters from person to device providing communication. Its transmission speed is very high with very easy maintenance and very low cost.

This uses Bluetooth, IrDA, and Zigbee as technology.

Examples of PAN are USB, computer, phone, tablet, printer, PDA, etc.
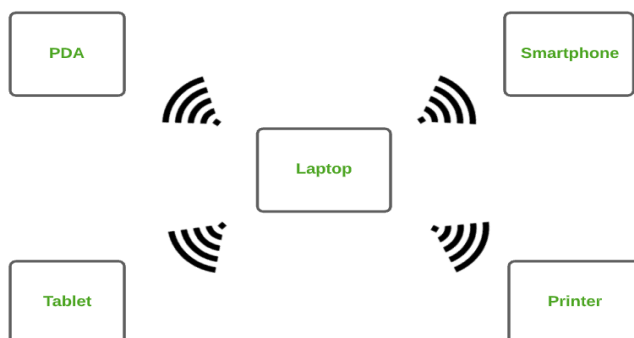

Personal Area Network (PAN)

2. Local Area Network (LAN)

LAN is the most frequently used network. A LAN is a computer network that connects computers through a common communication path, contained within a limited area, that is, locally. A LAN encompasses two or more computers connected over a server. The two important technologies involved in this network are Ethernet and Wi-fi. It ranges up to 2km & transmission speed is very high with easy maintenance and low cost.

Examples of LAN are networking in a home, school, library, laboratory, college, office, etc.
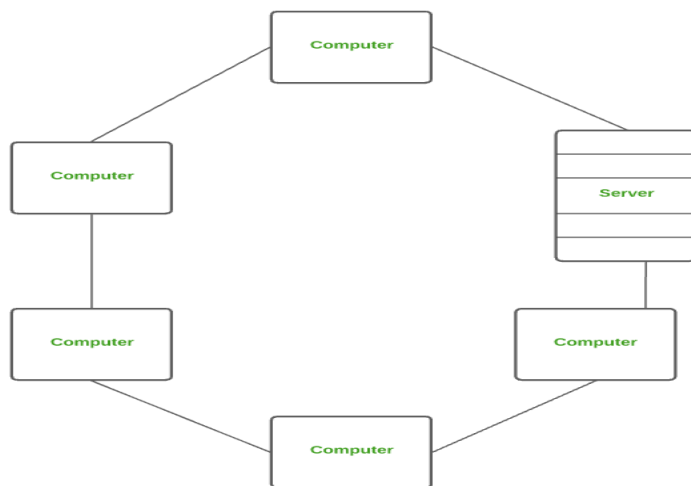

Local Area Network (LAN)

3. Campus Area Network (CAN)

CAN is bigger than a LAN but smaller than a MAN. This is a type of computer network that is usually used in places like a school or colleges. This network covers a limited geographical area that is, it spreads across several buildings within the campus. CAN mainly use Ethernet technology with a range from 1km to 5km.
Its transmission speed is very high with a moderate maintenance cost and moderate cost.

Examples of CAN are networks that cover schools, colleges, buildings, etc.
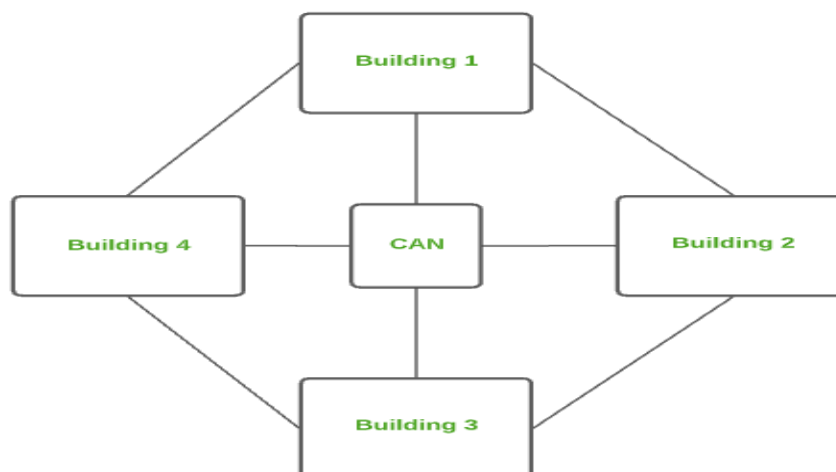
Campus Area Network (CAN)

