LEARNING MATERIAL

ON

DATA COMMUNICATION AND COMPUTER

(4TH SEMESTER)

DEPARTMENT OF INFORMATION TECHNOLOGY

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SUBJECT: - DATA COMMUNICATION AND COMPUTER NETWORK
TH-2

SEMESTER-4TH

1. **Network and Protocol**

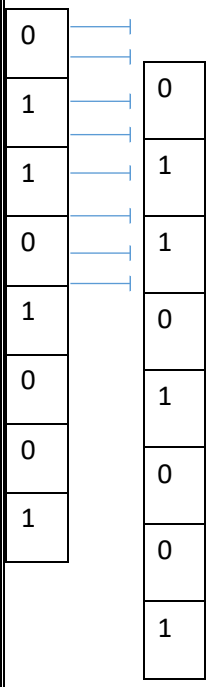
Data Transmission: Exchange of data, Commands and other information refers to between a computer and its terminal or between two computers. It digital devices. movement of bits over some physical medium Connecting 2 or more There are 2 options of transmission of bits:

I. Parallel Transmission. II.

Serial Transmission.

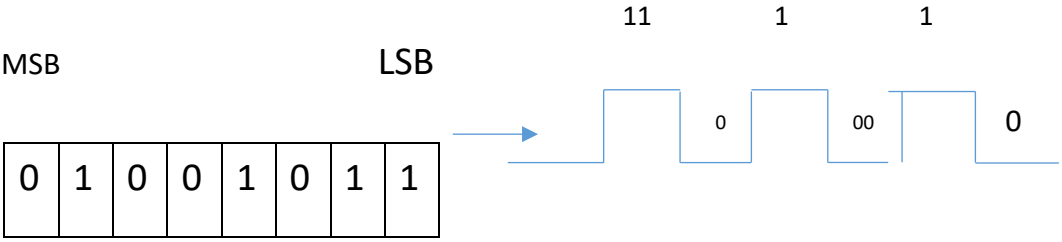
Parallel Transmission.

In this transmission, all the bits of a byte are transmitted simultaneously on separate wire and multiple circuit inter connecting the two devices. It is practically only if two devices like computer and its associated printer.



Serial Transmission.

Bits are transmitted severally one after another. The LSB is usually transmitted first.



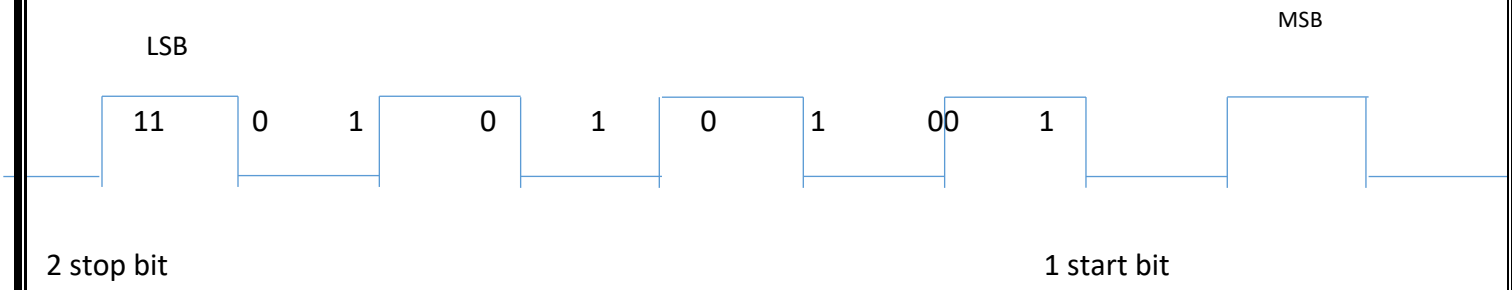
The major difficulties in Serial data transfer is to delete the beginning of each new character in the bit Stream. If it is unable to achive this it will not be able to interpret the bit stream Currently.

Timing refers to how the receiving system knows that the start of bit & the end of a group of bits.

Tow Major timing Schemes are used.

I. Asynchronous Transmission
II. Synchronous Transmission

Asynchronous Transmission

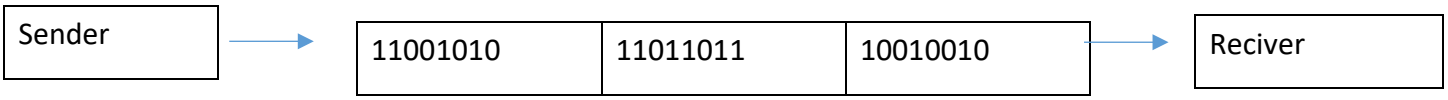


It sends only one character at a time where a character is either an alphabet or number. Each character is a start bit & ending each character is one more stop bit.

This transmission is simple & expensive to implement. It is used mainly with serial port or dial up connection. It requires start & stop bits. Ex for every byte of data add 1 start & 2 stop bits. Start bit require to send a bit.

Asynchronous transmission is normally used for speed of up to 3000bits per second.

Synchronous Transmission



It sends packet of characters at a time. A start frame is used to tell the receiving station that a new packet of character is arriving & to synchronize the receiving station internal clock proceeds each packet. The packet also have end frames. The packet can contain up to 64000 bits. Both start & end frames have a special bit sequence that the receiving station recognizes to indicate start & end of packet. The start & end frames may be only 2 bytes each. This transmission is more efficient as little as only 4 bytes (3 start & 1 stop byte) are required to transmit up to 64kb.

Start/Stop bit: - The purpose of start bit is to noticing the receiving station of a new character arriving usually the LSB send first. There could be 1 or 2 stop bit.

Different between Synchronous and Asynchronous Communication:

1. In the asynchronous scheme each character sent by the sending end includes start and stop bits as synchronous bits. 2. There can be gaps between two adjacent characters in the asynchronous communication. 3. Less Efficiency. 4. Slow transmission time. 5. Asynchronous communication used when slow speed peripherals communication with the computers.	1. In the Synchronous scheme, after a fixed number of data bytes a special bit pattern called SYNC is sent by the sending end. 2. There is no data between two adjacent character in the Synchronous communication scheme. 3. High Efficiency. 4. Fast transmission time. 5. Synchronous communication is used generally when two computers are communication to each other at a high speed.

Protocol: A network define rules and conventions for communication between network devices.

Protocol Architecture: There are only few protocol architectures that are relevant today.

- OSI Reference today.
- TCP/IP protocol suit. ➢ AMT protocol stack.

Network Architecture: Network architecture refers to the layout of the network, consisting of the hardware, software, connectivity, communication protocols and model of transmission, such a wired or wireless.

Needs for a protocol Architecture: The transfer of life and data between two computer or devices, there must be data path between the two computers, either directly or via communication network. The following task to be formed for data communication.

- The source system must activate the data communication path of the desired destination system.
- The source system must sure that the destination system in prepared to receive data.
- The file transfer application on the source system must sure that the file management program on the destination system prepared to accept and store the file for this particular user.
- If the file formats used on the two systems are incompatible, one or the other system must perform a format translation function.

Standards: Standard means set of rules. Standards are required to govern the physical, electrical and procedural characteristic of communication equipment.

Standard ISO – OSI

International Organization for standardization (ISO) developed in 1977, the open system interconnection on (OSI) model. This is a universal Architecture, developed to facilate computer communication. It breakdown the task of communication into 7 independent layers. Each layer has its own task and represents a particular function.

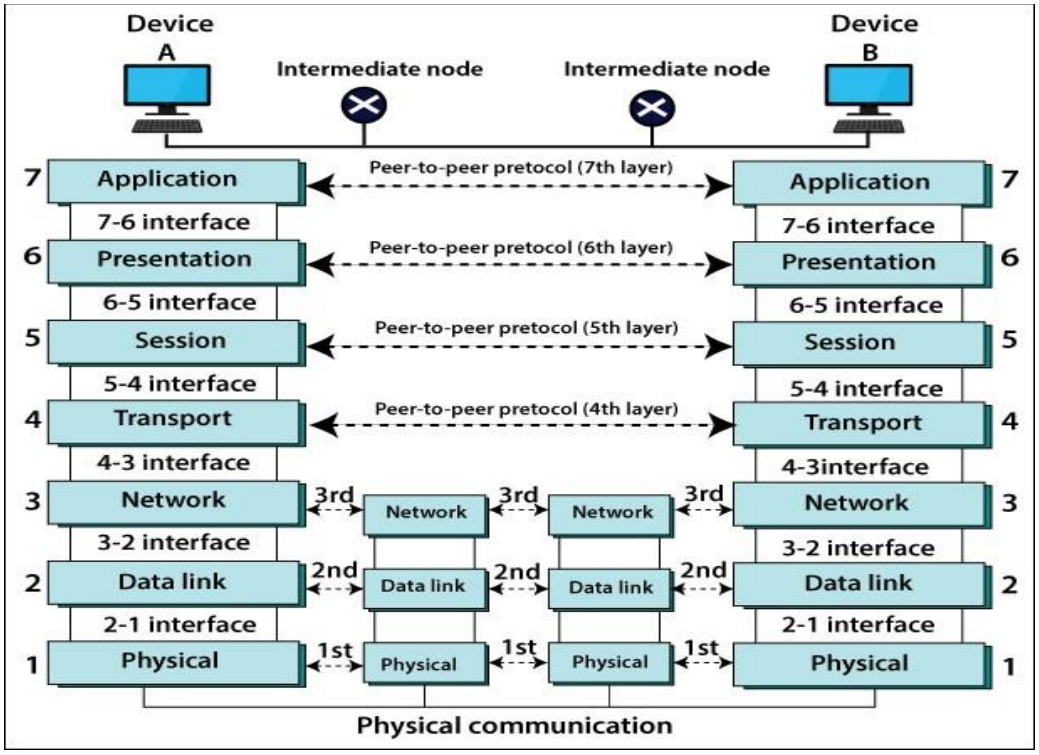
The OSI model breaks down the task of the Communication into seven layer and indepent -functions performed by seven indepent layer. Each layer takes to the neighboring layer.

OSI Working:

Let us understand how the seven layer function is sending data from computer A to computer B. Computer A issues a file transfer command to its application layer which is passes file to the presentation layer. The presentation layer reformats the data, so that B can understand it. The formatted data in then passed on to the session layer, which request for a connection established between the session layer of ‘A’ and ‘B’ and passed the data to the transmit layer. The transport layer reassembles the data. Send them to the data link layer that breaks the packet into data frames. It adds the source and destination adder with error cannot checks to each

frame. The data frames are finally transmitted to the physical layer. In physical layer data in Stream bits. 'B' receives the bits at physical layer and passes them into the data link layer, which verify that no error is occurred.

Network layer ensure that the selected rout is reliable and passes the data into transport layer. Transport layer reassemble the data packets into the file and transferred to the session layer. Session layer is conforms that the transfer is complete. The data is now passed to the presentation layer which may reformat it, to suit the environment of B, and transmits to the Application layer. Computer B can now access the original data sent by the application layer.

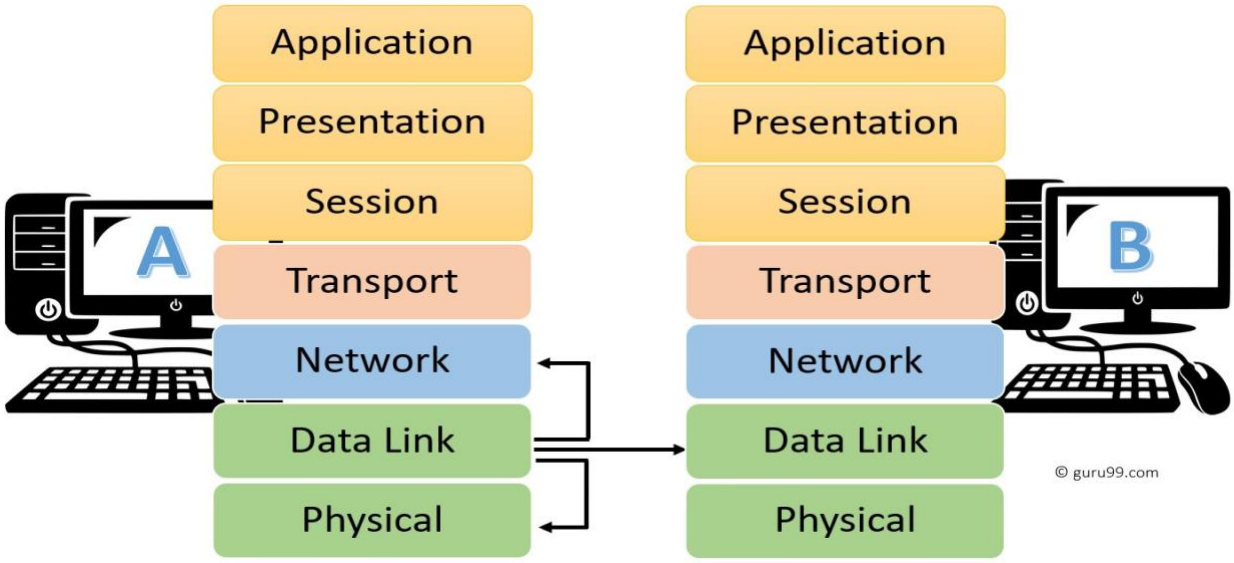


Major Functions of 7-layer OSI MODEL:

Physical Model: It transfers the raw bits form one computer to another. It defines the physical and electrical details. Electrical means pulse. Physical devices mean Hubs, Computer cable, Multiplexer etc.

Data Link Layer: It is responsible for errorfree frame transmission. The devices in data link layer is bridges.

Network Layer: It is responsible for setting up the appropriate routing of data. This layer uses the devices like routers and gateways.



Transport Layer: Errorfree Packet delivery with no loss and duplication. Reassemble the packet into original form and send to the session layer. The purpose of OSI model is open communication between different system without requiring change to the logic of the hardware and software. The OSI model is not a protocol. It is a model for understanding a network architecture.Session Layer: This layer is establishing a logical connection for the communication process is called Session.

Application Layer: It is the topmost layer of OSI model. It provides user acces to the network. It provides the services like E-mail.

The purpose of OSI model is open communication between different system without requiring change to the logic of the hardware and software. The OSI model is not a protocol. It is a model for understanding a network architecture.

SUBJECT: - DATA COMMUNICATION AND COMPUTER NETWORK TH-2

SEMESTER-4TH 2. Data

Transmission & Media:

Data Transmission: Concept and Terminology:

Data Transmission occurs between transmitter and receiver over some transmission medium. Transmission media classified into guided and unguided. In both case, communication is in the form of electromagnetic waves.

Example:

Guided Media: Twisted pair cable, Coaxial Cable and Optical Fiber.

Unguided Media: It is also known as wireless. Propagation through air, vacuum and seawater.

Guided transmission medium may be point-to-point or multipoint.

Point-to-Point: It provides a direct link between two devices. In direct link signals propagate directly from transmitter to receiver. With no intermediate devices, other than amplifier or repeaters used to increase signal strength.

Multipoint: More than two devices share the same medium. A transmission medium may be simplex, half duplex, full duplex.

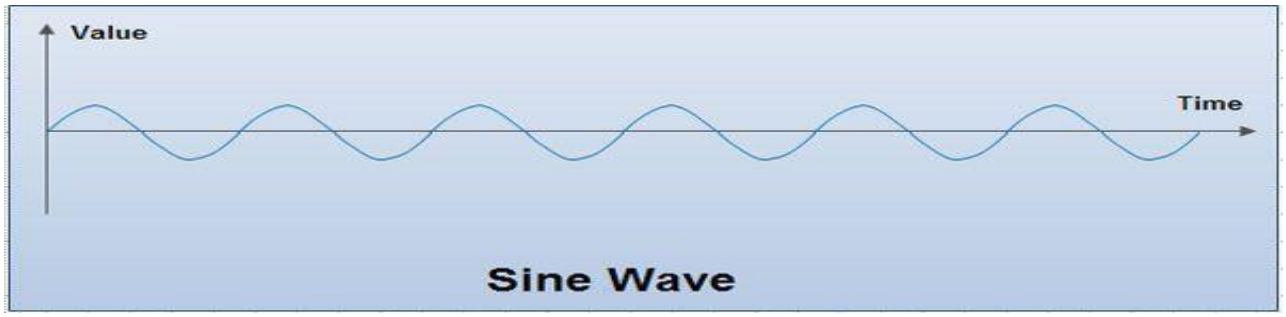
Simplex: In this case signals are transmitted in only one direction.

Half Duplex: In this case both stations can transmit but only one at a time.

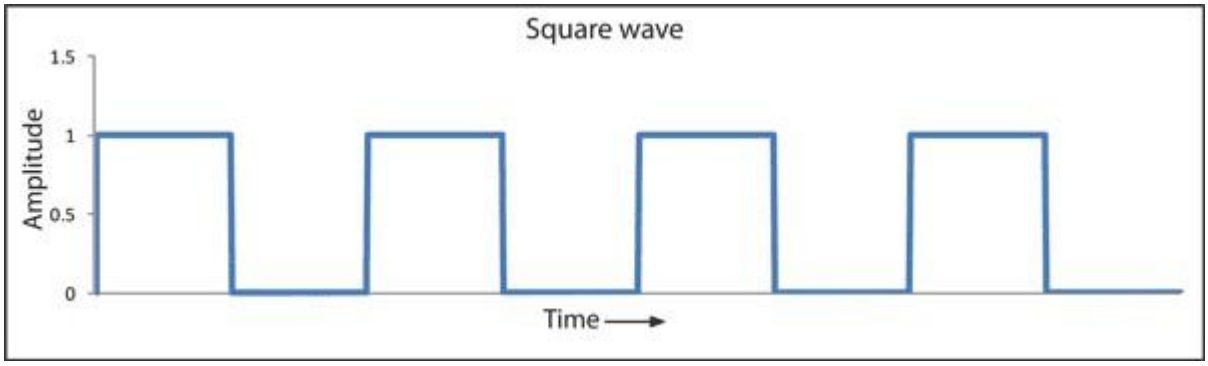
Full Duplex: In this case both stations can transmit simultaneously.

Signal: It is the physical representation of date. Signal is two type. Analog and digital.

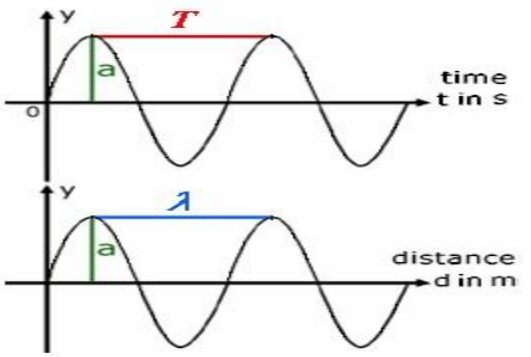
Analog Signal: It is connection electrical signal varying in time. There are no breaks or discontinuity.



Digital Signal: In digital signal the intensity maintains, a constant level for some period of time then changes to another constant level. It has two amplitude level one or zero, High/low, True/False.



