1.1 INTRODUCTION

This Lecture provides an introduction to computer networks and covers fundamental topics like data, information to the definition of communication and computer networks.

The main objective of data communication and networking is to enable seamless exchange of data between any two points in the world.

This exchange of data takes place over a computer network.

1.2 DATA & INFORMATION

Data refers to the raw facts that are collected while **information** refers to processed data that enables us to take decisions.

Ex. When result of a particular test is declared it contains data of all students, when you find the marks you have scored you have the information that lets you know whether you have passed or failed.

The word *data* refers to any information which is presented in a form that is agreed and accepted upon by is creators and users.

1.3 DATA COMMUNICATION

Data Communication is a process of exchanging data or information

In case of computer networks this exchange is done between two devices over a transmission medium.

This process involves a communication system which is made up of hardware and software. The hardware part involves the sender and receiver devices and the intermediate devices through which the data passes. The software part involves certain rules which specify what is to be communicated, how it is to be communicated and when. It is also called as a Protocol.

1.3.1 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.

1.3.2 Components of Data Communication

A Data Communication system has five components as shown in the diagram below:
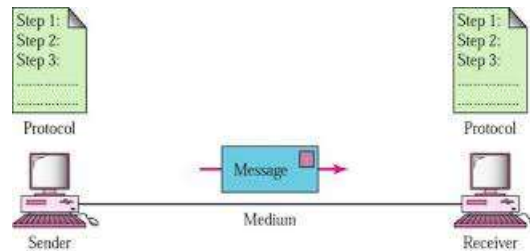
Fig(1) Components of a Data Communication System

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.

1.4 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.
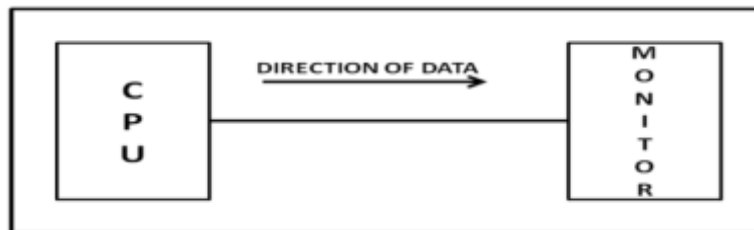5. **Video: Video** refers to broadcasting of data in form of picture or movie

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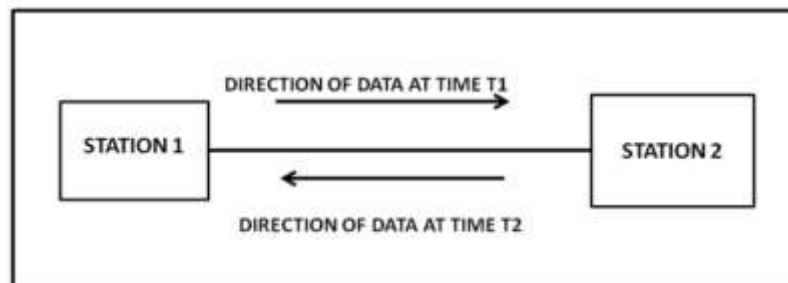1. Simplex
2. Half Duplex
3. Full Duplex

1.5.1 Simplex

Fig(2): 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 send data while a monitor only receives data.
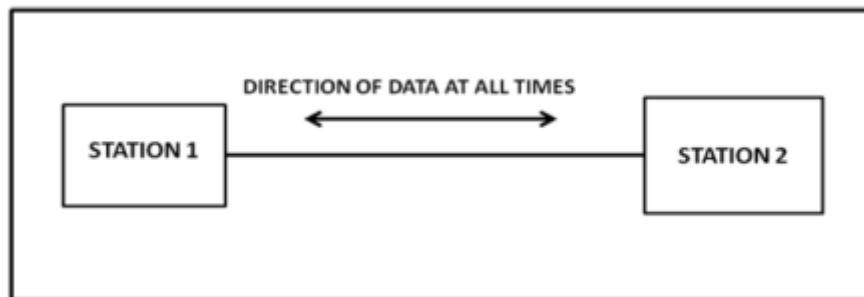
1.5.2 Half Duplex

Fig(3) 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.

1.5.3 Full Duplex

Fig(4): **Full Duplex**

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

1.6 COMPUTER NETWORK
- Computer Networks are used for data communications
- **Definition:** A computer network can be defined as a collection of nodes. A node can be any device capable of transmitting or receiving data. The communicating nodes have to be connected by communication links.
- A Compute network should ensure
  - ✓ **reliability** of the data communication process
  - ✓ **security** of the data
  - ✓ **performance** by achieving higher throughput and smaller delay times

1.6.1 Categories of Network
Networks are categorized on the basis of their size. The three basic categories of computer networks are:

A. **Local Area Networks (LAN)** is usually limited to a few kilometers of area. It may be privately owned and could be a network inside an office on one of the floor of a building or a LAN could be a network consisting of the computers in a entire building.