4. Metropolitan Area Network (MAN)

A MAN is larger than a LAN but smaller than a WAN. This is the type of computer network that connects computers over a geographical distance through a shared communication path over a city, town, or metropolitan area. This network mainly uses FDDI, CDDI, and ATM as the technology with a range from 5km to 50km. Its transmission speed is average. It is difficult to maintain and it comes with a high cost.
Examples of MAN are networking in towns, cities, a single large city, a large area within multiple buildings, etc.
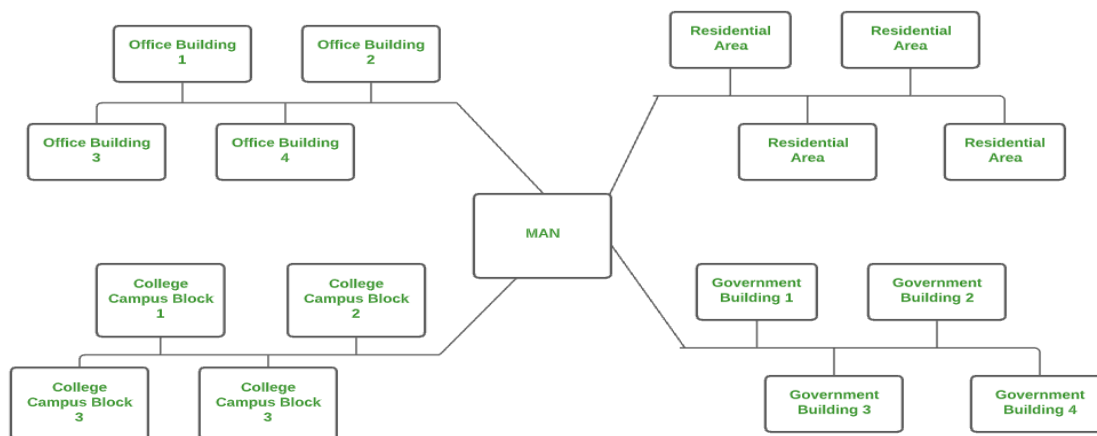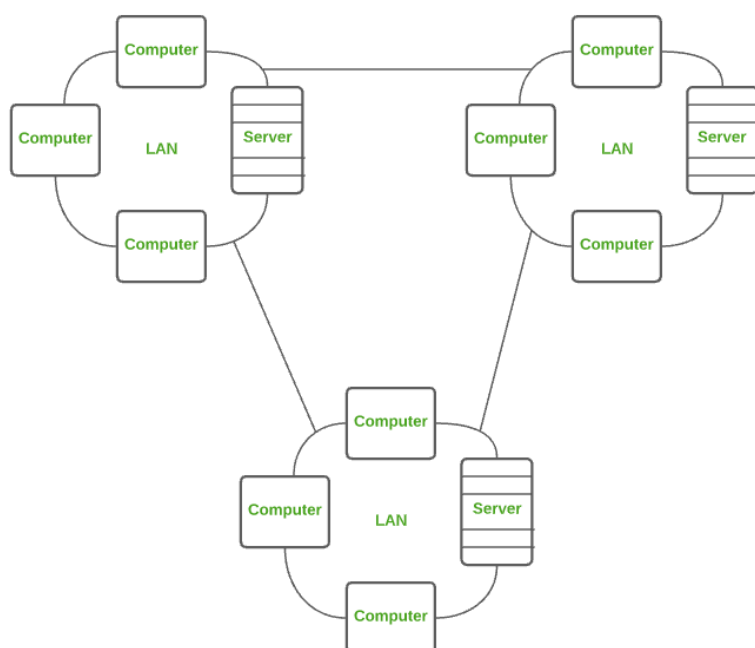
Metropolitan Area Network (MAN)

5. Wide Area Network (WAN)

WAN is a type of computer network that connects computers over a large geographical distance through a shared communication path. It is not restrained to a single location but extends over many locations. WAN can also be defined as a group of local area networks that communicate with each other with a range above 50km.