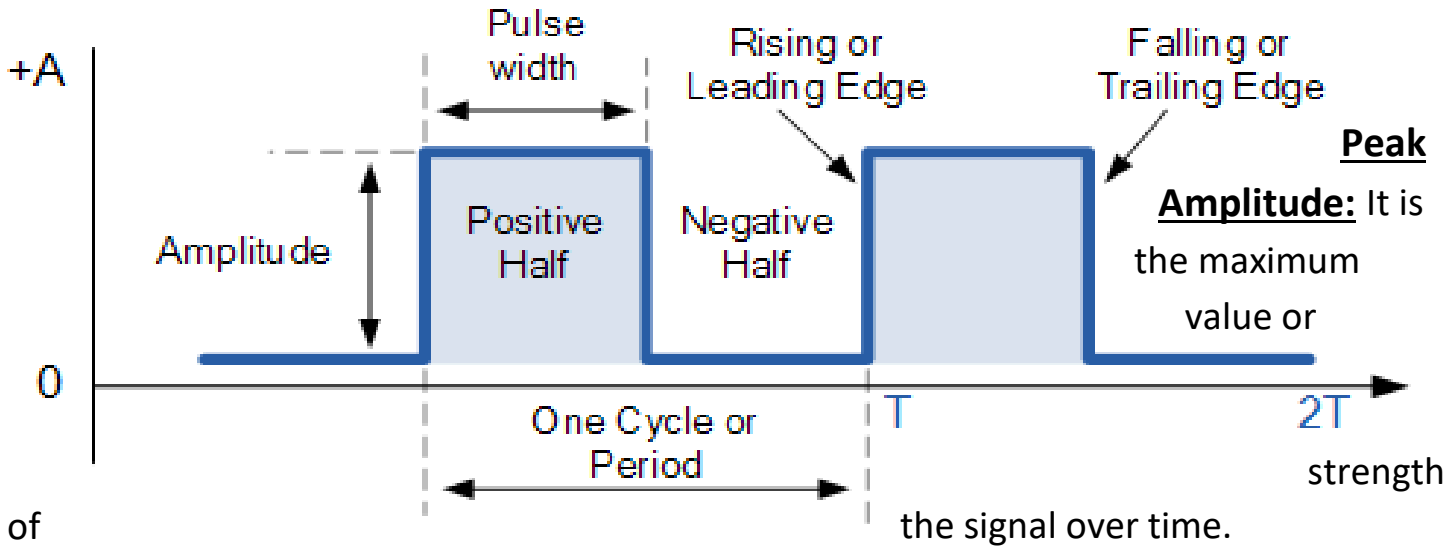
Period: Period is the amount of time (in ac) a signal needs to complete a cycle.



$$Wave\ Period = \frac{1}{Frequency} \quad or \quad T = \frac{1}{f}$$

$$Wave\ Period = \frac{Wavelength}{velocity} \quad or \quad T = \frac{\lambda}{v}$$

$$Unit\ of\ Wave\ Period: s$$

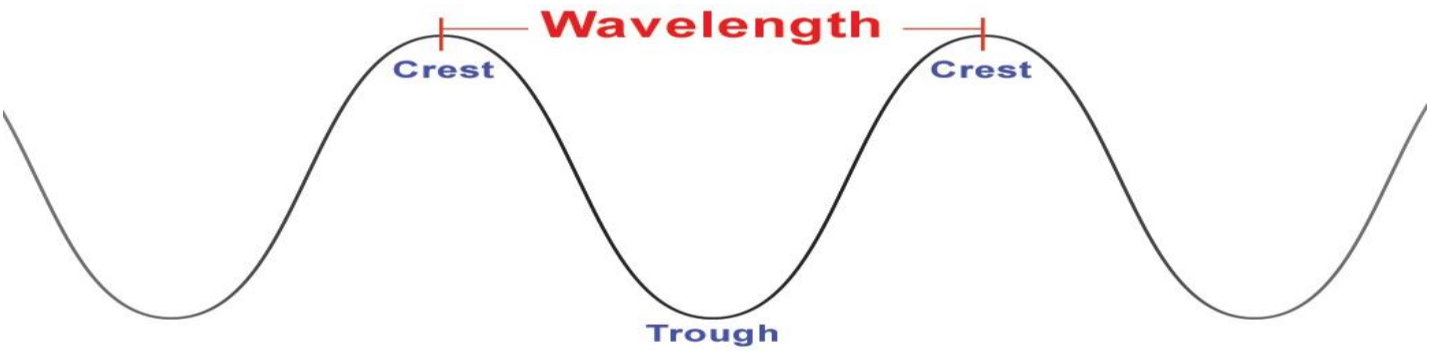


Peak Amplitude: It is the maximum value or strength of the signal over time.

Frequency: The Frequency is the rate at which the signal repeats.

Phase: Phase in a measure of the relative position in time within a signal period of signal.

Wavelength: Wavelength of a signal is the distance occupied by a signal cycle. OR web length is the distance between identical points in the adjacent cycle of a waveform signal propagated in space or along a wire.



Frequency domain concept:

Frequency: The frequency is the rate at which the signal repeats. Its unit is HZ.

Spectrum: The spectrum of a signal is the range of frequencies that it contains.

Bandwidth/effective bandwidth: Band Width refers to a range of frequencies used to transmit signals. Bandwidth may be through as the width of the pipe through which data transfer. Greater the width, larger the amount of data that can flow through it. Technically, it means the different between two frequencies. In analog transmission voice signal over copper wire. Band width is measured in cycle per second (or HZ). Ex: A telephone conversation required about 4000 Hertz (4k HZ). In digital transmission bandwidth is measured in BPS. For ex: Modem can send and receive data at 56,000 BPS (56KBPS) over ordinary telephone line.

Analog and Digital Data Transmission:

Data: Data is the entities that convey meaning.

Signal: Signals are electromagnetic representation of data.

Signaling: Signaling is the physical propagation of the signal along a suitable medium.

Transmission: Transmission is the communication of data by the propagation and processing of signal.

Analog and Digital Data:

Analog Data: Analog data is a continues value in some interval. Ex: voice, video and audio. Audio is the form of acoustic sound waves. Most analog data collected by temperature & pressure, are continuous valued. In case of Audio, the frequency components of speech may be found between approximately 100HZ to 7KHZ. In case of video, by using an interlacing technique a thicker free image without increasing the bandwidth.

Digital Data:

Digital data take on direct values. Ex: text and integer. Text means Character Strings.

IRA: (International Reference Alphabet): IRA is the most common type of text code. Each character in this code is represent 7-bit ASCII pattern. So 128 different chcracter may be represent longer than in necessary, and some of the pattern represent invisible control character.

IRA enabled characters are always stored and transmitted using 8 bits per character. The eight bit is a point used for error detection.

Analog and Digital Signals: In communication system data are propagated from one point to another by means of electromagnetic signals. An analog signal is a continuously varying electromagnetic wave that May be propagated over a verity of media, depending on spectrum, like guided or unguided media. Digital Signal is a sequence of voltage pulse that may be transmitted over a wire medium. Advantages of digital signaling is cheaper than analog signaling. Disadvantages of Digital signals is suffer more from attention.

Analog and Digital Transmission:

Analog Transmission: It is transmitting analog signal without regard to their content, the signal may be analog or digital. Analog signal will become weaker after a certain

distance. To achieve longer distances, the analog transmission system includes an amplifier which boost the energy in the signal and boost noise components. With amplifier cascaded to chive long distance, the signals become more and more distorted.

Digital Transmission: A digital signal can be transmitted only a limited distance before attenuation, noise and other impairments of the data. To achieve long distance, repeaters are used. Repeater receive the signal and regenerate the signal. Due to repeater the attention is overtime. The same technique may be used with an analog signal if the signal carries digital data. Digital transmission is more popular because: -

- **Digital Technology:** The advantages of LSI (Large-Scale Integration) and VLSI technology is dropping of cost and size of the circuitry.
- **Data Integrity:** Using of repeater than amplifier, the effect of noise and other signal impairments are not cumulative.
- **Capacity Utilization:** Digital signal become cost effective to transmission over very high bandwidth, satellite chamber and optical fiber. A high degree of multiplexing required to utilize such capacity effectively.
- **Security and Privacy:** Encryption techniques can be applied to digital data and to analog data that have been digitalized.
- **Integration:** By treating analog and digital data digitally, all signals have the same form and can be treated similarly. So economic and convenience can be achived by integrating voice, video and digital data.

Transmission Impairment: The term refers to a condition that causes information to be lost in a signal.

Transmission media are not perfect. This means that the signal at the beginning and end of the medium are not same. Sent data are received data are not same. Three types of impairment usually occur. 1. Attenuation, 2. Distortion, and Noise.

Attenuation: Attenuation means loss of energy. When a signal travels through a medium, it losses some of its energy so that it can overcome the resistance of the medium. To compensate for this loss, amplifiers are used to amplify the signal.

Distortion: Distortion means that the signal changes its form or shape. Distortion occurs in a composite signal, mode of different frequencies. Each signal has its own

propagation speed through a medium, therefore, its own delay is arriving at the final destination.

Noise: Noise is another problem. Several type of noise such as Thermal noise, Induced noise, Crosstalk noise and Impulse noise may corrupt the signal. Thermal noise is the random motion of electrons in wire. Induced noise is coming from sources such as motors and appliances. Crosstalk noise is the effect of one wire on the other. Impulse noise is a spike (a signal with high energy in a very short period of time.) that comes from lightning or power lines.

Transmission Medium: Transmission medium is the physical path between transmitter and receiver. Transmission medium is two types.

1. Guided
2. Unguided

Guided: In guided media electromagnetic waves are guided along solid medium such as

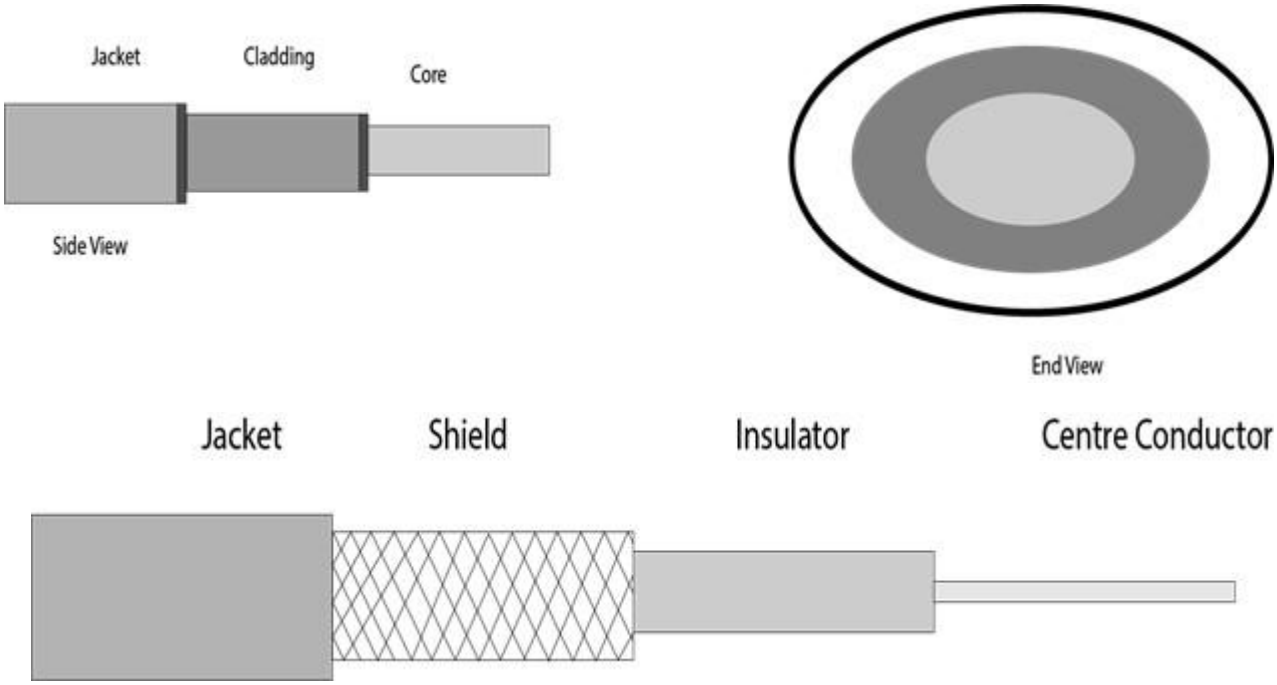
1. Copper twisted pair.
2. Copper Co-axial cable.
3. Optical fiber.

Quality of data transmission are depending upon both transmission medium and signal.

Twisted pair cable: It is the most widely used and least expensive medium.

Physical Description: It is consisting of two insulted copper wire arranged in a regular spiral pattern. A wire-pair acts as a signal communicate link. Number of these pairs bundled together and wrapping by a sheath. The twisting tends decrease the cross-talk interference between adjacent pairs of cable. The wires is a pair have thickness from 0.4 to 0.9.

Appliances: 1. This cable is applicable for both analog and digital. 2. This is commonly used for telephone network. 3. It is also used in house private branch exchange (PBX). 4. It is less expensive than co-axial and fiber optical.



Transmission Characteristics:

- For analog signals, amplifiers are required about every 5 to 6 km.
- For digital transmission (for both analog and digital signal), repeaters are required every 2 to 3 km.
- Twisted pair is limited distance, bandwidth and data rate compared to co-axial and fiber optics.
- Attention for twisted pair is very strong.

Twisted pair cable is two types.

- UTP (Unshielded twisted pair cable) is used in ordinary telephone wire.
- STP (Shielded Twisted pair) provided better performances at higher date rates. It is improved variety ad reduce interference due to metallic braid or sheathing.

Co-axial cable:

- It consists of two conductors.
- It operates over wider range of frequencies.
- It consists of a hollow outer cylindrical conductor that surrounds a signal inner wire conductor.
- The outer conductor is covered with a shield jacket.

- Its diameter is 1 to 2.5cm.

Appliances:

- TV distribution.
- Long-distance telephone transmission.
- Short-run computer system link.
- LAN.

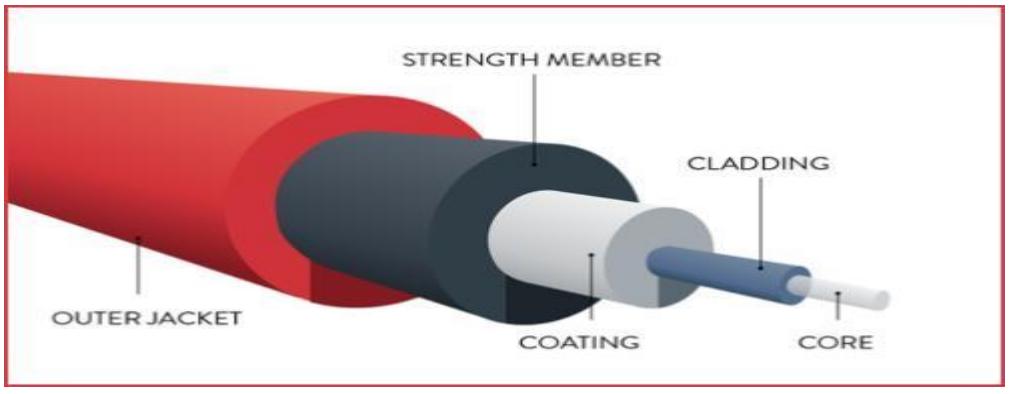
Transmission Characteristics:

- It transmits both analog and digital signals.
- It used higher frequencies and data rates.
- Less interferences to crosstalk.

Optical Fiber:

Physical Description:

- A optical fiber is a thin (2 to 125 um), Flexible medium guiding an optical ray.
- A optical fiber cable has a cylindrical shape and consist of core, cladding and jacket.
- Core is the innermost section and consist of fiber or glam or plastic and diameter is 8 to 100 um.
- Each fiber is surrounded by cladding. Cladding is made of glass or plastic different from core.
- The outermost layer is jacket. Jacket is composed of plastic and other material.



- Glass or plastic core.

- Laser or light emitting diode.
- Specially designed jacket. ➢ Small size and weight.

Application: Optical fiber uses a long-distance telecommunication and use in military application. Following are the characteristic-

1. Greater Capacity:
    - Higher Bandwidth so data rate of fiber optics is very heigh.
    - Data rate is hundreds of Gbps over tens of Kilometers.
    - A single fiber optical can carry 3,000,000 full duplex voice calls or 90,000 Tv chambers.
2. Smaller size and higher weight:
    - Optical fiber is very thin its diameter is sightly thicker than a human hair.
3. Lower Attenuation:
    - Attenuation is significantly lower than twisted pair and co-axial cable.
4. Electromagnetic Isolation: Optical fiber is electrically non-conductive, so it does not act as an antenna to pick-up electromagnetic signals.
5. Greater Repeater Spacing: Repeater spacing is tens in km. and hundreds of kms have been demonstrated.
6. Channel capacity: A given communication system has a maximum rate of data is known as channel capacity.

Wireless Communication: Wireless communication is the transfer if information between two or more points that are not connected by an electrical conductor. The most common wireless technologies use radio.

1. Microwave Frequencies: Frequencies is the range of about 1 GHZ to 40 GHZ are referred to as microwave frequencies.
2. Radio Range: Frequencies is the range of 30 MHZ to 1 GHZ are referred to as the radio range.

For unguided media transmission and reception are achieved by antenna.

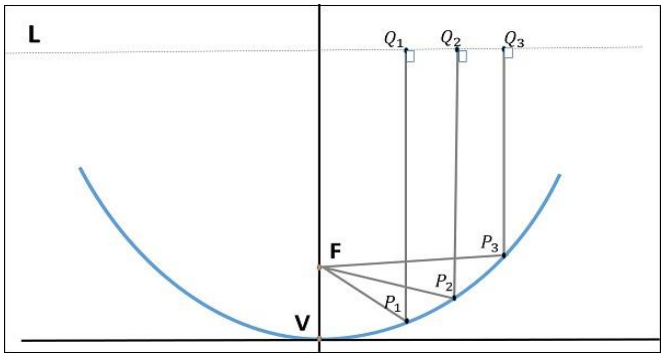
Antenna: Antenna (or Arial) is an electrical device which converts electrical power into radio waves and vice versa.

- It is usually used with radio transmitter or, radio receiver.
- For transmission of a signal electrical energy from the transmitter is converted into electromagnetic energy by the antenna and radiated into the surrounding environment (atmosphere, space, water).
- For reception of a signal electromagnetic energy is converted into electrical energy and fed into the receiver.
- In two ways communication the same antenna can be used for transmission and reception.
- An antenna will radiate power in all direction but does not perform equally in all direction.

Isotropic Antenna: An isotopic antenna is a point is space that radiates power in all directions equally.

Parabolic Reflective Antenna: This antenna uses a parabolic reflector, a curved surface with a cross sectional shape of a parabola, to direct the radio waves.

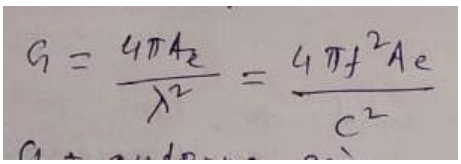
- Its main advantage is high directivity.
- High gained antenna for point-to-point communication.
- It is used in microwave and satellite appliances.
- The most common form is dish shape called disk antenna.



- Parabolic antenna based on geometrical properties.
- If a parabola is revolved about its axis, the surface generated is called parboiled.
- The fixed point to point is called focus.
- The fixed line is called directrix.

Antenna Gain

- The directive qualities of an antenna are measured by a dimensionless parameter called its gain.
- Gain in the ratio of power received by the antenna from a source along beam xis to the power received by a isotopic antenna. ➢ The gain of a parabolic antenna is



G= antenna gain
Ae= effective area
f= carrier frequency
c= speed of light
lambda(λ)= carrier wavelength

Terrestrial microwaves

- The terrestrial microwave transmission uses the radio frequency 1 to 4 ➢ The transmitter in a parabolic dish to get the best frequency and transmission.
- Both private network and common carrier can use terrestrial microwaves.

Application

- Terrestrial microwaves are used both radio (voice and TV transmission. ➢ It can also use for CCTV (Closed circuit TV) ➢ It can use a data link between LANs.

Advantages:

- It can cover a wide bandwidth and has multichannel transmission.
- It requires fever amplifier and repeaters for making its good quality.

Dis- advantages

- It can be expensive.
- The towery end receptors are costly.

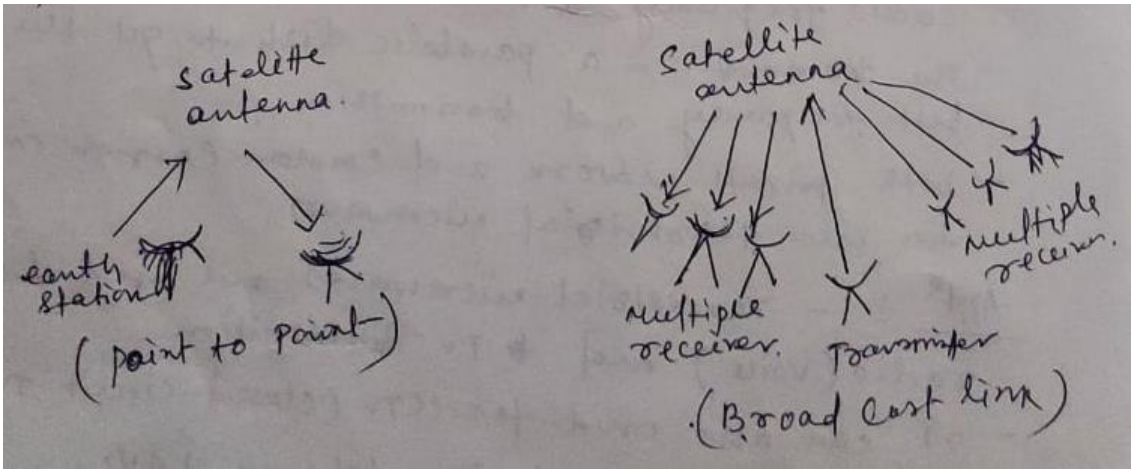
Satellite microwave

Satellite microwave is used to link two or more ground based microwave transmitter/ receives known as earth station or ground station.

Satellite receives on are frequency called uplink, amplifies or repeats the signal and transmit it on another frequency called downlink.

Transponder

A transpolar receive and transmits radio signal at a prescribed frequency range. The term transponder in the combination of transmitter and responder.



