The Concept of Data Communication evolved from sharing the computation power of computer along with various resources available in a computer environment such as printer, hard disk etc. With increasing demand for exchange of information across the globe, the need of data communication has increased in many folds. Data Communication, can be used to transfer or exchange information with in one building, one city, across cities, countries and continents. It is also possible to update and share data at different locations.

By Data Communication we mean the transportation of information from one point to another through a communication media. The word data refers to facts, concepts, and instructions presented in whatever form is agreed upon by parties creating and using the data. In the context of computer information systems data are represented by binary information units (or bits) produced and consume in form of 0s and 1s.

Data communication is exchange of data (in the form of 0s and 1s) between two devices via some form of transmission medium (such as wire cables). Data communication is considered local if the communicating devices are in the same building or a similarly restricted graphical area, and is considered remote if the devices are farther apart.

1.2 DATA COMMUNICATIONS

The main components of data communication are data sources, data sinks and communication media. The source is the originator of information, while sink is the receiver of information. The media is the path through which the information is transported to the sink from the sources. This media could be a telephone wire, a microwave system on a satellite circuit or a fiber optic line. Usually, the media is provided by one or more common communication carriers. The computer equipment is connected to the communication media through apiece of equipment called MODEM. This piece of equipment converted the digital signal to analog and passes it to the communication media through whom they are propagated towards the sink. The sink is similarly connected to the communication media through a modem and receives the propagated signals.

Data Source		Data Sink
	Media	
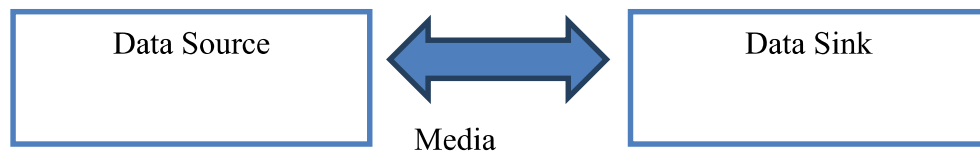
Communication Protocol

All communications between devices require that the devices agree on the format of data. The set of rules defining a format is called a protocol. At the very least, a communications, protocol must define the following

- rate of transmission (in baud or bps)
- whether transmission is to be synchronous or asynchronous
- whether data is to be transmitted in half-duplex or full-duplex mode

In addition, protocols can include sophisticated techniques for detecting and recovering from transmission errors and for encoding and decoding data.

Characteristics of Data Communication

The effectiveness of any data communications system depends upon the following four fundamental characteristics:

1. Delivery: The data should be delivered to the correct destination and correct user.

2. Accuracy: The communication system should deliver the data accurately, without introducing any errors. The data may get corrupted during transmission affecting the accuracy of the delivered data.

3. Timeliness: Audio and Video data has to be delivered in a timely manner without any delay; such a data delivery is called real time transmission of data.

4. Jitter: It is the variation in the packet arrival time. Uneven Jitter may affect the timeliness of data being transmitted

Data Communication Terminology

Data Communication is the process of transferring data from one machine to another machine such that the sender and receiver both interpret the data correctly.

1. Data Channel

In communications the term channel refers to a communications path between two computers or devices. It may refer to the physical medium, such as coaxial cable or to a specific carrier frequency (sub-channel) within a larger channel or wireless medium.

2. Baud

Pronounced bawd, it is the number of signaling elements that occur each second. The term is named after J.M.E. Baudot, the inventor of the Baudot telegraph code.

At slow speeds, only one bit of information(signaling element) is encoded in each electrical change. The baud, therefore, indicates the number of bits per second that are transmitted. For example, 300 baud means that 300 bits are transmitted each second (abbreviated 300 bps). Assuming asynchronous communication, which requires 10 bits per character; this translates to 30 characters per second (cps). For slow rates

you can divide the baud by 10 to see how many characters per second are sent.

At higher speeds, it is possible to encode more than one bit in each electrical change, 4,800 baud may allow 9,600 bits to be sent each second. At high data transfer speeds, therefore, data transmission rates are usually expressed in bits per second (bps) rather than baud. For example, a 9,600 bps modem may operate at only 2,400 baud.

3. Bandwidth

Bandwidth is the amount of data that can be transmitted in a fixed amount of time. For digital devices, the bandwidth is usually expressed in bits per second (bps) or bytes per second. For analog devices, the bandwidth is expressed in cycles per second, or Hertz(Hz).

The bandwidth is particularly important for I/O devices. For example, a fast disk drive can be hampered by a bus with a low bandwidth.