B. **Wide Area Network (WAN)** is made of all the networks in a (geographically) large area. The network in the entire state of Maharashtra could be a WAN.

C. **Metropolitan Area Network (MAN)** is of size between LAN & WAN. It is larger than LAN but smaller than WAN. It may comprise the entire network in a city like Mumbai.

1.7 PROTOCOL

• A Protocol is one of the components of a data communications system. Without protocol communication cannot occur. The sending device cannot just send the data and expect the receiving device to receive and further interpret it correctly.

• When the sender sends a message it may consist of text, number, images, etc. which are converted into bits and grouped into blocks to be transmitted and often certain additional information called control information is also added to help the receiver interpret the data.

• For successful communication to occur, the sender and receiver must agree upon certain rules called protocol.

• **A Protocol is defined as a set of rules that governs data communications.**

• A protocol defines what is to be communicated, how it is to be communicated and when it is to be communicated.

1.7.1 Elements of a Protocol

There are three key elements of a protocol:

A. **Syntax:**

• It means the structure or format of the data.

• It is the arrangement of data in a particular order.

B. **Semantics** :

• It tells the meaning of each section of bits and indicates the interpretation of each section.

• It also tells what action/decision is to be taken based on the interpretation.

C. **Timing**

• It tells the sender about the readiness of the receiver to receive the data

• It tells the sender at what rate the data should be sent to the receiver to avoid overwhelming the receiver.

Data Transmission

Analog and Digital Transmission:-

   Data can be transmitted either in the form of analog and digital data or analog and digital signal using Analog / Digital Transmission.

Analog Data and Digital Data

Data :-   data are raw facts that are meaningless . they are processed to form

              Information .

Analog Data :- Data that is continuous and have magnitude directly proportional to the data function is known as analog data . it is generally used to transmit real time data such as audio and video which changes the pattern of signal depending on intensity .

Digital Data :-

Data that uses discrete or uneven spectrum that if there is no continuity in data , then it is called Digital Data . it is used for transmitting text , integers or string of characters . it can be send , received and recreated no loss of content . data in digital form is represented in the form of binary number 0 and 1 .

Analog Signal and Digital Signal

Signal :- signals are the physical representation of data . data is exchanged in the form of signal through the transmission media . signals can be in the form of electrical impulse , radio wave or electromagnetic waves . signal can either be analog signal or digital signal .
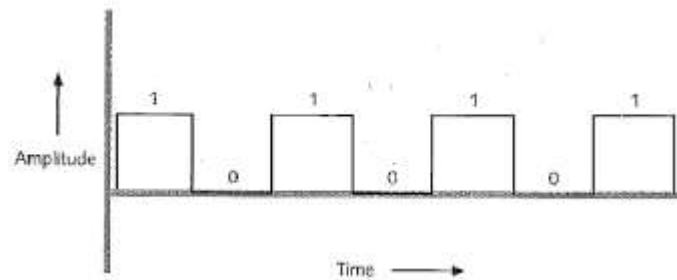
Analog Signal :-

Analog Signal is continuous signal that depends on intensity. Analog Signal is transmitted in the form of electromagnetic waves over the transmission media which is either guided transmission media such as twisted pair , coaxial cable or unguided media that include satellite communication , terrestrial microwave . Analog Signals are easily effected by noise that decrease the resolution of Analog Signal. Analog Signals are represented using sine waves .
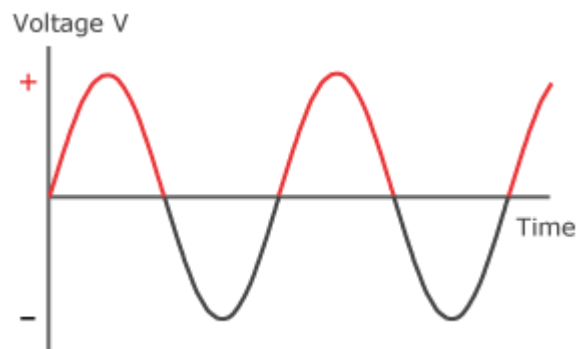
Digital Signal:-

Digital Signals are discrete signals that are independent of time and intensity . Digital Signals are transmitted in the form of sequence voltage pulses represented in binary form containing (0,1). Unlike analog signals that changes over a period of time, digital signals remain static and value of signals noted at fixed interval rather than using continuous interval. Digital Signals are not easily affected by an non

linearity such as noise. Error in Digital Signal can be detected and corrected which is not possible in analog signals.

Advantages of Digital Signal:-

- Inexpensive than analog signals .
- Digital Signals are not affected or harmed due to noise interference .

Disadvantages of Digital Signal:-

 Attenuation impairment is the major Advantages of Digital Signal, due to which the strength of signal is degraded which can result in loss of data at receiving end .

Transmission Link :-

- **Point-to-point link:-** in this link , there will be peer-to-peer connection in which only two devices are present , that share the communication channel .
- **Multipoint Link:-** in this link , there will be more than two devices that shares the communication channel.