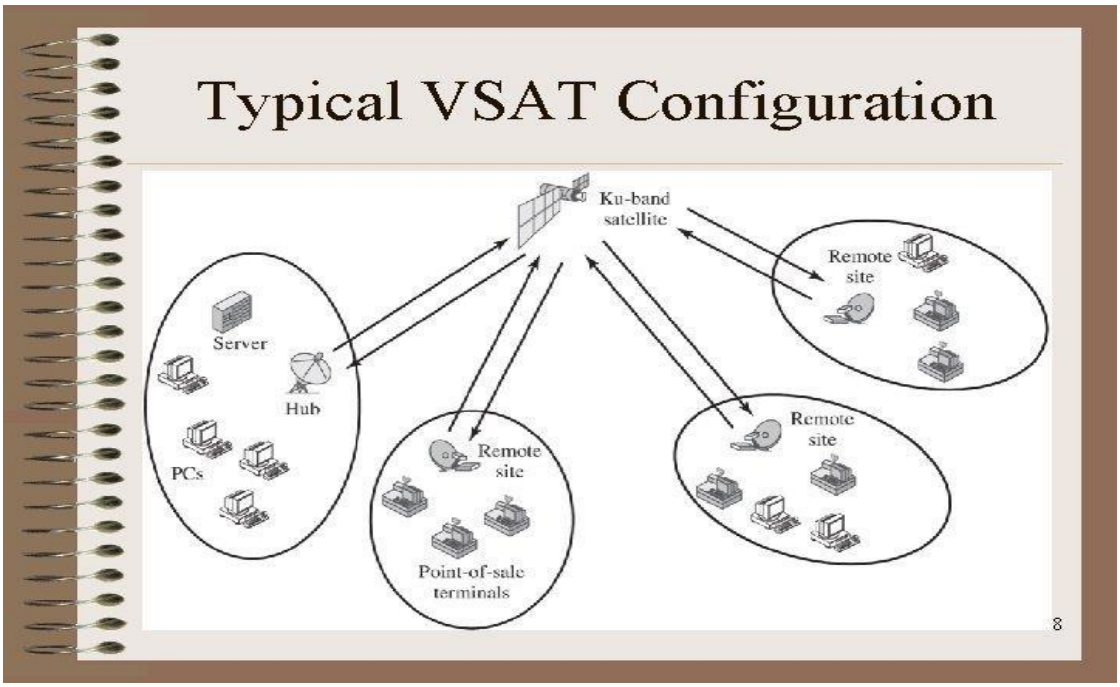
Appliances of satellite microwave:

Most implement appliances for the satellite is:

Television Distribution

- Long-distance telephone transmission ➢ Private business networks.
- Satellite transmission used point-to-point trunks between telephone exchange office.
- The most appliances of satellite technology to TV distribution is direct broadcast satellite (DBS).
- There are number of business data appliances for satellite. VSAT (Very small aperture terminal) system can divide the total capacity into a number of channels

and lease these channels to individual business users. A number of subscriber stations are equipped with low cost VSAT antenna.



SUBJECT: - DATA COMMUNICATION AND COMPUTER NETWORK TH-2

SEMESTER-4TH

3. DATA ENCODING

Data Encoding: In computer, encoding is the process of putting a sequence of character (letter, numbers, punctuation, and contain symbols) into a specialized format for efficient transmission or storage.

Decoding is the opposite process- the conversion of an encoded format back into the original sequence of characters.

Digital data, Digital signal: A digital signal is sequence of discrete, discontinuous voltage pulse. Each pulse is a signal element. Encoding scheme is an important factor in how successfully the receiver interprets the incoming signal.

Digital data analog signal: A modem converts digital data to analog signal. There are 3 ways to modulate a digital signal on an analog signal.

(i) amplitude shift keying (ASK): if a form of modulation which represent digital data on variations in the amplitude of a carrier wave. Two different frequencies represent '0' and '1'.

(ii) Phase shift keying (PSK): The phase of the carrier is discretely varied in relation either to a reference phase or to the phase of the immediately proceeding signal element, in accordance with data being transmitted. Phase of carrier signal is shifted to represent '0', '1'

(iii) Frequency shift keying (FSK): In FSK the change in frequency define different digits. Two different frequency represent- '0', '1'

Analog data to digital signal: The process is called digitization. Sampling frequency must be at least twice that of highest frequency present in the signal.

Digital modulation: In digital modulation, an analog carrier signal is modulated by a digital conversion.

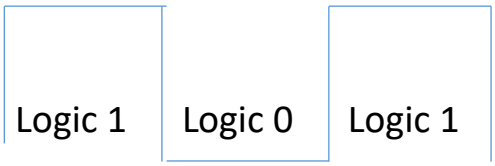
Types of digital modulation is

- Amplitude shift keying (ASK)
- Frequency shift keying (FSK)
- Phase shift keying (PSK)

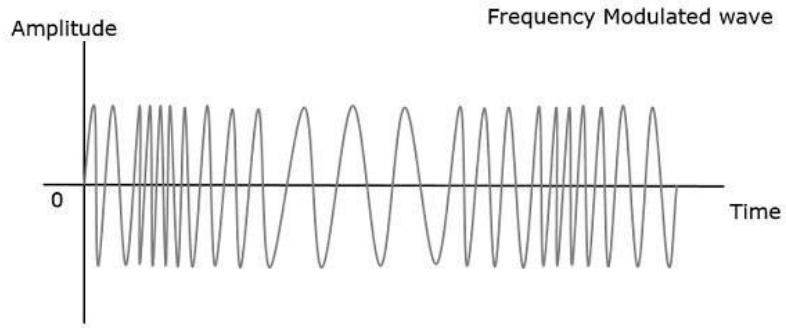
Amplitude Shift Keying (ASK):

In is the simplest digital modulation scheme. Two binary values, 0 and 1 are represented by two different amplitude. Both frequency and phase remain constant while amplitude changes. ASK transmission is highly noise interference.

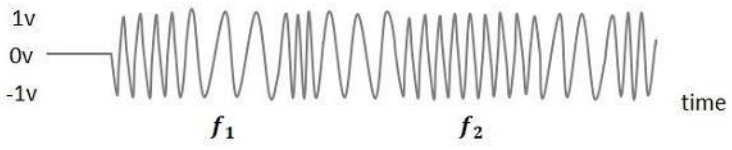
The amplitude of analog signal varies, keeping frequency and phase constant. The level of amplitude can be used to represent binary logi 0's and 1's and that can consider as off/on keying operation. '0' is the absence of easier and 1 is the presence of carrier.



(Modulating Frequency)



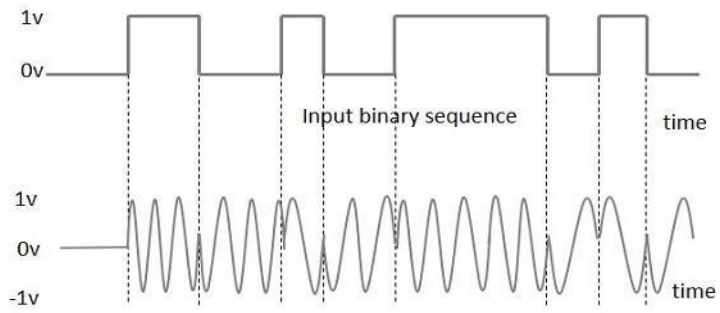
Frequency shift keying: In this method the frequency of the carrier is changed to two different frequencies depending on the logic state of the I/p bit stream. High cases center frequency to increase to maximum and low causes the center frequency decrease to minimum.



FSK Modulated output wave

Signaling: Signaling is the physical propagation of the signal along a suitable medium.

Phase shift keying: In this method the phase of the carrier changes between phases. In case of PSK a finite number of phases are used. Each phase assigned a unique bit pattern.



BPSK Modulated output wave

Analog and Digital Data Transmission:

Data: Data is the entities that convey meaning.

Signal: Signals are electromagnetic representation of data.

processing of signal.

Analog and Digital Data:

Analog Data: Analog data is a continues value in some interval. Ex: voice, video and audio. Audio is the form of acoustic sound waves. Most analog data collected by temperature & pressure, are continuous valued. In case of Audio, the frequency components of speech may be found between approximately 100HZ to 7KHZ. In case of video, by using an interlacing technique a thicker free image without increasing the bandwidth.

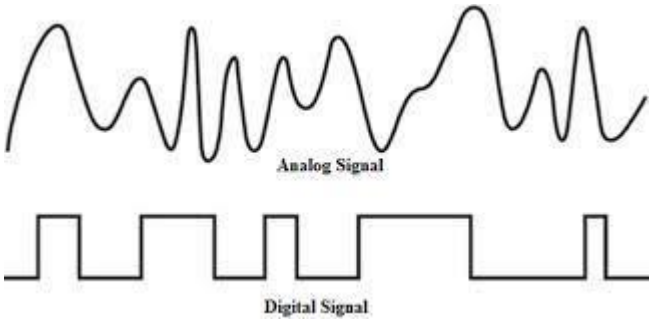
Digital Data:

Transmission: Transmission is the communication of data by the propagation and Digital data take on direct values. Ex: text and integer. Text means Character Strings.

IRA: (International Reference Alphabet): IRA is the most common type of text code. Each character in this code is represent 7-bit ASCII pattern. So 128 different chcracter may be represent longer than in necessary, and some of the pattern represent invisible control character.

IRA enabled characters are always stored and transmitted using 8 bits per character. The eight bit is a point used for error detection.

Analog and Digital Signals: In communication system data are propagated from one point to another by means of electromagnetic signals. An analog signal is a continuously varying electromagnetic wave that May be propagated over a verity of media, depending on spectrum, like guided or unguided media. Digital Signal is a sequence of voltage pulse that may be transmitted over a wire medium. Advantages of digital signaling is cheaper than analog signaling. Disadvantages of Digital signals is suffering more from attention.



SUBJECT: - DATA COMMUNICATION AND COMPUTER NETWORK TH-2

SEMESTER-4TH

4. DATA COMMUNICATION & DATA LINK CONTROL Error

Detection and Correction:

A system connect guarantee that the data received by one device are identical to the data transmitted by another device. Data can be corrupted during transmission. For reliable communication, errors must be detected and corrects error detection and

correction are implemented either at the data link layer or the transport layer of the OSI model.

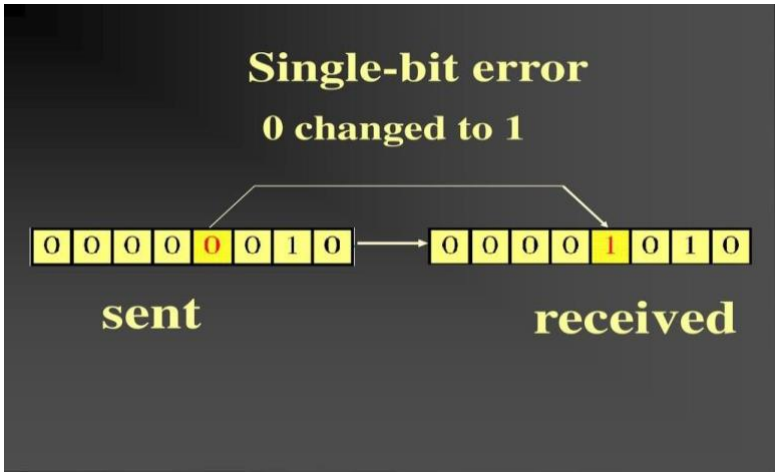
Types of Errors:

Errors can be categorized as:

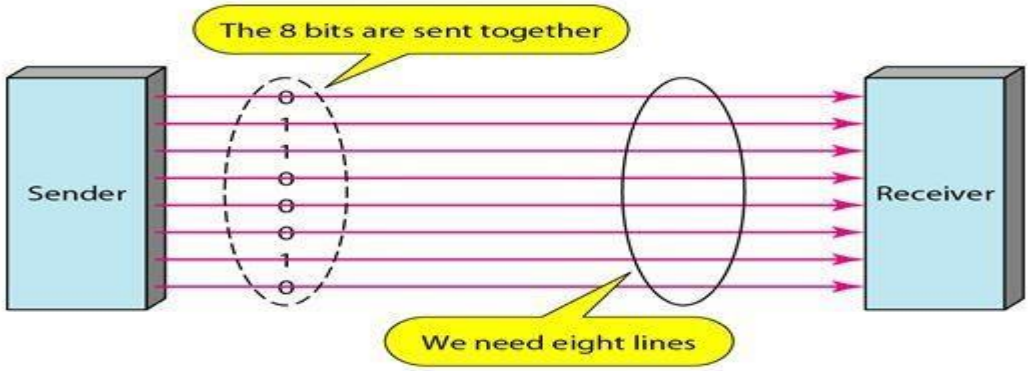
- Single bit error: one bit error per data unit.
- Burst error: two or more-bit errors per data unit.

Single-bit Error:

In a single-bit error, a 0 is changed to 1 or a 1 is changed to 0. Only one bit of a given data unit is changed from 1 to 0 or from 0 to 1.



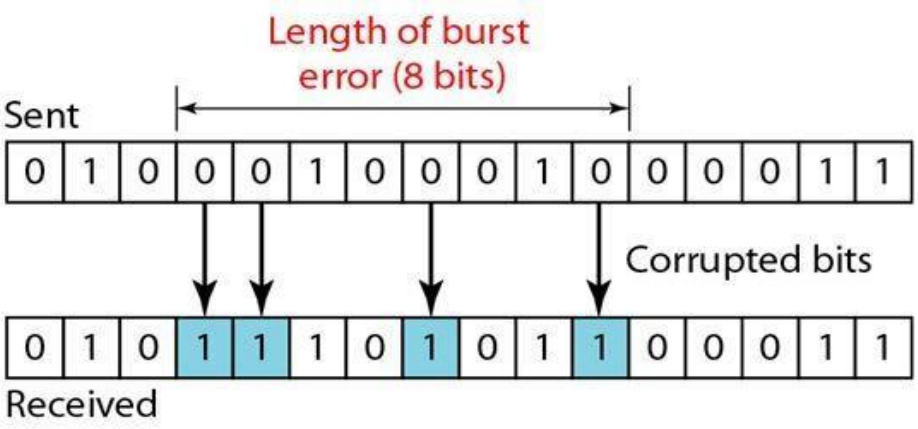
A single-bit error can happen if we are sending data using parallel transmission.



If eight wires are used to send all of the eight bits. A byte at the same time and one of the wires is noisy, one bit can be corrupted in each bye. Ex-between CPU and memory.

Burst Error:

The burst error means that two or more bits in data unit have changed from 1 to 0



The Length of the burst error is measured from the first corrupted bit to the last corrupted bit. Some bits in between may not have been corrupted. Burst error is most likely to happen in a serial transmission. When noise affects data, it affects a set of bits. The number of bits affected depends on the data rate and duration of noise.

Error Detection: Error detection uses the concept of redundancy. Which means adding extra bits for detecting error at the destination.

Four types of redundancy checks are used in data communication are-

- Vertical Redundancy check (VRC) or party check.
- Longitudinal Redundancy Check (LRC)
- CRC (Cyclic Redundancy Check)

VRC

In VRC, a redundant bit called a party bit is appended to every data unit so that the total number of 1s (including the party bit) becomes even.

Eg/- Even-party checking:

The sender wants to send the word “World” in ASCII

The five characters are coded as

1110111 101111 1110010 1101100 1100100

W o r l d

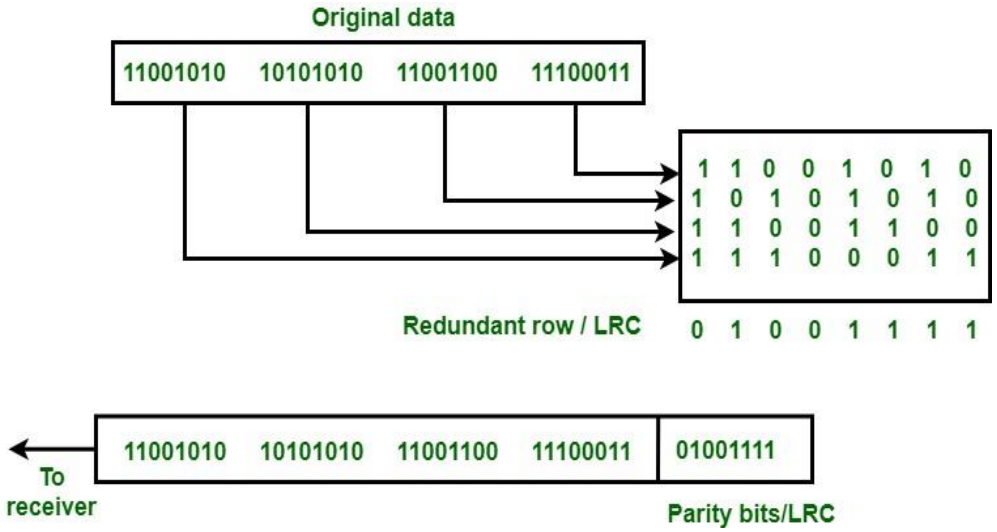
The first four characters has an even number of 1s, so the party bit is 0. The last character has three 1s can add number so the party bit 1 to make the total number of 1s even.

11101110 11011110 11100100 11011000 11001001

[The actual bits sent] **LRC:**

In LRC a redundant data unit follows n data units.

Eg/-



In longitudinal redundancy check, a block of bits is divided into rows and a redundant row of bits is added to the whole block.

Checksum:

To calculate a checksum

- Divided the data into sections.
- Add the section together using one's complement arithmetic.
- Take the complement of the final sum, this is the checksum.

Eg/-

16 bits is to be sent using a checksum of 8 bits.

```
10101001        subunit 1
00111001        subunit 2
11100010        sum (using 1s complement)
00011101        checksum (complement of sum)
```

Eg/-

```
00101001            1st bit of subunit 1 is damaged
10111001            1st bit of subunit 2 is damaged
00011101            checksum
11111111            sum
00000000            Ok 1's complement
```

Although data is corrupted, the error is undetected.

CRC:

The calculation of the check is normally a hardware operational of transmission interface, the redundancy bits used by CRC are divided dividing the data unit by a predetermined divisor, the remainder is the CRC.

Data/Polynomial generator – Remainder

Eg/-

Let the data be considered, to be: M= 1100011001

The generator polynomial

$G(x) = X^4 + X^3 + X^2 + 1$

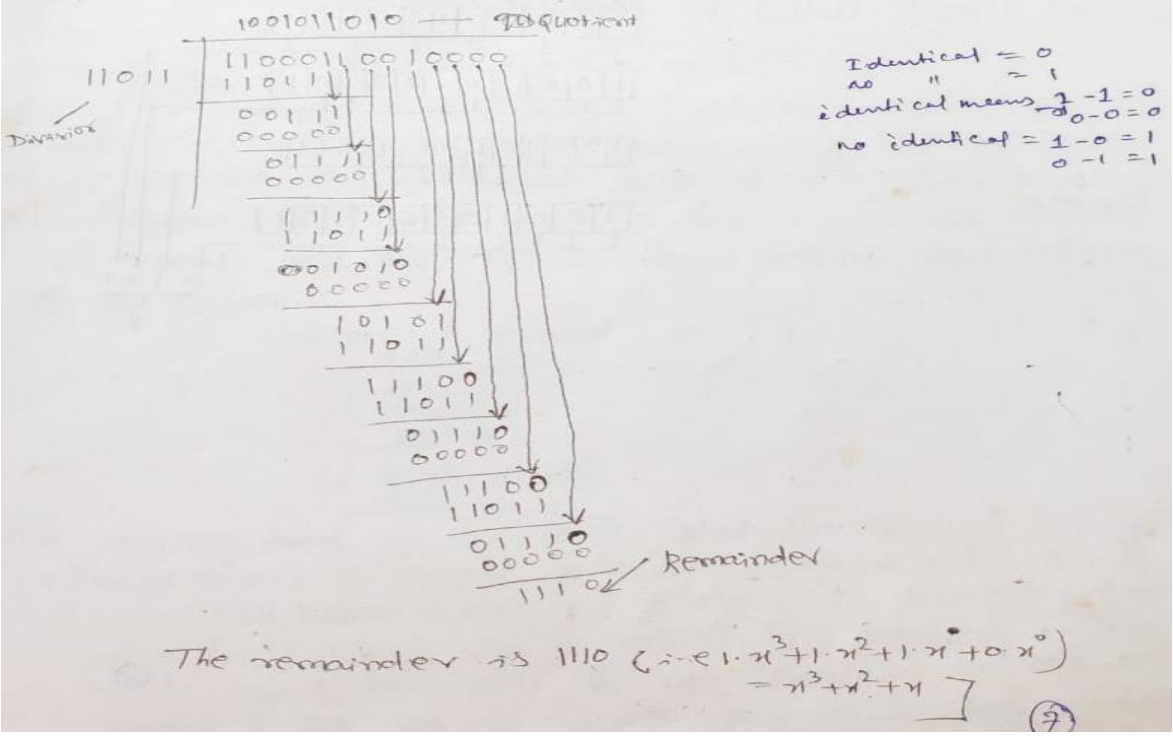
$= 1.X^4 + 1.X^3 + 0.X^2 + 1.X + 1.X^0$

$= 11011$

Number of Zeros to be append= Degree of highest term present in G(X)

The message bit pattern after appending 0's can be written as: 1100110010000

Using modulo 2, Divide the message bit pattern by the generator bit pattern fill the final remainder is obtained.



Shannon Theorem/ Capacity:

The Shannon capacity is a formula to determine theoretical maximum rate for a channel.