4. Data Transfer Rates

The amount of data transferred per second by a communication channel is known as data transfer rate. It is measured in bits per second (bps)

Components of Data Communication

A Data Communication system has five components as shown in the diagram below:
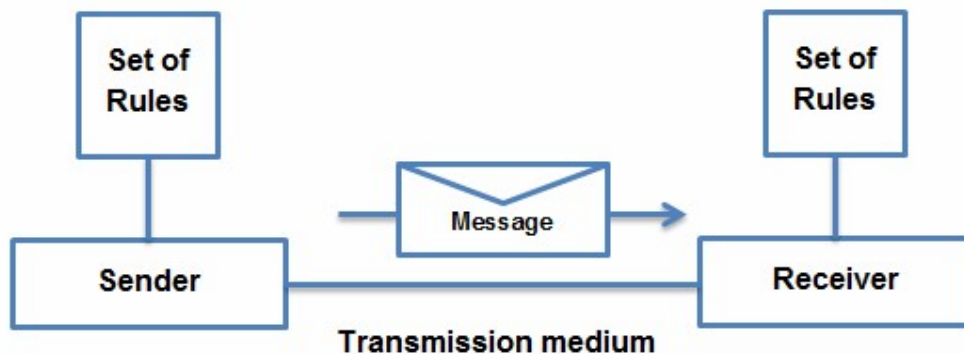
Fig. Components of a Data Communication System

1. Message:

Message is the information to be communicated by the sender to the receiver.

2. Sender

The sender is any device that is capable of sending the data (message).

3. Receiver

The receiver is a device that the sender wants to communicate the data (message).

4. Transmission Medium

It is the path by which the message travels from sender to receiver. It can be wired or wireless and many subtypes in both.

5. Protocol

It is an agreed upon set or rules used by the sender and receiver to communicate data. A protocol is a set of rules that governs data communication. A Protocol is a necessity in data communications without which the communicating entities are like two persons trying to talk to each other in a different language without know the other language

Data Representation

Data is collection of raw facts which is processed to deduce information. There may be different forms in which data may be represented. Some of the forms of data used in communications are as follows:

1. Text

Text includes combination of alphabets in small case as well as upper case. It is stored as a pattern of bits. Prevalent encoding system : ASCII, Unicode

2. Numbers

Numbers include combination of digits from 0 to 9. It is stored as a pattern of bits. Prevalent encoding system : ASCII, Unicode

3. Images

An image is worth a thousand words ‖ is a very famous saying. In computers images are digitally stored. A Pixel is the smallest element of an image. To put it in simple terms, a picture or image is a matrix of pixel elements. The pixels are represented in the form of bits. Depending upon the type of image (black n white or color) each pixel would require different number of bits to represent the value of a pixel. The size of an image depends upon the number of pixels (also called resolution) and the bit pattern used to indicate the value of each pixel. Example: if an image is purely black and white (two color) each pixel can be represented by a value either 0 or 1, so an image made up of 10 x 10 pixel elements would require only 100 bits in memory to be stored. On the other hand an image that includes gray may require 2 bits to represent every pixel value (00 - black, 01 – dark gray, 10 light gray, 11 –white). So the same 10 x 10 pixel image would now require 200 bits of memory to be stored. Commonly used Image formats : jpg, png, bmp, etc

4. Audio

  Data can also be in the form of sound which can be recorded and broadcasted. Example: What we hear on the radio is a source of data or information. Audio data is continuous, not discrete.

5. Video

Video refers to broadcasting of data in form of picture or movie.

Data Flow

We devices communicate with each other by sending and receiving data. The data can flow between the two devices in the following ways.
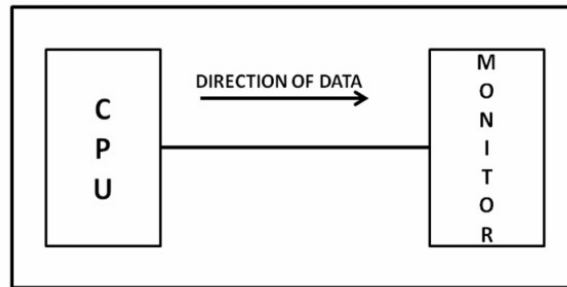1. Simplex
2. Half Duplex
3. Full Duplex

1. Simplex

Figure: Simplex mode of communication

  In Simplex, communication is unidirectional. Only one of the devices sends the data and the other one only receives the data. Example: in the above diagram: a CPU sends data while a monitor only receives data.
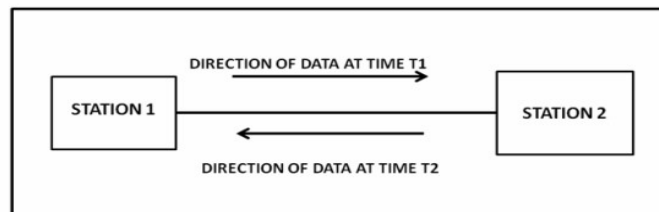
2. Half Simplex