Here we use Leased-Line & Dial-up technology. Its transmission speed is very low and it comes with very high maintenance and very high cost.

The most common example of WAN is the Internet.

Wide Area Network (WAN)

Comparison between Different Computer Networks

Parameters	PAN	LAN	CAN	MAN	WAN
Full Name	Personal Area Network	Local Area Network	Campus Area Network	Metropolitan Area Network	Wide Area Network
Technology	Bluetooth, IrDA,Zigbee	Ethernet & Wifi	Ethernet	FDDI, CDDi. ATM	Leased Line, Dial-Up

Parameters	PAN	LAN	CAN	MAN	WAN
Range	1-100 m	Upto 2km	1 – 5 km	5-50 km	Above 50 km
Transmission Speed	Very High	Very High	High	Average	Low
Ownership	Private	Private	Private	Private or Public	Private or Public
Maintenance	Very Easy	Easy	Moderate	Difficult	Very Difficult
Cost	Very Low	Low	Moderate	High	Very High

Applications of Computer Networking

Some of the applications of Computer Networking are discussed below:

- **Resource Sharing:** Resource Sharing is one of the important applications of Computer Networking. You can share a single software among Multiple users. We can also share Hardware Devices via this technique.
- **Communication:** Communication Medium means various ways through which we can communicate like Email Calls, broadcasts, etc.
- **Home Applications:** Home Applications are an important application of Computer Networking. Examples are User-to-User Communication, Entertainment, E-Commerce, etc.
- **Business Applications:** Business Application is also an important application of Computer Networking. Almost all companies are doing business online with the help of Computer Networking.
- **Social Media:** Social Media is one of the recent and widely used applications of Computer Networking. It helps people in getting news, feed, current trending topics of all types, etc.
- **Access to Remote Information:** Computer Networking helps in accessing remote information from the end-users. For Example. details required for train tickets, plane tickets, etc.
- **Cloud Computing:** Computer Networking has facilitated the development of cloud computing, which allows users to store and access data and applications from remote servers via the internet.
- **Virtualization:** Networking technologies also enable virtualization, which allows multiple virtual machines to run on a single physical machine, improving resource utilization and reducing costs.
- **Online Education:** Computer Networking has revolutionized education by providing online learning platforms, distance education, and virtual classrooms.
- **Remote Working:** Networking technologies have enabled remote working, allowing employees to work from home or other locations outside of the office. This has become especially important during the COVID-19 pandemic.

- **E-commerce:** Computer Networking has facilitated the growth of e-commerce by allowing businesses to sell their products and services online and reach a global market.
- **Telemedicine:** Networking technologies have also enabled telemedicine, allowing doctors and healthcare providers to provide remote medical consultations and diagnosis to patients in remote locations.
- **Real-time Collaboration:** Networking technologies enable real-time collaboration, allowing people to work together on projects and share information in real-time, no matter where they are located.

Advantages of Computer Networking

Some of the main advantages of Computer Networking are discussed below:

- **Central Storage of Data:** Files can be stored on a central node (the file server) that can be shared and made available to every user in an organization.
- **Connectivity:** There is a negligible range of abilities required to connect to a modern computer network. The effortlessness of joining makes it workable for even youthful kids to start exploring the data.
- **Faster Problem-solving:** Since an extensive procedure is disintegrated into a few littler procedures and each is taken care of by all the associated gadgets, an explicit issue can be settled in lesser time.
- **Reliability:** Reliability implies backing up information. Due to some reason equipment crashes, and so on, the information gets undermined or inaccessible on one PC, and another duplicate of similar information is accessible on another workstation for future use, which prompts smooth working and further handling without interruption.
- **Flexible:** This innovation is known to be truly adaptable, as it offers clients the chance to investigate everything about fundamental things, for example, programming without influencing their usefulness.
- **Security through Authorization:** Security and protection of information are additionally settled through the system. As just the system clients are approved to get to specific records or applications, no other individual can crack the protection or security of information.
- **Storage capacity:** Since you will share data, records, and assets with other individuals, you need to guarantee all information and substance are legitimately put away in the framework. With this systems administration innovation, you can do most of this with no issue, while having all the space you require for capacity.

Disadvantages of Computer Networking

Some of the main disadvantages of Computer Networking are discussed below:

- **Expensive:** Execution of the network can be expensive in the case of an initial setup, as the wires and the cost of the cable are high and sometimes equipment is also costly.

- **Virus and Malware:** Computer Networking can lead to the spreading of viruses to another computer through the network.
- **Management of the network:** Management of the Network is quite difficult as it requires skilled persons to handle that large network. It requires training of people who are employed in this work.
- **Loss of Information:** In case of a crash of the Computer Network, it can lead to the loss of information or not being able to access information for some time.
- **The system can be Hacked:** In the case of Wide Area Networks(WAN), there is a threat of Hacking of the System. Some security features should be added to prevent such things.

History of the Internet:

The first question that pops into your mind is probably, "Who started the internet?". The Internet was developed by Bob Kahn and Vint Cerf in the 1970s. They began the design of what we today know as the 'internet.' It was the result of another research experiment which was called ARPANET, which stands for Advanced Research Projects Agency Network. This was initially supposed to be a communications system for the Defense Team of the United States of America - a network that would also survive a nuclear attack. It eventually became a successful nationwide experimental packet network. But when was the first Internet started? It is believed that on 6 August 1991, when the World Wide Web opened to the public.

Reference Model

A reference model is a model representing a class of domains (e.g., a reference model for production planning and control systems). It is a conceptual framework or blueprint for system's development.

It is a conceptual layout mainly used to describe how the communication between devices should occur.

- One of the main advantages of the reference model is that it defines the standards for building components of the network thereby permitting multiple-vendor development.
- Reference models define which functions should be performed at each layer of the model and thus they promote standardization.

The most important reference models are:

1. OSI reference model.
2. TCP/IP reference model.

OSI model

The Open System Interconnection (OSI) is hypothetical models that label a framework of networking for implementing protocols distributed in 7-layers. It is a non-tangible model based on some hypothetical working mechanism. This model does not achieve any real purpose in the process of networking. It is just a conceptual structure which helps in better understanding the complex interactions taking place with different devices.

The OSI model was developed by the International Standards Organization (ISO) where the model is segregated into seven layers with particular usage. These layers are shown one after another in the diagram below. Every layer is assigned to a specific function, and some protocols and each layer supplies some services to the layer next to it. The different layers are explained below:

The 7 Layers of OSI
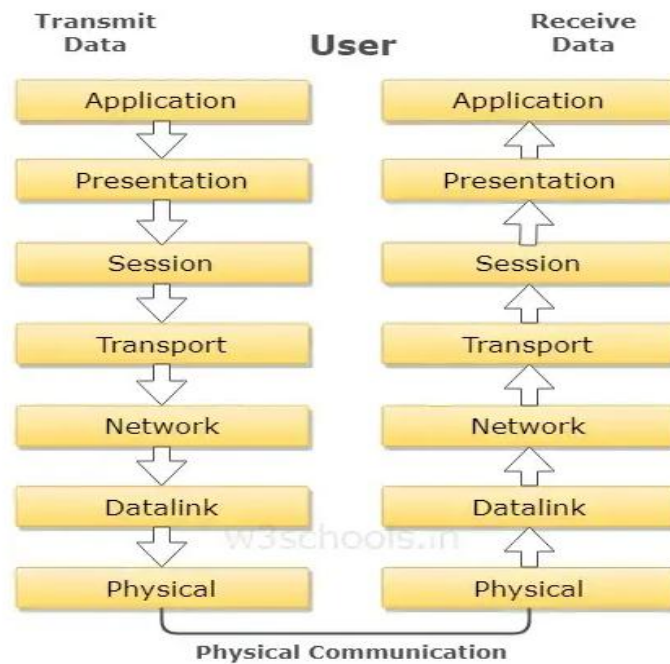
1. **The Physical Layer**: This layer is accountable for activating, preserving as well as disengaging the physical connection. In this step, the conversion of digital bits to an electrical signal is done. This layer also determines whether the link setup is simplex, half-duplex or full-duplex.
2. **The data-link layer:** In this layer, placing of links in the physical connection and placing of packets on the network frames are done. It has two sub-layers:
    1. Logical Link Control layer and
    2. Media Access Control layer (MAC)
3. **The network layer:** This layer deals with routing and addressing of data so that it can be sent to the right destination for outgoing and incoming transmissions at the packet level.
4. **The transport layer**: In this layer, packetization of data is done and managed, and then the packets are delivered along with checking for errors in data packets. Protocols that are used in this layer are the TCP and UDP.
5. **The session layer:** This layer is responsible for setting up of conversion as well as coordinating and termination of conversation session. Various services provided in this layer include verification and reconnection once interrupted.
6. **The presentation layer:** This layer typically converts incoming and outgoing data from its existing presentation format to other.
7. **The Application Layer:** In this layer, different services like manipulation of data in numerous ways is provided along with retransferring the records containing information. Operations like sign-in and password verification are done in this layer.

TCP/IP Reference Model

Protocols are a collection of rules that direct every achievable communication over the internet. The full-form of TCP/IP is Transmission Control Protocol and Internet Protocol. By the name of these two protocols, a network model is named which is a practical Internet architecture. These protocols portray the data flow between the source system and the destination system. This model has been divided into four distinct layers.

1. **The physical layer**: This layer determines the protocols which will function on a link that is the network component interconnecting the hosts. This layer implements the Ethernet for structuring the local area networks and Address Resolution Protocol (ARP) as the prime protocol.
2. **The network layer:** This layer is also termed as Internet layer in the TCP/IP model which deals with packets and the different networks for transportation of the packets across boundaries of the network.
3. **The transport layer:** This layer is accountable for preserving end-to-end communications in the network. The TCP deals with communication among hosts as well as provide multiplexing and reliability in the network.
4. **The application layer**: It presents applications having standardized data exchange mechanism. Protocols used in this layer are Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP), Post Office Protocol 3 (POP3), etc.

OSI Reference Model   **TCP/IP Reference Model**
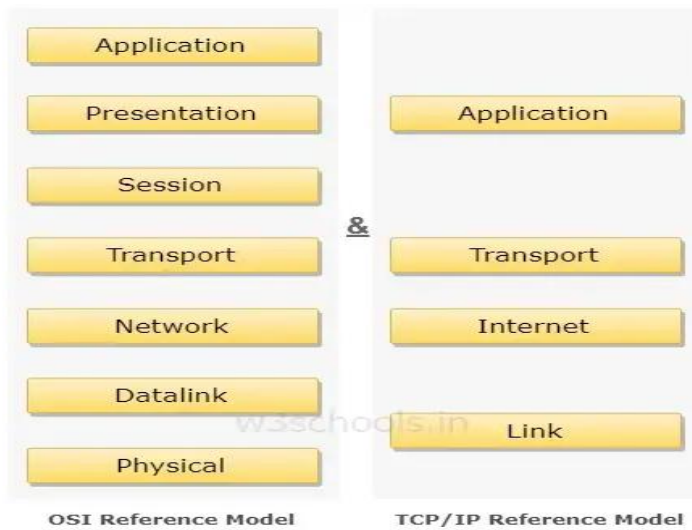
The above figure shows the different layers of the TCP/IP model concerning the OSI model.