The maximum data of a noisy channel whose bandwidth is BHZ given by

$C = B \log_2 (1+S/N)$

S/N = Signal to noise rate

B = Bandwidth of channel is bits

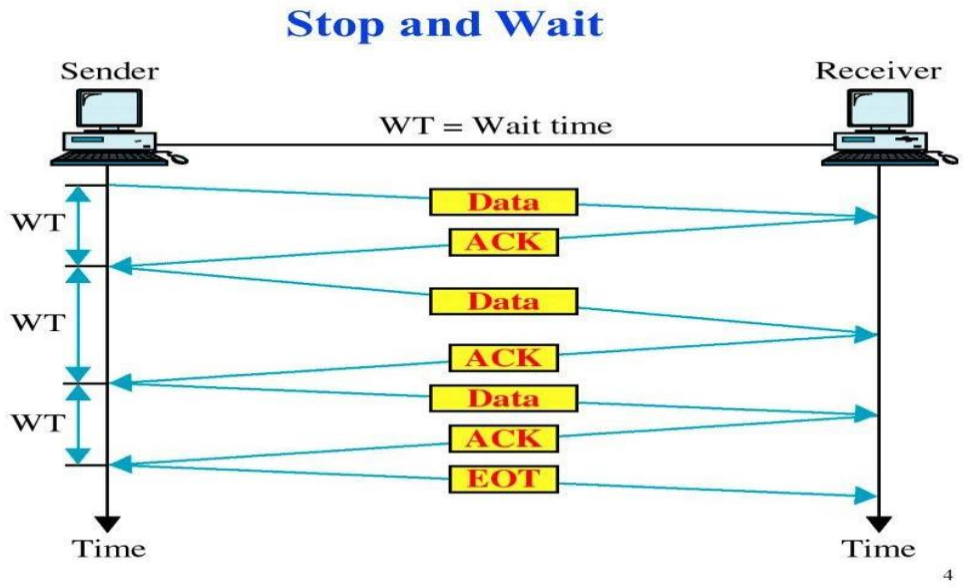
C= Capacity of channel in bits

If random noise is present, the situation electorates rapidly. We have considered only noise loss channel. Noise is the external energy that corrupt a signal.

Flow Control:

Qus: Flow is one of the key aspect of data link control. In most protocols, Is a set of procedure that tell the sender how much data it can transmit before it must wait for an acknowledgement, for the receiver. There are 2 important issues.

1. The flow of data must be allowed without acknowledgement of the receiver.



Any receiving device has a limited speed for processing incoming data & limited amount of memory. The receiving device must be able to inform about limits, before sending and to request the transmitting device fewer frames for temporary stop. The rate of such processing is often slower than the rate of transmission. The next transmission will only be sent on receipt of 'Ack' from the receiver when not the sent any more packets until a future response indicates a state of readiness to receive more. The RNR (Receiver not Ready) response is shown in figure.

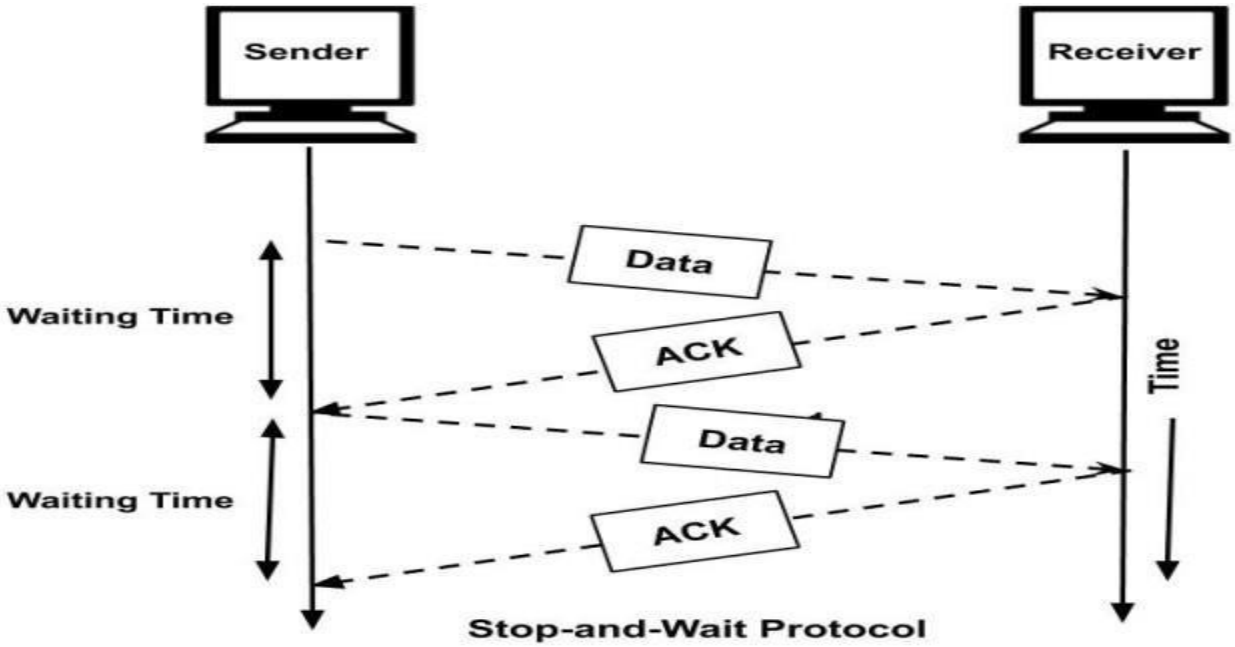
2. As Frames-cum-in the receiver acknowledgment either frame by frame or several frame at a time. If a frame arrives damaged, the receiver sends the error massage. Thus, flow control refers to a set of procedure that tells the sender how much data it can transmit before it must wait for ACK from the receiver.

Protocol: - Sets of rules created for the process of communication between computer over network. There are 2 category of flow control.

1. Stop & wait (Send 1 frames at a time).
2. Sliding window (Send several windows at a time)

Stop & Wait Flow Control: -

In this mechanism the sender waits for an Ack, which is expects after sending of every data frames. Only when ACK massage received the ACK frame & then sent. At the end of the massage, the sender transmits an EOT (end of transmission) which tells the receiver there is no more massage has to be received.



Stop-and-Wait Protocol

Advantages: -

1. It is quite simple to reali.
2. There is no chance of any data missing at the receiver end.

Disadvantages:

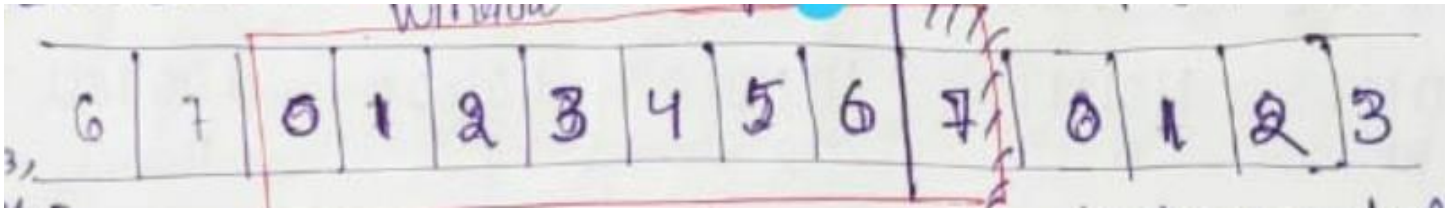
1. It is very slow.
2. If the link is long then the entire time required for transmission increase.

Sliding Window:

This mechanism operates at the octal level. In the technique the sender can transmit several frames before receiving the ACK. The link can be used efficiency. The receiver acknowledges only some of the frames using single ACK to conform the recoupled multiple data frames.

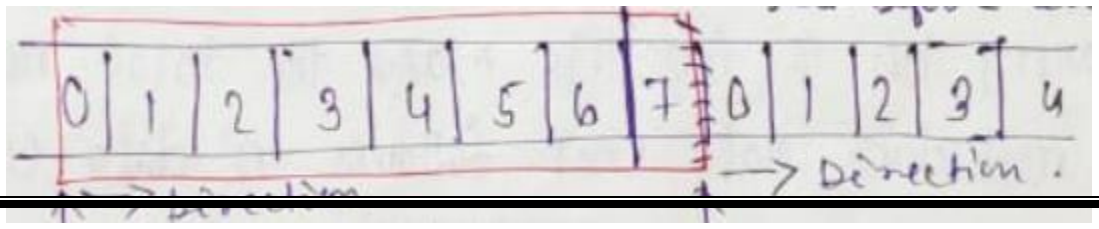
The sliding window is an imaginary box available at both sender & receiver. In this technique frames can be acknowledged at any point without waiting for windows to fill up, also frames can be transmitted as long as the window is not fill. The frames are numbered modulo- n, that means they are numbered from 0 to n-1, for an example;

If n = 8 the frames are numbered 0,1,2,3,4,5,6,7,0,1,2,3,4,5,6,7,0,1,…… the size of the window is n-1.



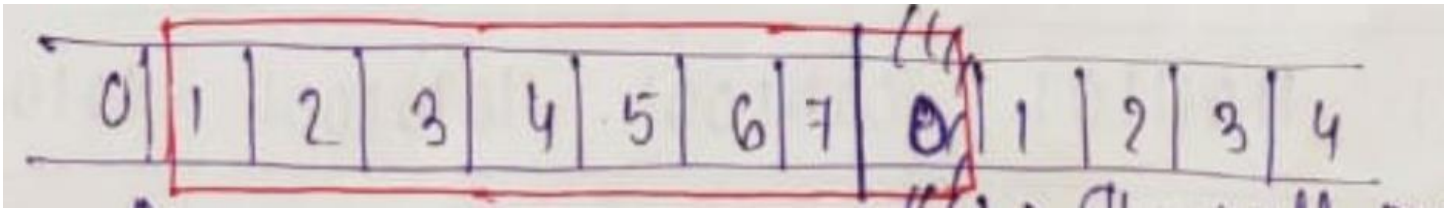
The window can hold n-1 frames at either end. Therefore, a maximum of n-1 frames may be sent before an ACK required. The windows cannot cover the whole module (8 frame) it covers one frame less.

Sender Window:



At the beginning of transmission, the sender contains frames. When the frames are transmitted than the left boundary of window moves in word. Once an acknowledgment arrives, window expand. This expansion takes now frames in window which is equal to the no. of frames acknowledgement by ACK.

Receiver Window:



This wall moves to the left when a frame is received. This window shrinks from left when data flow is received, where as it expanded to right when ACK. Massage are sent.

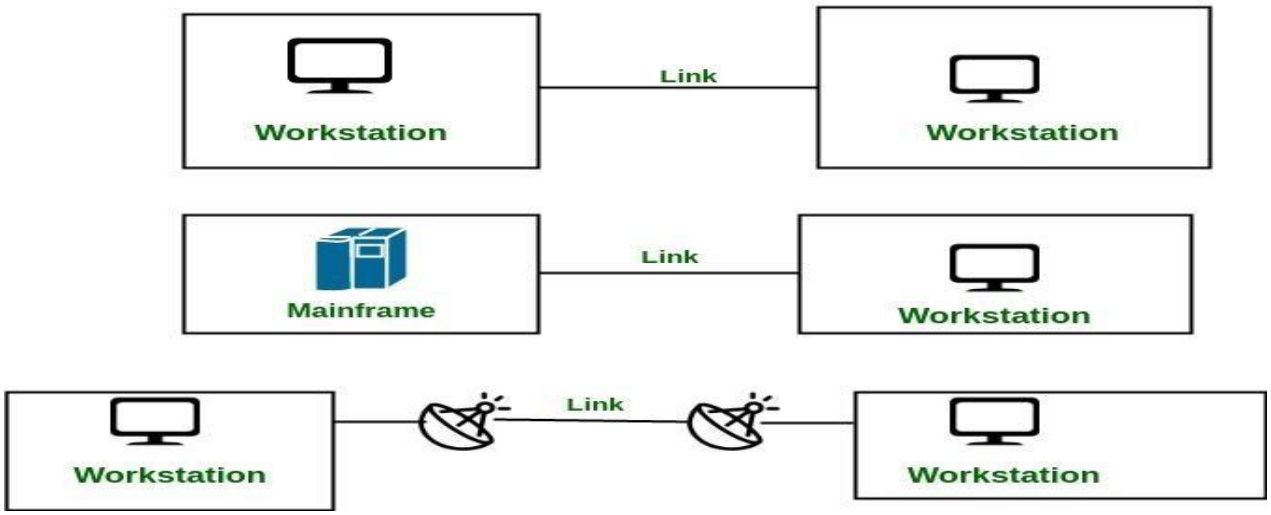
Line configuration:

Topology:

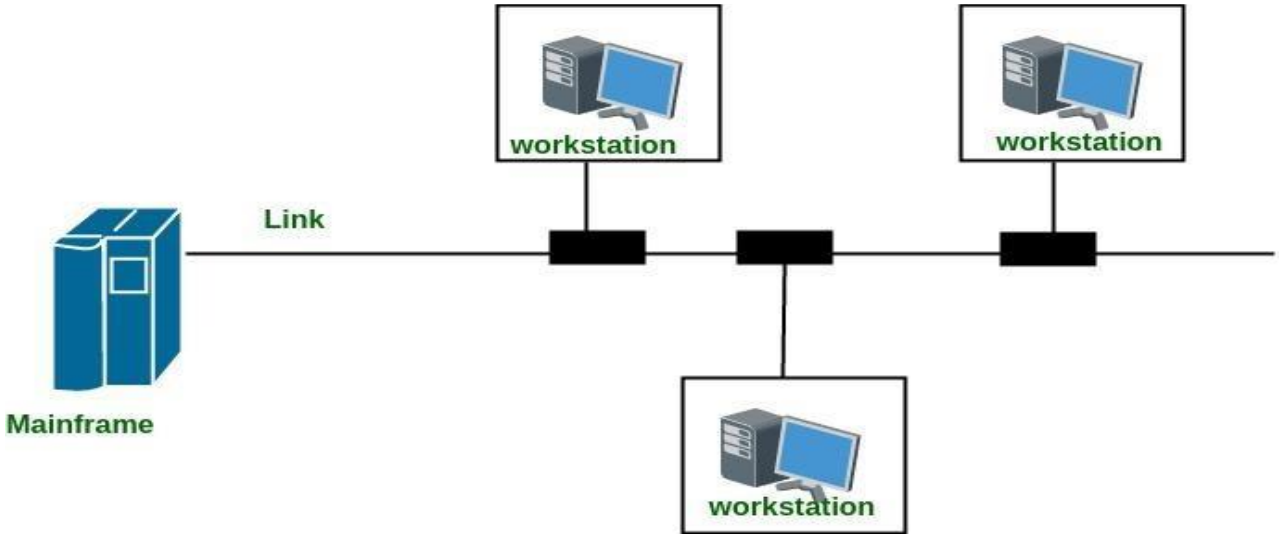
Topology is the physical arrangement of station on a transmission medium. Topology may be point-to-point or multipoint. If there are only two stations the link in point-topoint. If there are more than two station then it is a multipoint topology.

Half duplex:

In this transmission only one of two stations on a point-to-point link may transmit at a time.



Full duplex: In this transmission two stations can simultaneously send and receive data from each other.



Error Control: Error control refers to mechanism to detect and correct errors that occur in the transmission of frames. These are two possibility of two types of error:

1. Lost frame
2. Damaged frame

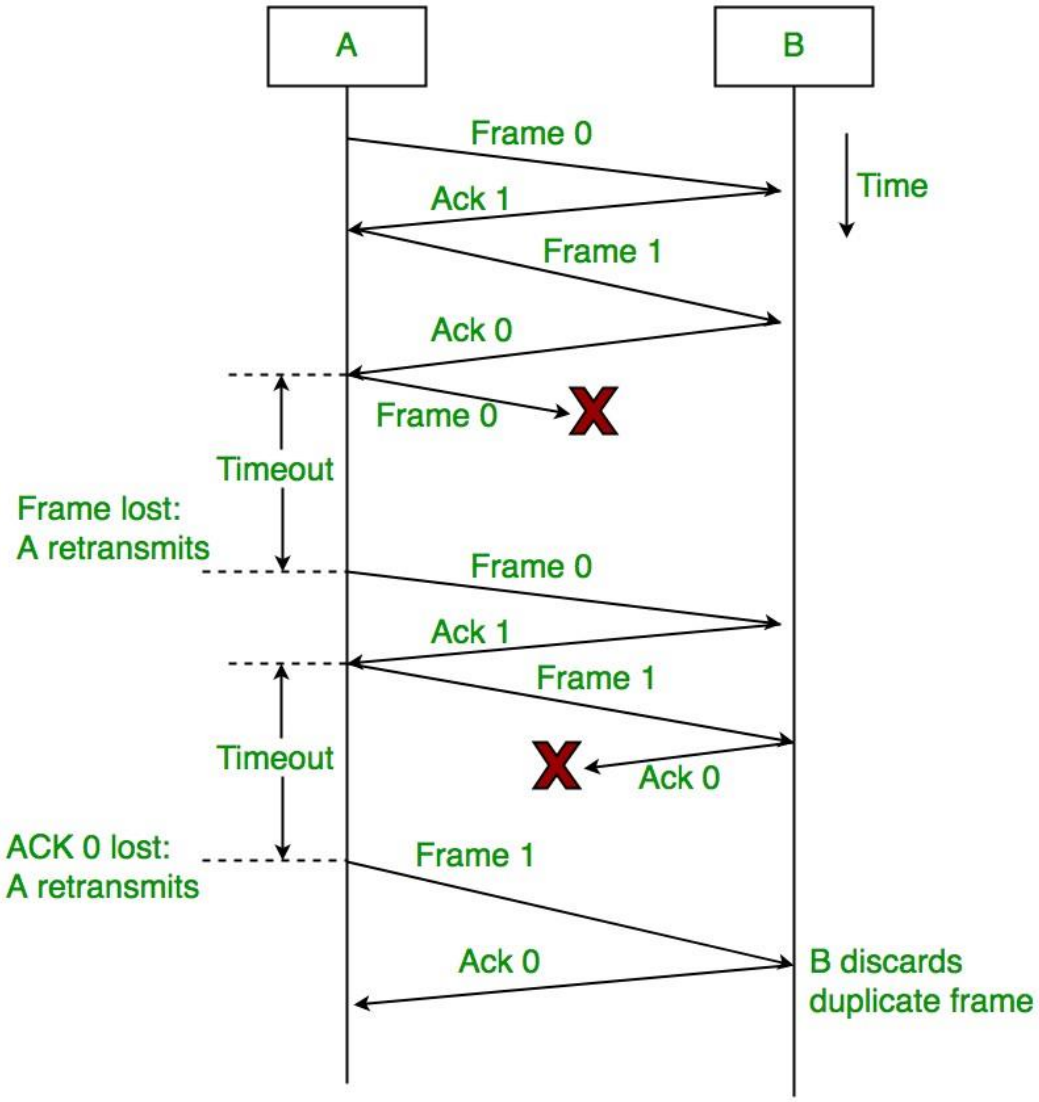
Error control technique for noisy channels are:

1. Stop and wait ARQ
2. Go back -N ARQ
3. Selective -reject ARQ

ARQ: Automatic Repeat request. It is an error-control method for data transmission.

Stop & Wait ARQ: Stop & Wait ARQ based on the stop & wait flow control techniques. In this technique the source station transmits a single frame and then must wait for ACK. No other data frames can be sent until the destination stations reply arrives at the source station. Two sorts of error could occur.

1. The arrived frame at destination end could be damaged.



2. The second sort of error in a damage ACK.

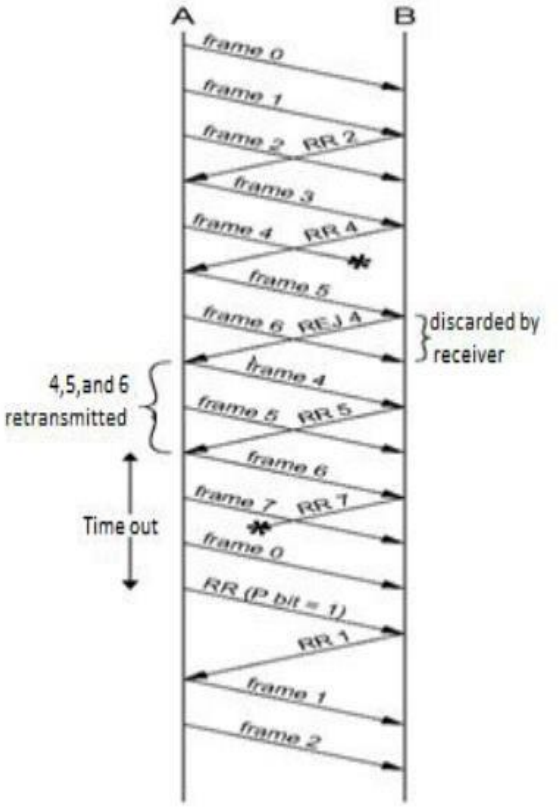
Go-ARQ: control is sliding While occurs.

back-N- This error technique based on window. no error The

destination will acknowledgement incoming frames RR (Receiver Ready). If the receiver end detects the error in frame, it may send REJ (Reject) ACK for that frames. The 40-back-N technique take care of the following.

1. Damaged Frame: In the received frame is invalid the destination end discards the frame and takes no further action for that frame.
2. Damaged RR: B receives frame i and sends RR(i+1), which means error in transmit.
3. Damaged REJ: If a REJ is lost, equivalent to damaged frames.

negative ACK. It is called SREJ. Or those that time out.