Figure: Half Duplex Mode of Communication

  In half duplex both the stations can transmit as well as receive but not at the same time. When one device is sending other can only receive and vice-versa (as shown in figure above.) Example: A walkie-talkie.
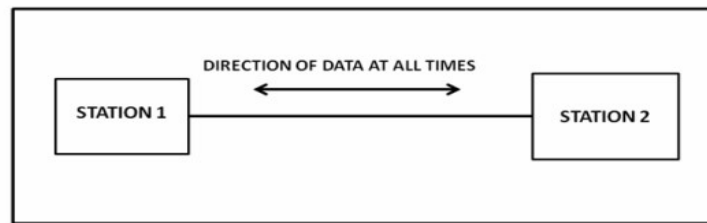
3. Full Duplex

Figure: Full Duplex Mode of Communication

In Full duplex mode, both stations can transmit and receive at the same time. Example: mobile phones

1.3 NETWORKS

A computer network is a group of computers that use a set of common communication protocols over digital interconnections for the purpose of sharing resources located on or provided by the network nodes. The interconnections between nodes are formed from a broad spectrum of telecommunication network technologies, based on physically wired, optical, and wireless radio-frequency methods that may be arranged in a variety of network topologies.

The nodes of a computer network may include personal computers, servers, networking hardware, or other specialized or general-purpose hosts. They are identified by hostnames and network addresses. Hostnames serve as memorable labels for the nodes, rarely changed after initial assignment. Network addresses serve for locating and identifying the nodes by communication protocols such as the Internet Protocol.

Computer networks may be classified by many criteria, including the transmission medium used to carry signals, bandwidth, and communications protocols to organize network traffic, the network size, the topology, traffic control mechanism, and organizational intent.

Computer networks support many applications and services, such as access to the World Wide Web, digital video, digital audio, shared use of application and storage servers, printers, and fax machines, and use of email and instant messaging applications.

1.4 NETWORK TYPES

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.

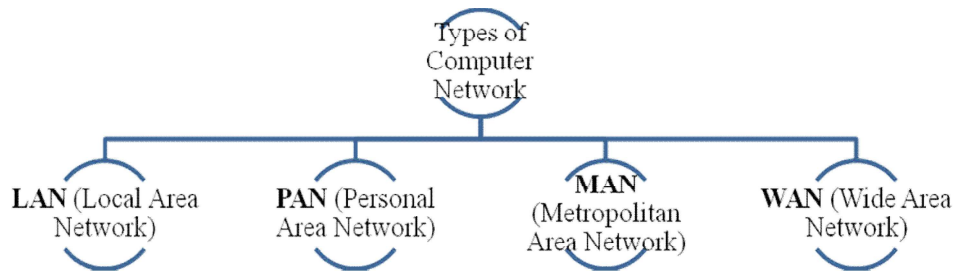A computer network can be categorized by their size. A computer network is mainly of four types:

Figure : Types of network

1. LAN (Local Area Network)

- Local Area Network is a group of computers connected to each other in a small area such as building, office.

- LAN is used for connecting two or more personal computers through a communication medium such as twisted pair, coaxial cable, etc.

- It is less costly as it is built with inexpensive hardware such as hubs, network adapters, and Ethernet cables.

- The data is transferred at an extremely faster rate in Local Area Network.

- Local Area Network provides higher security.

Figure LAN (Local Area Network)

2. PAN (Personal Area Network)

- Personal Area Network is a network arranged within an individual person, typically within a range of 10 meters.

- Personal Area Network is used for connecting the computer devices of personal use is known as Personal Area Network.

- **Thomas Zimmerman** was the first research scientist to bring the idea of the Personal Area Network.

- Personal Area Network covers an area of **30 feet**.

- Personal computer devices that are used to develop the personal area network are the laptop, mobile phones, media player and play stations.

Figure PAN (Personal Area Network)

There are two types of Personal Area Network:

➢ Wired Personal Area Network
   Wireless Personal Area Network: Wireless Personal Area Network is developed by simply using wireless technologies such as WiFi, Bluetooth. It is a low range network.

➢ Wireless Personal Area Network
   Wired Personal Area Network: Wired Personal Area Network is created by using the USB.

Examples of Personal Area Network:

➢ **Body Area Network:** Body Area Network is a network that moves with a person. **For example**, a mobile network moves with a person. Suppose a person establishes a network connection and then creates a connection with another device to share the information.

➢ **Offline Network:** An offline network can be created inside the home, so it is also known as a **home network**. A home network is designed to integrate the devices such as printers, computer, television but they are not connected to the internet.