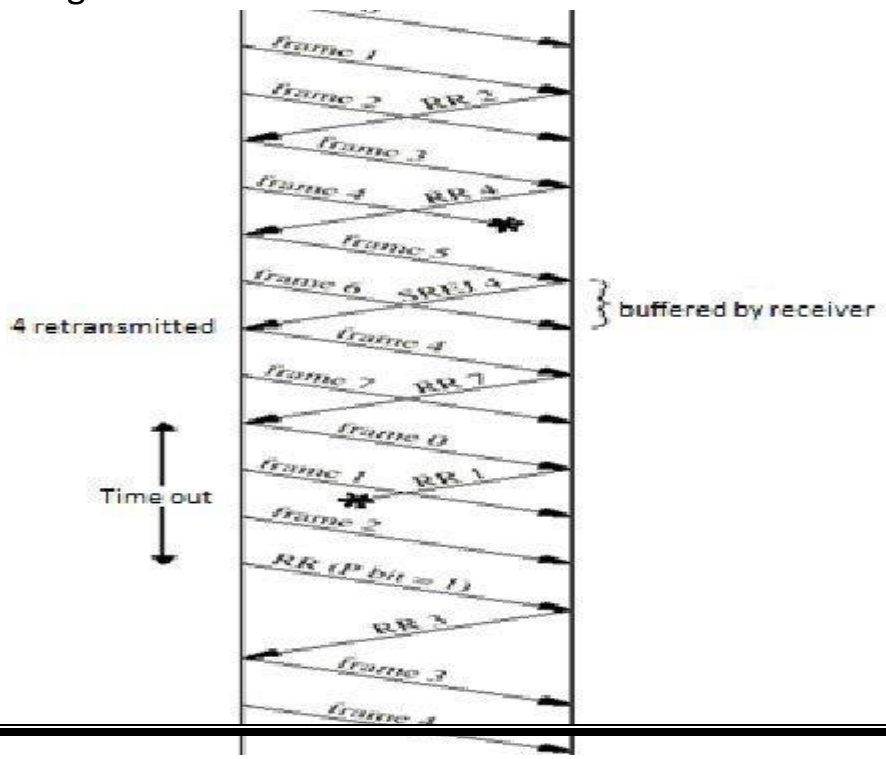


In this example frame-4 is damaged frames 5 and 6 are received out of order and are discarded by 'B'. When frames 5 arrives, B immediately sends a REJ. When the REJ to frames 4 in received not only frames 4 but frame 5 and 6 must be retransmitted.

<u>Selective- Reject ARQ</u>: This ARQ retransmitted only those frames, that receiver a

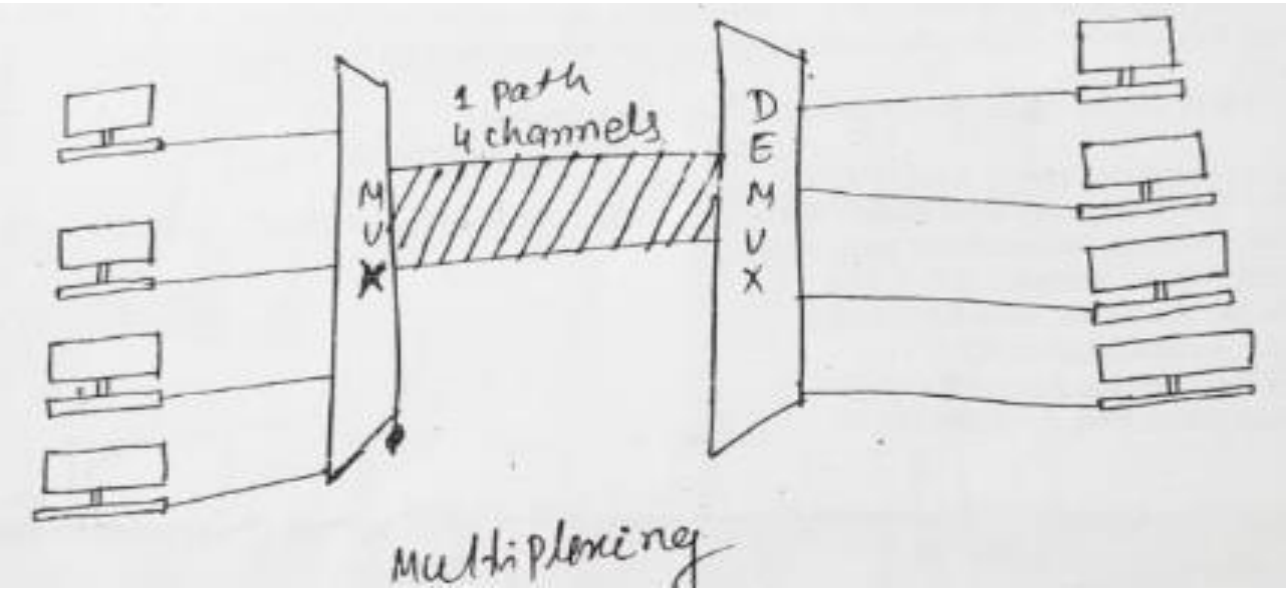
Example: Frame 4 is damaged when frame 5 is received out of order, B sends a SREJ4, indicating that frame 4 has not been received. 'B' sends a SREJ4. 'B' continuous to accept incoming frames and better than until a valid frame 4 is received.

Example:



1. Station A sends frames 0 through 7 to stations B.
2. Station B receives all seven frames and communality ACKS with RR7.
3. Because of a noise burst, the RR 7 is lost.
4. A timeout ad retransmits frame 0.
5. B has already advanced it receive window to accept. Frames 7,0,1,2,3,4 and 5. Then it assumes that frame 7 has been lost ad this is a new frame 0, which it accepts.

Multiplexing: Multiplexing is the simultaneous transmission of multiple signals across a



signal data link. In a multiplexed system, n devices share the capacity of one link.

Multiplexing in the telephone network allows for multiple connections occurring over the same physical connection. Path refers to physical link. Channels refers to a portion of a path that carries a transmission between a given pair of devices. One path can have many channels.

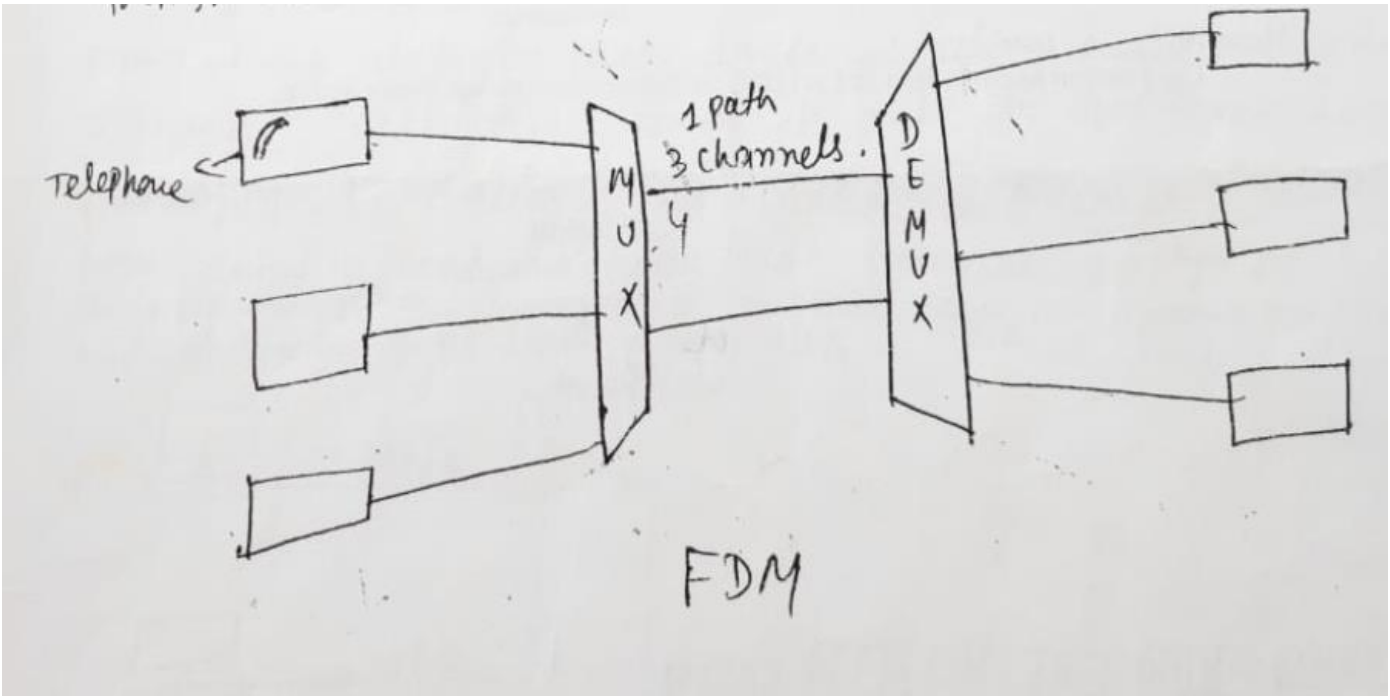
Signals are multiplexed using basic techniques:

- Frequency division multiplexing (FDM)
- Time division multiplexing (TDM)

Frequency Division Multiplexing:

Frequency division multiplexing (FDM) is an analog technique that can be applied when the bandwidth of a link is greater than the combined bandwidth of the signals to be transmitted. The analog telephone network user frequency division multiplexing.

The transmission path is divided into three parts, each representing a channel to carry one transmission.

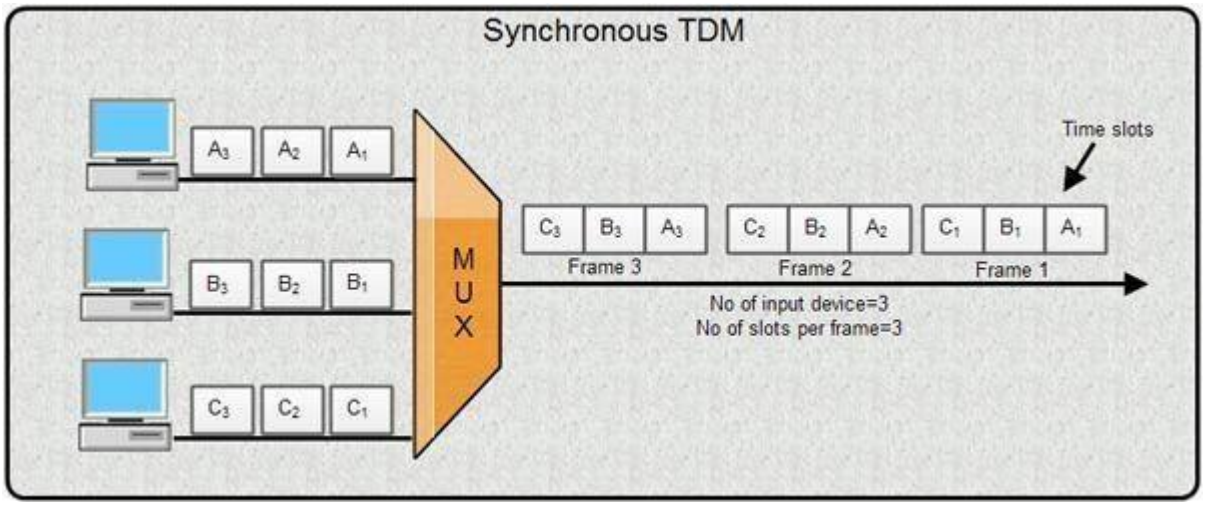


Time Division Multiplexing (TDM):

TDM can be applied when the data rate capacity of the transmission medium is greater than the data rate required by the sending and receiving devices. Digital signals are multiplexed over a link using time division multiplexing. TDM can be implemented in two ways: Synchronous TDM and asynchronous TDM.

Synchronous TDM:

Synchronous means the multiplexer allocates exactly the same time slot to each device at all times. The order in which each device sends its data to the frame is unvarying. If a device is unable to transmit or does not have data to send its time slot remains empty. In a synchronous system, if we have n input lines, the frame contains a fixed number of at least n time slots.



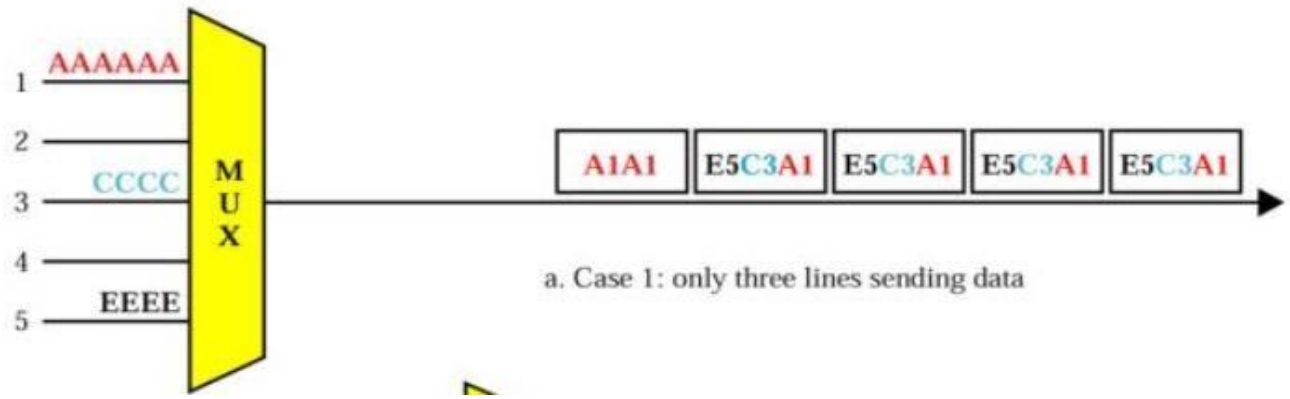
Asynchronous TDM:

It allows a number of lower speed I/P lines to be multiplexed to a single speed line. Asynchronous TDM can support more devices than Synchronous.

No of i/p = 5

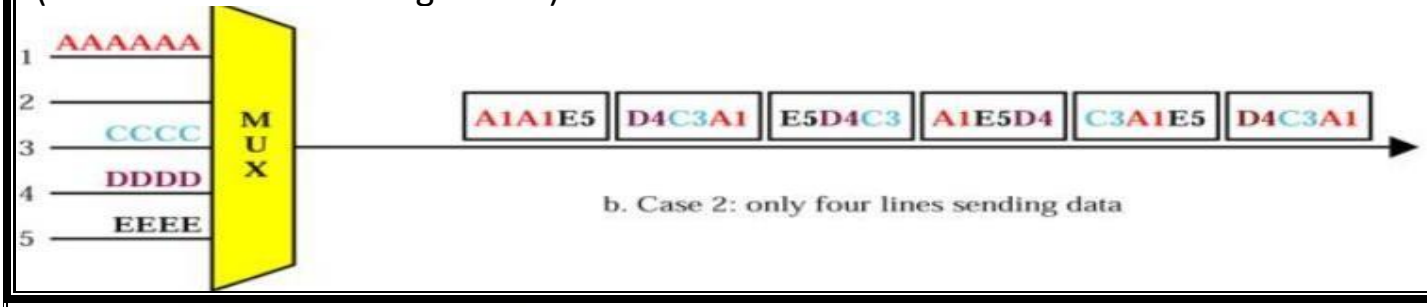
No of slots in each frame = 3

In this case only three lines sending data



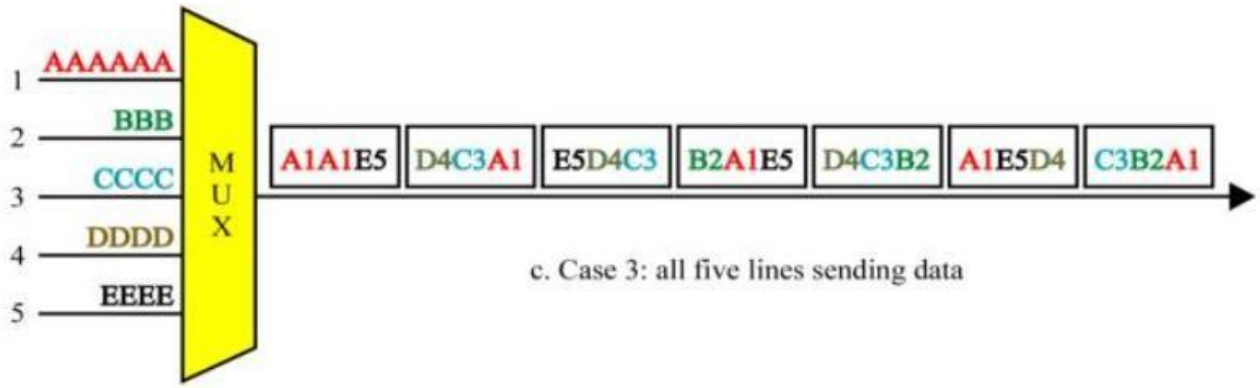
a. Case 1: only three lines sending data

In below case, 4 lines are sending data, one more than the number of slots pen formula. (frames in 3 and sending 4 lines)



b. Case 2: only four lines sending data

In below case all five lines sending data.



c. Case 3: all five lines sending data

STDM (Statistical time division multiplexing):

Definition: STDM is one method for transmitting several types of data simultaneously across a single transmission cable or line STDM is often used for managing data being transmitted via a LAN or WAN. In three situations the data is often simultaneously transmitted from any number of i/p devices attached to the network, including computers, printer or fax machines. STDM can also be used in telephone switch-based settings to manage the simultaneously calls going to or coming.

The concept behind STDM is similar to TDM. TDM allows multiple users or I/P devices to transmit or receive data simultaneously by assigning each device the same, fixed amount of time on one of the TDM method works well in many cases, but does not always account for the varying data transmission needs of different devices or users.

SUBJECT: - DATA COMMUNICATION AND COMPUTER NETWORK TH-2

SEMESTER-4TH

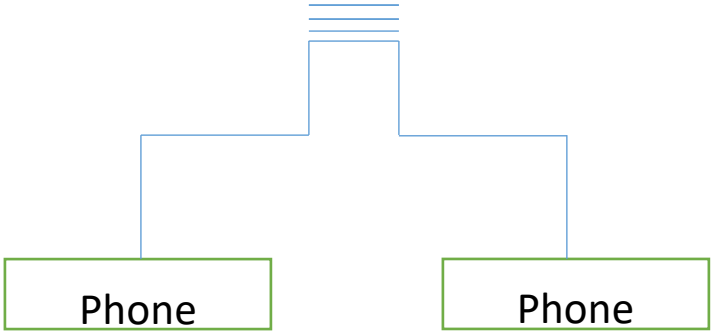
5. SWITCHING & ROUTING

Switching Technology: It is an important technique which enhance the communication process by providing independent path i.e., free of data collision.

In determines how connection are made & how data moves over the network. The popular switching techniques are:

1. Circuit Switching
2. Massage Switching
3. Packet Switching 4. Virtual Switching **Circuit Switching:**

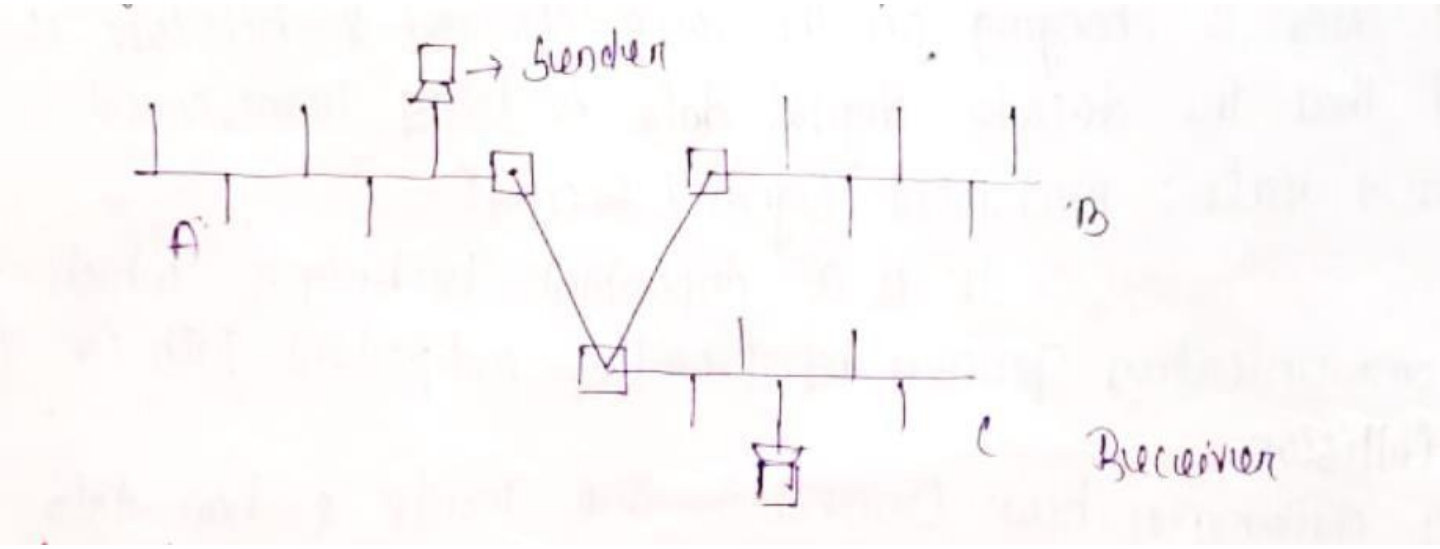
A circuit switched network transmits a massage by providing a complete path of transmission links from the originating node to destination node. It transmits special signaling massage. The data transmit without no intermediate store & forward delay. The entire fixed path is allocated to this transmission until it releases the path, no other device can use the channel.



Massage Switching:

It transmits a massage among the nodes by moving the massage through various links & massage buffers. In this case a massage can store and then transmitted to the next

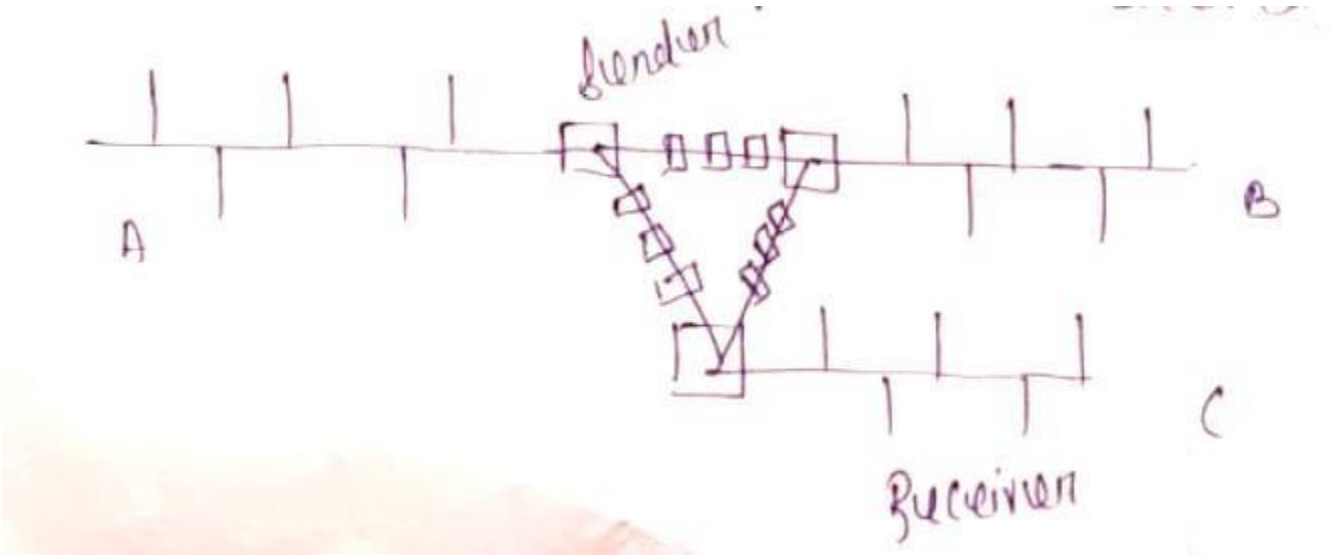
node. A massage transmission from the node does not start until a buffer at the next node know the root has been allocated to it. The path for the massage transmission may be fixed. This type of network also called store & forward network. There is a possibility of massage conquestion & queiring in the nodes. Massage delay is more here comparatively.



Packet Switched Network:

In this technique, message is decomposed into fixed sized segment. Each packet takes different root until they reach the destination node.

Packet may not receive the same order. So, the packet is reassembled at the receive belonging to a particular massage are hold in a memory buffer of destination node until all packets of that massage have arrived.



Difference between Circuit Switching & Packet Switching

Circuit Switching	Packet Switching
1. Dedicated transmission path 2. Continuous transmission of data 3. Massages are not stored. 4. Path is established for entire conversation. 5. Call set up delay, (negligible) 6. Busy signal is called party buy. 7. Overload may block call set up. 8. User responsible for massage loss protection. 9. Usually, no speed or code conversation. 10. Fixed bandwidth transmission.	1. No dedicated path. 2. Transmission of packet. 3. Packet are stored. 4. Path is established until delivered. 5. Packet set up delay. 6. Sender may be notified if packets not deriver it. 7. Overload increase packet delay. 8. Network may be responsible for induvial packets. 9. Speed code conversation. 10. Dynamic use of bandwidth.

Virtual Switching:

This is using a dedicated path for transmission of packets & it is fast enough for interactive communication.

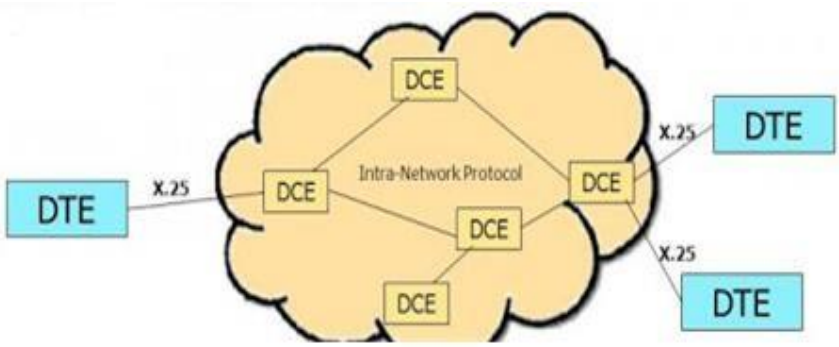
Through packets this switching is stored & forwarded from node to node & no path is established initially. First packet which is transmitted initially forms a virtual circuit & the other packet follow the virtual path. This switching technique erasure speed & dynamically uses the bandwidth available.

The X.25 Protocol:

Definition: X.25 is a standard protocol used for packet switching across computer network. X.25 protocol works at the physical, Datalink and Network layer of the OSI model. X.25 contains up to 128 bytes of data. X.25 network holds packet assembly at the source device, delivery and then disassembly at the destination. It is not only switching but also error checking and retransmission provides. It supports Simultaneously multiple conversation.

The Model:

- Network Has Multiple Nodes (DCEs)
- Host Computers (DTEs) Outside
- Hosts Have Addresses Like Phone Numbers
- Virtual Call Setup



- Virtual Transfer

Routing in Packet Switching:

- Routing is a key function to determine a best path from any source to any destination.
- There exist multiple paths.
- The best path depends upon - Minimize number of hops.
- Minimize end-to-end delay.
- Maximize available bandwidth.

Characteristics:

- Correctness: Correct route and accurate delivery of packets.
- Robustness: adoptive to changes of network topology and varying traffic load.
- Efficiency: Rapid finding of the route and minimization of control messages.
- Simplicity
- Stability

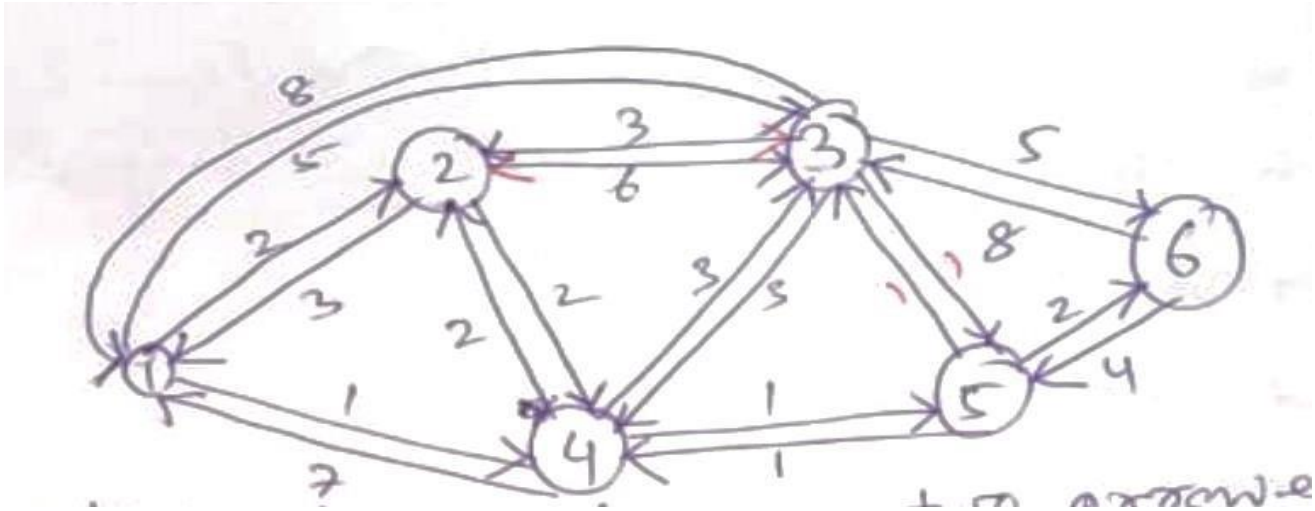
- Fairness
- Optimality

Performance Criteria:

- Used for Selection of route
- Minimize hop
- Least Cost

Selection of route depends upon performance criteria. Minimize hop in the least cost routing.

Example of Packet Switched Network:



In the above figure two arrowed lines between a pair of nodes represents the link between nodes. And the corresponding numbers represents the current link cost in each direction,

1. Shortest path from node 1 to 6 in 1-3-6 (cost = 5+5 = 10)
2. Least cost path in 1-4-5-6 (cost = 1+1+2 = 4)

Decision Time and Place:

1. Decision time in determined by whether the routing decision is made on a packet or virtual CKT basis.

2. Decision place refers to which node or nodes in the network are responsible for the routing decision.
    1. Distrusted
    2. Centralized
    3. Source

Routing Strategies:

- Fixed
- Flooding
- Random
- Adaptive

Fixed Routing:

- For fixed routing, single permanent route for each source to destination pair.
- Determine router using a least cost algorithm
- Rout fixed, at least until a change in network topology.

Central Routing Directory

1	2	3	4	5	6
—	1	5	2	4	5
2	—	5	2	4	5
4	3	—	5	3	5
4	4	5	—	4	5
4	4	5	5	—	5
4	4	5	5	6	—

Node 1 Directory

Destination	Next node
2	2
3	4
4	4
5	4
6	4

Node 2 Directory

Destination	Next node
1	1
3	3
4	4
5	4
6	4

Node 3 Directory

Destination	Next node
1	5
2	2
4	5
5	5
6	5

Node 4 Directory

Destination	Next node
1	1
2	2
3	5
5	5
6	5

Node 5 Directory

Destination	Next node
1	4
2	4
3	3
4	4
6	6

Node 6 Directory

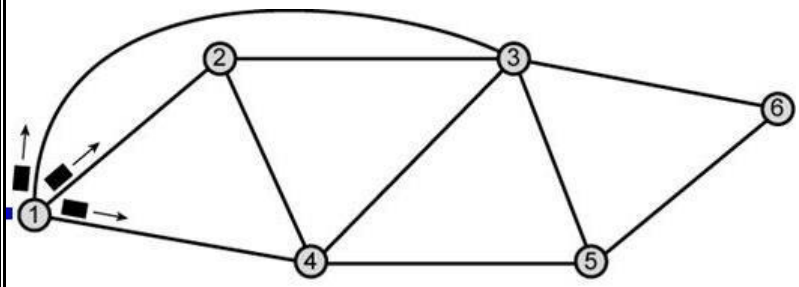
Destination	Next node
1	5
2	5
3	5
4	5
5	5

Flooding:

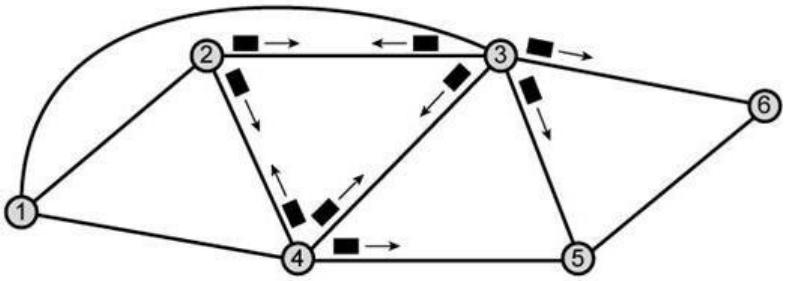
- No network information required.
- Packet sent by node to every neighbor.
- Incoming packets retransmitted can every link except incoming link.
- Eventually a number of copies will arrive at destination.
- Each packet is uniquely numbered do duplicate can be discarded.
- Nodes can remember packets already forwarded to keep network load in bounds.
  - Can include a hop court in packets.

Hop: Hop represents one portion of the full path between source and destination.

Hop Count- represents the total number of devices a given piece of data (packet) passes. Ex- data passes through a number of intermediate.

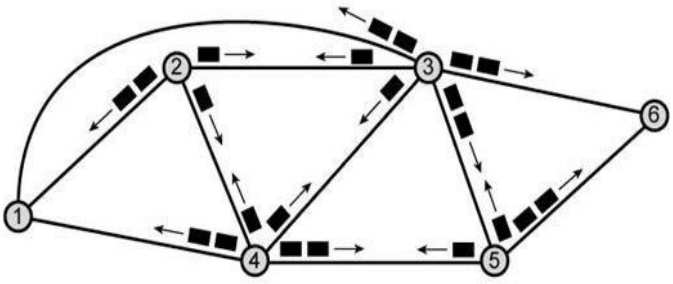


(a) First hop



(b) Second hop

Figure Shows: A packet is to be sent from node 1 to 6.



(c) Third hop

- On the first hop, three copies of packet one created
- On the second hop, all these copies, total of nine copies are created
- One of these copies reaches node 6, which recognizes that it is the intended destination and does not retransmit.
- Other nodes generate a total of 22 new copies for their third and final hop.
- If a node is not keeping track of the packet identifier, it may generate multiple copies at the 3rd stage.

Properties of Flooding:

- All positive routers are fried.
- At least one packet to arrive at the destination minimize hop count-route.
- All nodes are visited.

Random Routing:

Random routing has the simplicity and robust of holding with far less traffic load

- Node selects one outgoing path for retransmission of incoming packets.
- Selection can be random or round robin.
- Can select outgoing path based or probability calculation. The probability based on data rate.
- No network information needed.
- Route in typically neither least cost nor minimize hop.

Adaptive Routing:

- Almost all packet switching used adaptive routing - Routing decision change in following condition.
- 1. Failure, 2. Congestion

Failure: When a node or trunk fails, it can no longer be used as part of a route.

Congestion: When a particular portion of the network in heavily congested, it is desirable to route packets around rather than through the area of congestion.

Adaptive routing requires information about network. Information about the network must be exchanged among more complex.

- The routing decision more complex.
- Tradeoff between quality of network information and overhead.
- An adaptive strategy reacts too quickly, causing congestion producing too slowly.

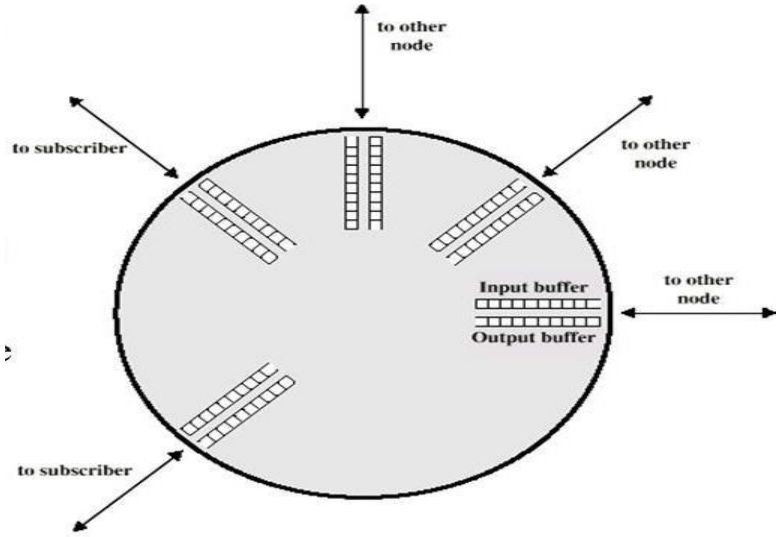
Advantages:

- An adaptive strategy prevalent (wide spread) for two reasons.
- An adaptive routing strategy can improve performance.
- An adaptive routing strategy can support in congestion control.

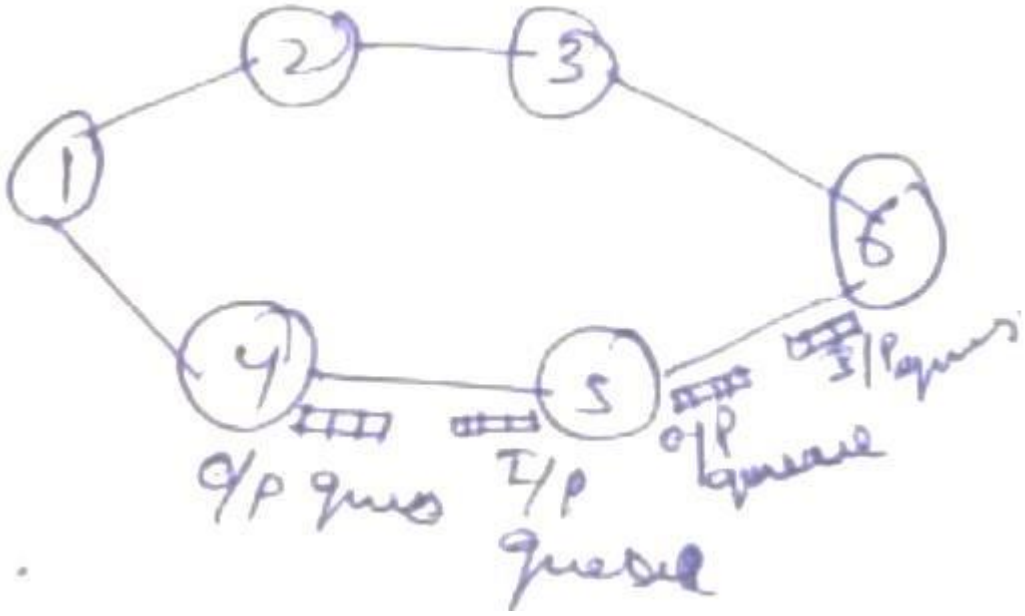
Congestion:

Congestion refers to a network state where a node or link carries so much data that it may deteriorate network service quality, resulting in quing delay, frame or data packet loss and blocking of new connections.

Effect of Congestion:



- Any node has a number of I/O ports for packet receiving and for departure.
- We can consider there are two buffers at each port.
- One buffer for accept arriving packet. And another, hold packets waiting to deport.
- Packets arriving are stored at input buffers.
- Then routing decision made.
- Then packet moves to output buffer.
- Packets queued for o/p transmitted as fast as possible based on statistical time division multiplexing.
- If packets arrive to fast to be routed, or to be out port, buffers will fill.
- When such saturations point in reached, one of two strategies can be adopted. - Can discord packets.
- Can use flow control.



Figures shows node 6 prevent the flow of packets from node 5, this causes the o/p buffer in node 5 for the port 6 to fill up.

- Then congestion propagate through network.

Congestion control:

Important congestion control techniques are:

1. Back Pressure.
2. Choke packet.
3. Implicitly congestion signaling.
4. Explicitly congestion signaling.

Back Pressure:

This technique produces an effect similar to back pressure in fluids flaming down a pipe.

- If node becomes congested it can slow down or half flow of packets from other nodes.
- It means that other nodes may have to apply control in incoming packet rates.
- It propagates back to source.
- It can be restricted to logical connections, so that the flow from one node to the next node in only restricted or halted.

- Backpressure can be used in connection-oriented network that allows hop-by-hop flow control.
- Back pressure can not used in ATM or frame relay.

Choke Packet:

- Choke packet is a control packet generated at a congested node and transmitted back to source node to message protocol.
- An example of choke packet is ICMP (Internet control message protocol).
- Either a router or a destination end sends this message to a source end system.
- Source end request the rate of sending traffic reduced to the destination.
- Source cuts back until no more source queue message.
- The source must discard packets because of a full buffer.

Implicit Congestion Signaling:

When network congestion occurs two things may happen.

1. Transmission delay may increase with congestion.
2. Packets are discarded.

- Source can defect these as implicitly indication of congestion.
- Implicitly signaling in an effective congestion control technique in connection less (Datagram) networks.
- Implicitly signaling can also be used in connection-oriented networks. For example- In frame relay networks and the LAPF control protocol. (LAPF- Link access procedure for frame relay)

Explicitly congestion signaling: (explicitly -> Clearly expressed)

Explicitly in the purpose of explicit congestion avoidance techniques.

- Network alerts end systems to increasing congestion with in the network.
- Explicit congestion signal can work in two directions.

Explicit congestion signaling:

1. Forward direction.
2. Backward direction.

Backward direction: Congestion avoidance procedure initiated in opposite direction on packet required.

Forward Direction: Congestion avoidance procedure should be initiated in same direction as packet required.

Categories of explicit signaling:

1. Binary: A bit in a packet as it is forwarded by the congested node.
2. Credit Based: The credit indicated hoe many octets or how many packets source may transmit. Credit based schemes are common for end-to-end flow control.
3. Rate based: These schemes are based on providing data rate limit.

To control congestion, any node along the path of the connection can reduce the data rate limit in a control message to the source.

Traffic management: When a node is saturated, must discard packets. It can apply some simple rule to discarded most recent arrival. Some discard policies are

1. Fairness 2. Quality of service 3. Reservations

Fairness: If all of the queue buffers are of equal length, then the queue with the highest traffic load will discard more often.

Quality of Services: A node transmit higher priority packets ahead of lower priority packets in the same queue. Or node maintain different queues for different QOS level and give preference to higher levels.

Reservation: One way to avoid congestion and also to provide assured service to appliances is to use a reservation scheme. Ex: - ATM network- Traffic contract between user and network.