➢ **Small Home Office:** It is used to connect a variety of devices to the internet and to a corporate network using a VPN

3. MAN (Metropolitan Area Network)

- A metropolitan area network is a network that covers a larger geographic area by interconnecting a different LAN to form a larger network.

- Government agencies use MAN to connect to the citizens and private industries.

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- In MAN, various LANs are connected to each other through a telephone exchange line.

- The most widely used protocols in MAN are RS-232, Frame Relay, ATM, ISDN, OC-3, ADSL, etc.

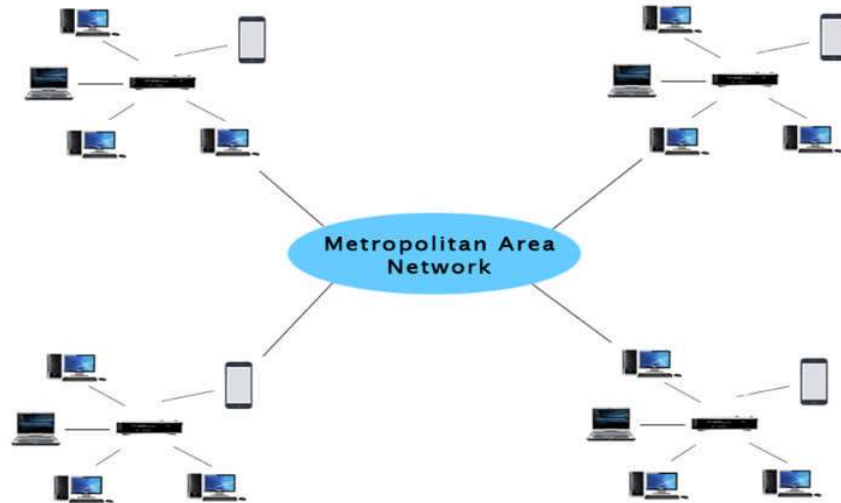- It has a higher range than Local Area Network(LAN).

Figure MAN (Metropolitan Area Network)

Uses of Metropolitan Area Network:

- MAN is used in communication between the banks in a city.

- It can be used in an Airline Reservation.

- It can be used in a college within a city.

- It can also be used for communication in the military.

4. WAN (Wide Area Network)

- A Wide Area Network is a network that extends over a large geographical area such as states or countries.

- A Wide Area Network is quite bigger network than the LAN.

- A Wide Area Network is not limited to a single location, but it spans over a large geographical area through a telephone line, fibre optic cable or satellite links.

- The internet is one of the biggest WAN in the world.

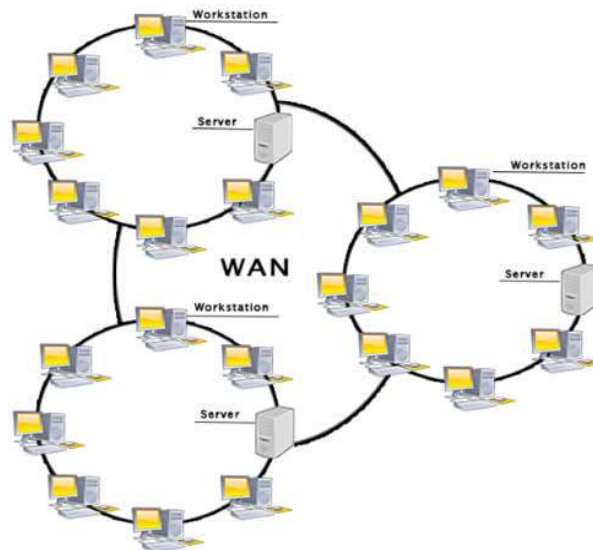- A Wide Area Network is widely used in the field of Business, government, and education.

Figure WAN(Wide Area Network)

Examples of Wide Area Network:
Mobile Broadband: A 4G network is widely used across a region or country

Last mile: A telecom company is used to provide the internet services to the customers in hundreds of cities by connecting their home with fiber.

Private network: A bank provides a private network that connects the 44 offices. This network is made by using the telephone leased line provided by the telecom company.

1.5 INTERNET HISTORY

What is Internet?
The Internet (or internet) is the global system of interconnected computer networks that uses the Internet protocol suite (TCP/IP) to communicate between networks and devices. It is a network of networks that consists of private, public, academic, business, and government networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies. The Internet carries a vast range of information resources and services, such as the inter-linked hypertext documents and applications of the World Wide Web (WWW), electronic mail, telephony, and file sharing.

Brief History of Internet
A network is a group of connected communicating devices such as computers and printers. An internet (note the lowercase letter i) is two or more networks that can communicate with each other. The most notable internet is called the Internet (uppercase letter I), a collaboration of more than hundreds of thousands of interconnected networks. Private individuals as well as various organizations such as government agencies,

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