Congestion control in packet switching network:

Some mechanism for control congestion in packet switching network.

- Send control packet to some or all source nodes. This approach needs additional traffic on the network during a period of congestion.

- Rely on routing information. May react too quickly.
- End to end probe packets. Adds to overhead.
- Add congestion info to packets as they cross nodes.

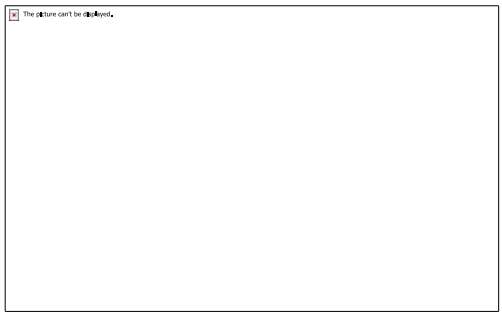
- Either backward or toward.

SEMESTER-4TH 6.

SUBJECT: - DATA COMMUNICATION AND COMPUTER NETWORK TH-2

Definition: The graphical or geometrical representation of computer network.

The types of connection requested usually described the no. of devices that can be connected to a single cable of the transmission media. Normally two types of connections are there.



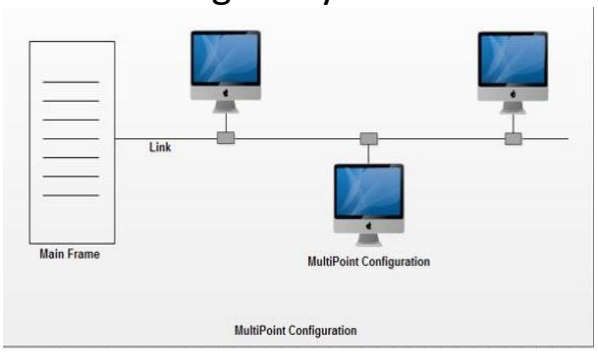
1. Point-to-Point connection
2. Multi point connection

Point-to-Point connection:

It direct link between two devices

Multi Point:

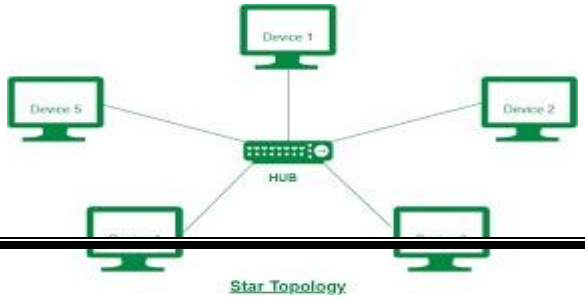
In multipoint connection sharing the same band width among every device connected to the media.



Star Topology:

In star topology cable runs from every computer to centrally located device called hub. Huns are specially repeaters.

(Repeaters- it is a device) that overcome the electromechanical limitation of media. Each computer on a star network communicates with a central hub that resend the message either to all the computers or only the destination computer. Ethernet 10 base T is a popular network based on the star topology.



LAN TECHNOLOGY

Advantages:

- Easy to modify and add new computers. This is possible by simply adding a new cable without disturbing the rest of the computer.
- Less expensive than mesh topology.
- Each device needs only one link & one port.
- Easy to install
- Easy to diagnosis network fault.
- Single computer failure does not affect the network.
- Ordinary telephone cables can be used.

Disadvantages:

- Since each node must be connected to central hub more cabling is required when compared to other topology like tree, bus, ring. - Failure of the central hub brings the network down.

Bus Topology:

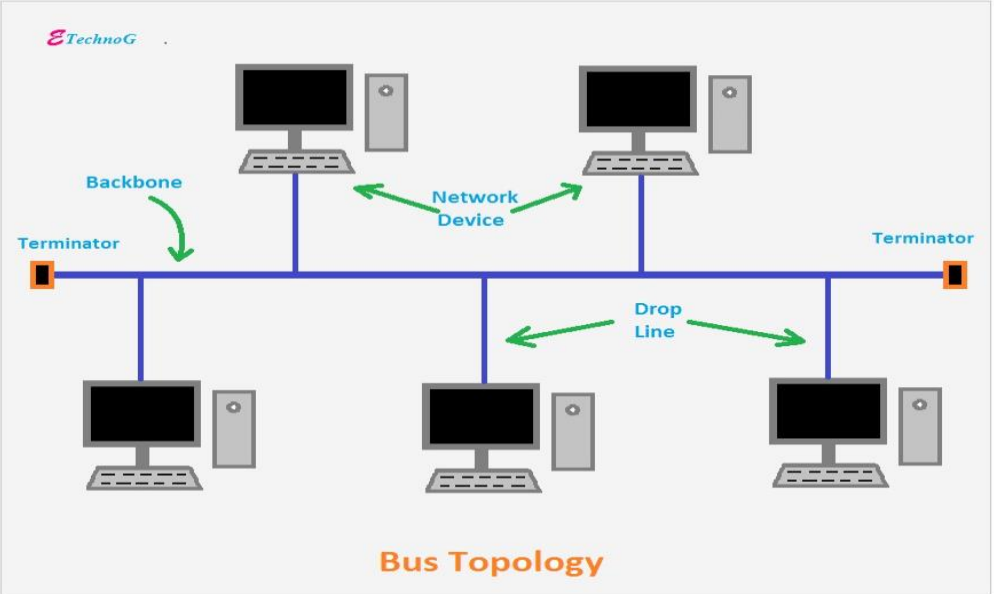
A bus topology is a multipoint connected topology. One long cable act as a back bone to link all the devices in the network. Nodes are connected to the bus cable by drop lines and tapes. A dropline is a line running between a device and main cable. A tape is a connector that splices into the main cable. As the signal becomes week when it travels farther in the back bone.

Advantages:

- Simple, reliable and easy to use.
- Easy to installation and cheaper when compared with another topology.
- Less cabling.

Disadvantages:

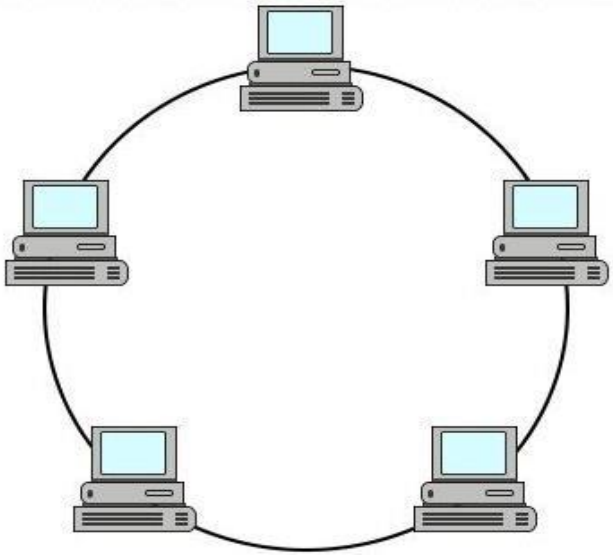
- All computer shares the same bus hence an increase in the no. of computers degrades the performance of the network after a certain limit.
- Can be used in small networks.
- Reconfiguration is difficult.
- Fault identification is difficult.
- Adding new nodes is difficult.
- A fault on the cable stop all transmission’



Ring Topology:

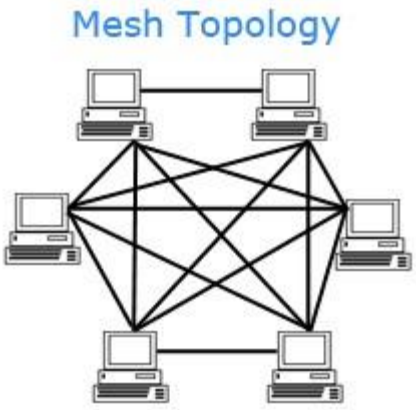
In ring topology each device has a dedicated point-to-point line configuration only with two devices on either side of it.

A signal is passed along the ring in one direction, from device-to-device until it reaches its destination.



Advantages:

- The transmission capacity is shared equally among all attached station.



- Error rates are low.
- Access is guaranteed under heavy load.
- Routing is a single ring.

Disadvantages:

- It is more difficult to add new station to a ring than other topology.
- Repeaters are required in each station interface.
- One station interface could break the whole ring if it is fault.

Mesh Topology:

This type of topology is point-to-point link between devices. A fully connected mesh network has n(n-1)/2 physical channels to link n devices. To accommodate every device on the network must have (n-1) input and output ports. In this topology dedicated link between two devices.

Advantages:

- Use of dedicated links eliminates the traffic problem.
- If one link becomes un-usable it does not effect the entire system.
- Privacy is maintained.

Disadvantages:

- The amount of cabling required is high - The no. of I/o port required is high.

Structured Wiring system/cabling system:

The emphasis on the ability to maintain and manage the network. It becomes more dominant. Weakness is the physical cable layer can be identified quite easily.

In bus topology, if a break occur the network is effectively divided or partitioned. A break can occur for many reasons caused by maintenance work, if network services such as: server break from a station. The system is effectively un-available for the station.

Star topology are slightly healthier if the break occur on a connection between hub and station is lossed. Only a single station is Provide useless. If a major fault develops in the central hub, a total system crash will occur.

A ring function by circulating bits around the network. If a break occur nothing will operate. Unless there is a dual facility built in so that self-healing can be achived.

Network Components:

1. Host Computers
2. Terminals
3. Media

1.Host Computers:

It provides the data bases and application programs to be accessed by the various terminals, users. The host computer is connected to a node of the communication network through communication link. A terminal user generally accesses the network through a terminal controller.

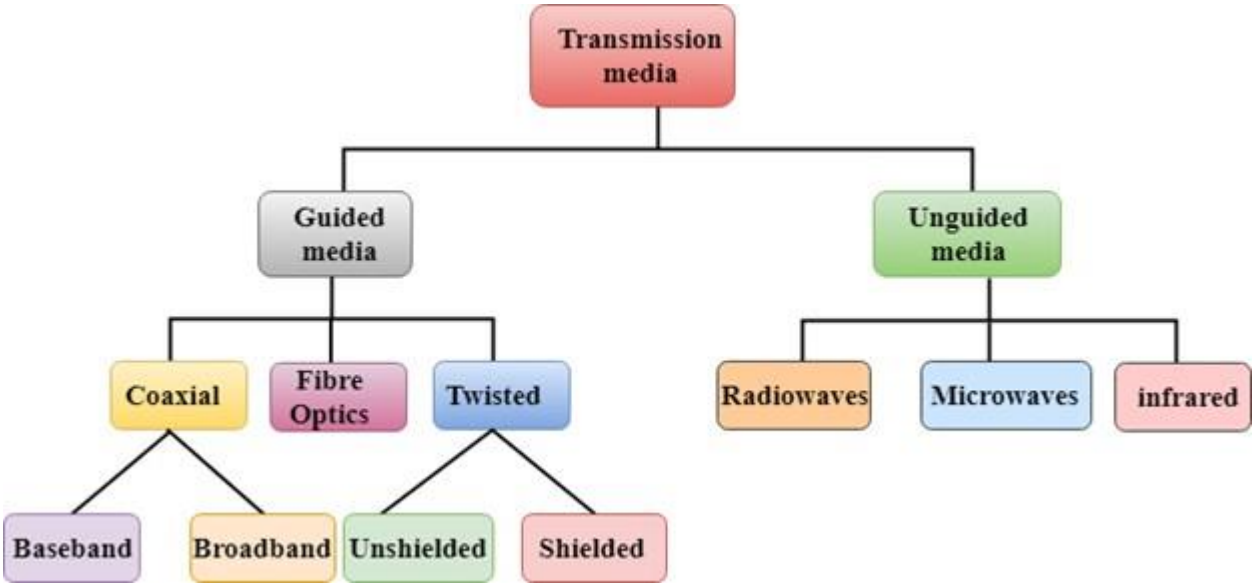
2.Media:

The Function of the media is, information transmitted effectively and efficiently. Information is transmitted normally through electromagnetic or electric signal. An electrical signal in the form of current. While an electromagnetical signal is a series of electromagnetic energy pulse at various frequencies. Satellite is the electromagnetic signal.

The physical path through which the computer can send and receive signals is called the transmission medium.

Transmission media classified into two categories

1. Guided



2. Un-Guided

Guided:

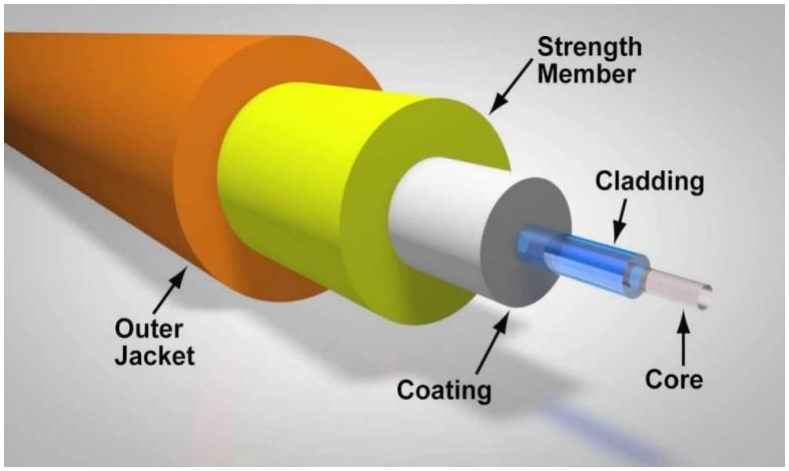
1. Fiber Optics
2. Co-axial Optics
3. Twisted pair cable (TPC)

Tpc again divided into 2 types

1. UTPC (Unsealed TPC)
2. STPC (Sealed TPC)

Fiber Optics:

In this case light is a media for communication. Fiber optics cable have a core surrounded by a cladding forming the fiber. The entire cable is enclosed in an



The light source the optical fiber can either be a LED or an ILD (Injection Leaser Diode). LED are cheaper source but they provide unfocused light in a distance. In leaser is very focused and it create very narrow angle by controlling the angle of incidence.

- Reduce signal attenuation and higher band width. [attenuation: Signal becomes weaker during transmission is called attenuation]

outer jacket

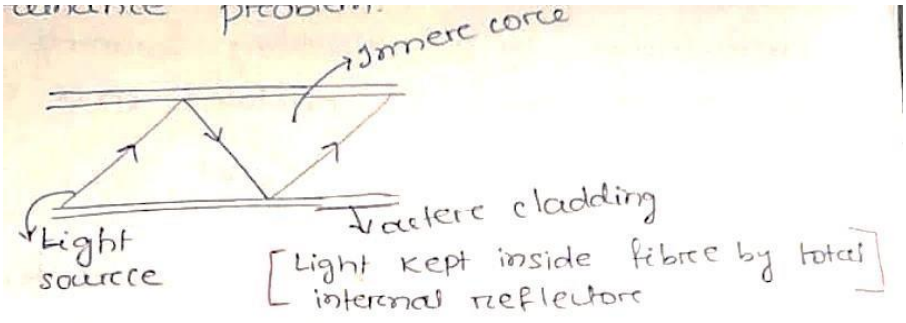
Both the core and cladding is made up of glass, but of different densities. In addition, the inner core must be ultrapure and completely regular in size small variation in the size of the channel alter the angle of the reflection & disturb the signal.

Advantages:

- Noise Resistance.

Disadvantages:

- Cost of installation is very high.
- Maintenance Problem.



Uses:

The most significant technology breaks through in data transmission has been development of optic communication has been development of optic communication system. Optical fiber use in distance telecommunication. After improvement in performance, it used in new area of application such as local network. The different among optical fiber, twisted pair and co-axial cable is:

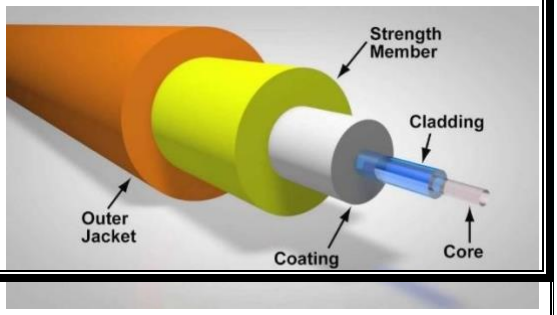
Band Width:

Data rate of a medium increased with frequency. The frequency of optical fiber is GBPS over 10's kms but 100's of MBPS over about 1km for Co-axial and few MBPS over 1km for twisted pair.

Diameter: The advantage of small size in weight reduces structural support requirement.

Lower attention: Attention is significantly timer for optical fiber than for co-axial cable or twisted pair and is ……. Over a wide range.

Electromagnetic Isolation: Optical fiber system are not affected by external electromagnetic fields. Thus, the system is not to interference, implies noise and crosstalk. Do not radiate energy causing little interference with other equipment and providing a high degree of securely. From dropping, in addition fiber in difficult to tap.

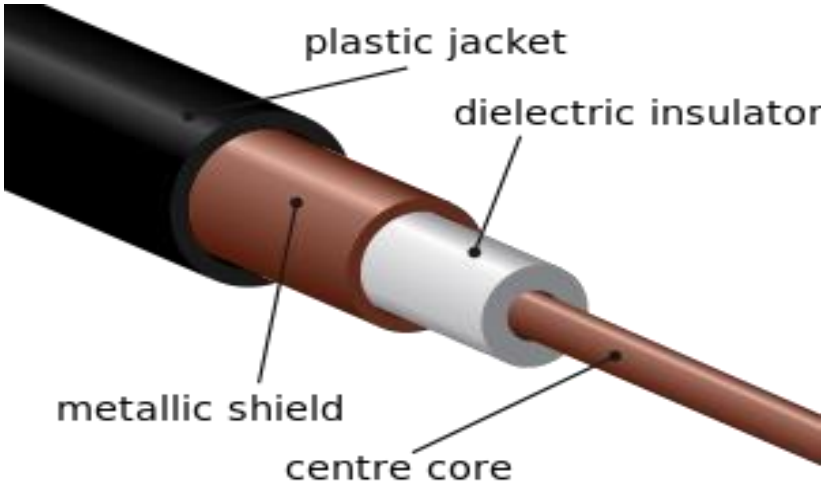


Twisted Pair Cable: A twisted pair cable consists of two bunches of thin copper wire, each bunch enclosed separately in plastic insulation, then twisted around each other to reduce interference by adjacent wire. It is called as UTP because other than the plastic coating around the two individual bunches of copper wires, nothing shields it from outside interference.

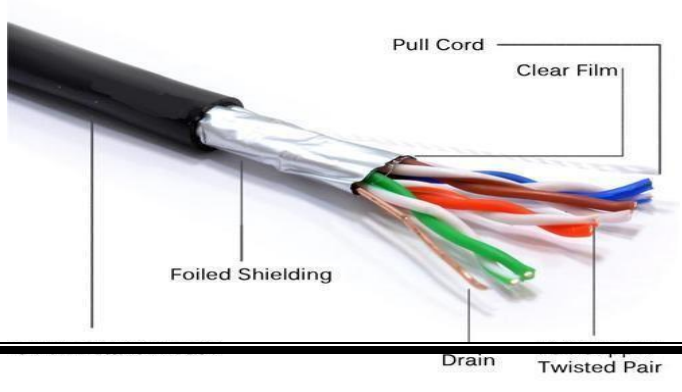
Lower Attention:

Attention fiber system are not affected by external electromagnetic fields. Thus, the system is not interference, pulse noise and crosstalk. Do not radiate energy causing little interference with other equipment and providing a high degree of security.

Co-axial Cable:



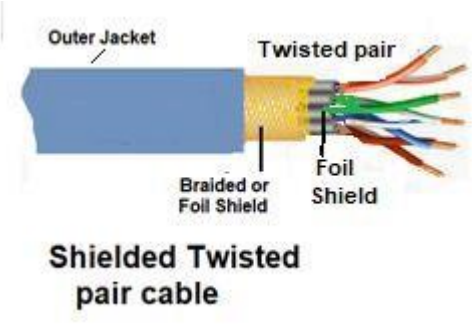
It carries the signal of higher frequency range than twisted pair cable. Instead of having two wires a co-axial cable has a central core conductor of solid wire enclosed in an insulating that in turn is encased in an outer conductor of metal foil. The outer conductor is also enclosed in an insulating and a plastic cover protects this whole arrangement.



UTPC: It is most common type of telecommunication medium used today. Its frequency range is suitable for both voice and data. A twisted pair cable consists of two conductors, each with its

own-colored plastic insulation. By twisting the cumulative effect at the interference is equal on both the wires. The total effect on the noise at the receiver end is o.

STPC:



Shielded Twisted pair cable

It is also commonly available. It has a metal foil that encases each pair of insulated conductors. This metal foil prevents the penetration of electromagnetic noise. It also eliminates cross talk i.e., one of the most undesired effects that occur between one circuit and other circuit.

Lan Protocol Architecture:

All LAN protocols share the common LLC specifications, but- vary with MAC and Physical layer specification. The standard for LLC is disignated as IEEE 802.0.

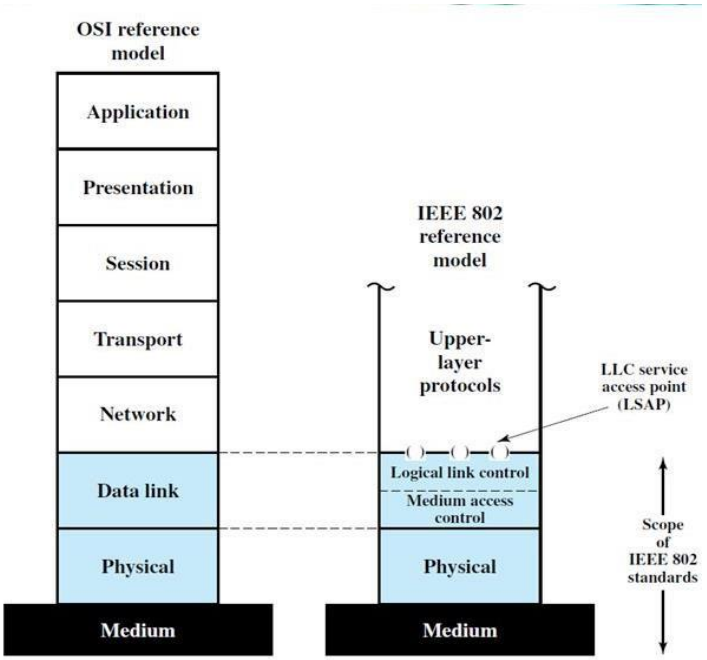
IEEE 802 referance module corresponds to the physical layer of OSI model. IEEE 820.2 module working from the bottom up. The function of physical layer of IEEE 802 in

- Encoding/ decoding of signals. -
Bit transmission/ recepion.

Above the physucal layer the functions are

1. On transmission, assemble data into a frame with address and error detection field.
2. On reception, disassemble frame, and frame address recognition and error detection.
3. Govern access to the LAN transmission medium.
4. Provide an interface to higher layers and perform flow and error control.

These functions typically associated with OSI layer 2 **LLC**



has two characterstics:

1. It must support the multiaccess, shared-medium nature.
2. It is relieved of some details of sime link acces by the MAC Layer.

LLC specifies the mechanism for adderssing stations across the medium and for controlling the exchange of data between two users.

MAC (Medium Access Control)

LANS and MANS consists of collection of devices. Devices must share the network's transmission capacity. The function of MAC in controlling access to the transmission medium efficient use of that capacity. Key parameters in any MAC techniques are

- Control in exercised in centralized.
- Control in exercised in Distributed.

In centralized Scheme: A station wishing to transmit must with until it receives permission from the controller.

Advantage:

- Priority and guaranteed capacity
- It enables the case of relativity simple access logic at each station.

Dis Advantages:

- It creates a single point of failure – There is a point in the network that it fails, cases the entire network to fail.
- It may act as a bottleneck, reducing performance.

Distributed Scheme: In decentralized network, the station collectively, perform a

MAC function to determine dynamically the order in which station transmit. In this scheme access control techniques in two type Synchronous and Asynchronous.

Asynchronous fashion function divided into three categories.

- Round Robin
- Reservation
- Contention

Round Robin: Each station in turn in given the opportunity to transmit.

Reservation: For stream traffic, reservation techniques are well suited. In general time on the medium in divided into slot. Reservation may be made in centralized or distributed fashion.

Contention: For bursty (sudden) traffic, contention (disagreement) are manually appropriate.

MAC frame format: The MAC layer receives the block of data from LLC layer. MAC frames have a format

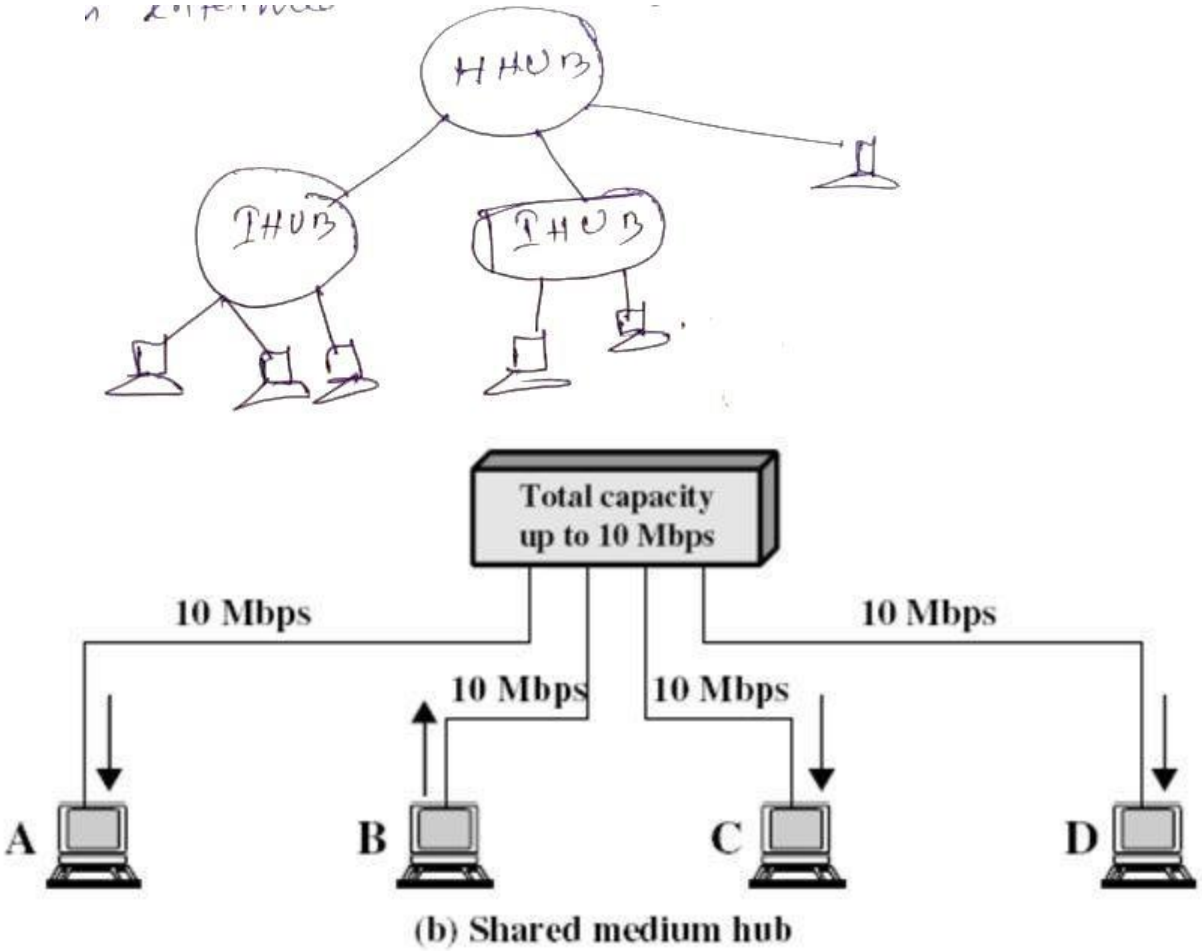
- MAC control: This field contains any protocol control information needed for the functioning of the MAC protocol. Ex: Prior level could be indicated have.
- Destination MAC address: The destination physical attachment point on the LAN for this frame.
- LLC: The LLC data from the next higher layer.
- CRC: This is an error detecting code.

HUBs:

Generally, the hub used in star-topology. Hub is the central element of star layout. Each station connects to the hub by two lines (transmit and receive). The hub acts as a repeater. When a signal station transmits, the hub repeats the signal on the

outgoing line to each station. The length of the line is limited to 100meter for STPC. In case of fiber optics length of line is maximum 500m.

Multiple levels of hub can be cascaded in a hierarchical configuration. Two level configurations. One in header hub (HHUB) another is intermediate hubs (IHUB).



(b) Shared medium hub

Bridge:

Bridge is a device which connect similar LANS, and identical protocols. Bridge uses in physical and datalink layer of OSI model.

Features of Bridge:

- Reliability: By using bridges, the network can be partitioned into self-contained units.
- Performance: Performance on a LAN declines with an increase in the number of devices or the length of the wire.

communication. two distinct geographically

A number of smaller LANS give improved performance if devices can be clustered through Bridge.

- Security: The establishment of multiple LANs improve security of

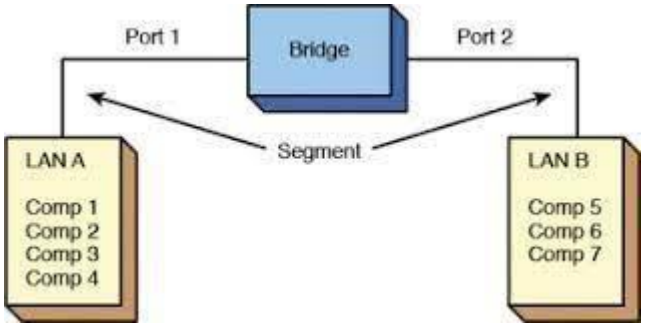
- Geography: Two separate LANs are needed to support devices clustered in

Functions of Bridge:

- Read all frames transmitted on ‘A’ and

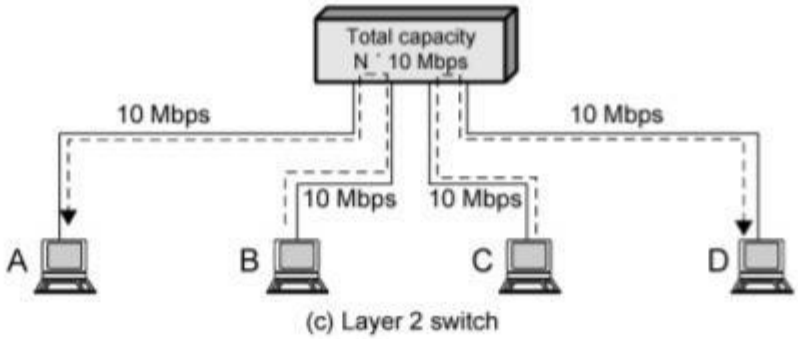
- Using MAC protocol for ‘B’ retransmit

- Do the same for ‘B’ to ‘A’ traffic.



Switches:

Layer 2 switch, has replaced the hub. Sometimes Layer 2 switch in referred as a switching hub. The central hub acts as a switch, much as a packet switch or circuit switch. With layer 2 switch, an incoming frame from a particular station is suitable to the appropriate o/p line to be delivered to the destination. At the same time other unused lines can be used for switching other traffic. Figure shows ‘B’ in transmitting a frame to ‘A’. At the same time c is transmitting to ‘D’. current throughput on the LAN in 20 mbps. Although each individual device in limited to 10 mbps.



(c) Layer 2 switch

location: ex: two building

accept these addressed to any

station on B. each frame on B.

Features of Switch:

- No changes required to the software and hardware.
- Each attached device has a dedicated capacity equal to that of the entire original LAN.
- Additional device can be attached to the layer 2 switch.

1. Store-and-forward switch: In this case accept a frame on an i/p line, buffer and then routs it to the appropriate o/p line.
2. Cut- through switch: In this case advantage in destination address appears at the beginning of the MAC frame.

Ethernet:

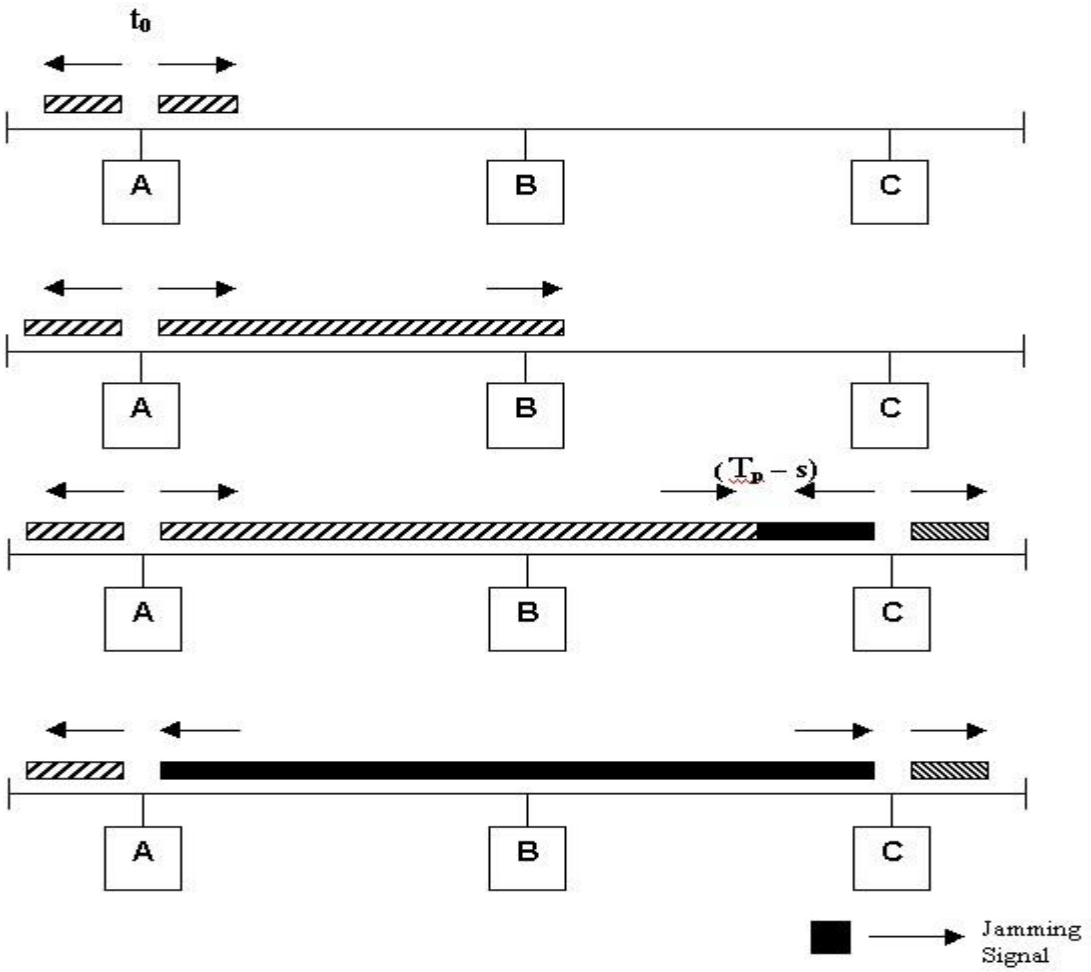
Ethernet is the most widely installed LAN technology. It is a physical and datalink layer technology. Ethernet uses a bus or star topology and supports data transfer rate. Ethernet uses CSMA/CD access method to handle simultaneously demands. Ethernet supports 10 Base T, 100 Base T, 1000 Base T.

CSMA/CD: (Carrier-sense multiple access with collision detection):

CSMA: A station wishing to transmit. First lister to the medium to determine of another transmission is in progress (Carrier Sense). If the medium is in use, the station must wait. If the medium is idle, the station may transmit. It may happen that more than one or two stations transmit at same time, if this happens there will be collision. The data from both transmissions will be completed and not received successfully. The waste can be reduced if a station continuous to listen to the medium while transmitting. There are the following rules for CSMA/CD.

1. If the medium is Idle, transmit, otherwise go to step 2.
2. If the medium is busy, continue to listen until the channel is idle, then transmit immediately.

3. If a collision is detected during transmission, then transmit a brief jamming signal to assure that all station knows that there has been a collision so that stations can cease the transmission.
4. After transmitting the jamming signal wait for a random amount of time referred as back off then attempts transmit Again. (Repeat from step 1)



This technique is for baseband bus. At time to, station 'A' begins transmitting addressed to 'D'. At t1 both B and C are ready to transmit, 'B' sense a transmission and so detect, 'C' is still unaware of 'A's' transmission (because the leading edge of A's transmission has not yet arrived at C) and begins its own transmission. When A's transmission reaches C, at t2, C detect collision and ceases transmission. The effect of collision propagates back to 'A' at t3 a ceases transmission.

With CSMA/CD the amount of wasted capacity is reduced to the time it takes to detect a collision. Concluded that the amount of time that it takes to detect a collision is no greater than twice end-to-end propagation time.

Fiber Channel:

Fiber channel is a technology for transmitting data between computer devices at data rates of up to 4Gbps. Fiber channel is especially suited for connecting computer server to shamed storage device and for interconnection storage controllers and drivers.

Fiber Channel Architecture:

It provides various communication protocols on the storage unit. The units that are interconnected are referred to as nodes. Each node has one or more ports. Fiber channel is primarily used in storage area network (SAN) in enterprise storage. Fiber channel networks are known as fabric. Fiber channel mainly runs on optical fiber cables.

Fiber channel protocol is a transport-protocol that predominantly transports SCSI commands over fiber channel network. Fiber channel is intended to satisfy.

- Full-duplex links with two fiber per link.
- Support for distances up to 10km.

- Small connectors.
- High-Capacity utilization.
- Greater connectivity than existing multidrop channel.

Fiber channel protocol Architecture:

The fiber channel standard is organized into five levels.

- FC 0 physical media: Includes optical fiber for long distance application, coaxial for high speed over short distance, and STPS for lower speeds over short distance.
- FC 1 Transmission protocol: Defines the signal encoding scheme.
- FC 2 framing protocol: Deals with defining topology, frame format, flow and error control.
- FC 3 common service: Includes multicasting. (Multicasting: - one type of many-to-many in a group communication where information is addressed to a group of destination computers)
- FC 4 mapping: Defines the mapping of various channel and network protocols to fiber channel.

Fiber channel physical media and topologies:

The transmission media: available under fiber channel include STP, co-axial cable and optical fiber data rate range from 100Mbps to 3.2Gbps. Point-to-point link distance range from 33m to 10km.

Topologies: There are three major fiber channel topologies, describing how a number of points are connected together.

1. Point-to-point: Two devices are connected directly to each other. This is the simplest topology, with limited connectivity. Maximum port 2. Medium is dedicated.

2. Arbitrated loop: In this design, all devices are in a loop or ring, similar to token ring networking. Adding or remaining a device from the loop causes all activity or the loop to be interrupted. The failure of one device causes a break in the ring. Maximum ports 126.
   Medium in Arbitrated:

- A minimal loop containing only two ports. Similarly point-to-point.
- Only one pair of ports can communicate concurrently on a loop.
- Arbitrated loop has been rarely used after 2010.

3. Switched fabric: In this design, all device is connected to fiber channel switches, similar to Ethernet.
   Advantages of this topology over point-to-point or Arbitrated loop include:

- The fabric can support tens of thousands of ports.
- The switches providing optimized path via fabric shortest path first (FSPF) - The traffic between two ports flew through the switches.
- Filene of a port is isolated to a link and should not affect operation of other port.
- Multiple pair of ports may communicate simultaneously in a fabric.
- Maximum ports 2^{2m} - Medium is dedicated

Wireless LAN Technology: (WLAN)

WLAN is a wireless computer network that links two or more devices using a wireless distribution method. WLAN fall into two categories.

Infrared (IR) LANs: In this techniques, device or system convey data through IR radiation. IR LAN is limited to a single room because infrared light does not pernitrate walls.

Spread Spectrum LANs: Spread spectrum is a form of transmitted signal is deliberately varied. This results in a much greater bandwidth than the signal would have if its frequency were not varied.

Transmission techniques: Three alternative transmission techniques use for IR data transmission.

1. Directed beam IR: This technology used to create point-to-point links. A focused IR data link can have a range of kilometers.
2. An omnidirectional configuration: Involves a single base station that is within line of sight of all other station the LAN. This station is mounted on the celling. Transceivers transmit a directional beam aimed at the willing base unit.
3. In diffused configuration: in this case, all of the IR transmitters are focused and aimed at a point on a diffusely reflecting ceiling. IR radiation striking the ceiling in reradiate omnidirectional and picked up by all of the receivers.

SUBJECT: - DATA COMMUNICATION AND COMPUTER NETWORK TH-2

SEMESTER-4TH

7. TCP/IP TCP/IP

Protocol Suit:

Internet uses TCP/Ip protocol suit on network and transport layer for providing various services.

TCP/Ip is a set of protocols that enables communication between components. It is known as Transmission control protocol/Internet protocol.

TCP/IP suit:

TCP/IP suit consists of following protocols.

1. IP (Internet Protocol), 2.TCP, 3.ARP, 4. RARP, 5. ICMP, 6.UDP, 7. OSPF, 8.FTP, 9. SMTP, 10. TELNET, 11. SLIP, 12. PPP.

IP (Internet Protocol):

The Ip handler the address part of each data packet that is transmitted from one computer to another on the internet.

The features of IP are as follows:

- IP uses network address for addressing
- For Switching: It uses packet switching method. - It uses route selection, error control - It is the network layer protocol.

Transmission Control Protocol (TCP):

TCP is the IP suits' transport layer protocol. TCP is one of the main protocols in the TCP/IP network.

Features of TCP:

1. TCP provides reliable, enhanced error checking.
2. Exchange stream of data.
3. TCP guarantees the delivery of data in the same order in which they were sent.
4. TCP manages assembly and reassemble of the packets sent over the internet.

ARP (Address resolution Protocol):

Typically, ARP used on a LAN. ARP is a network layer protocol. ARP address has the IP address of the network on which the node is located. To find out the ARP address, host requests to IP address.

Reverse Address Resolution Protocol (RARP):

It is also used in LAN. Its Function like ARP but in reverse. To find out the IP address, A host uses RARP. The host broadcasts its physical address and the RARP server replies with the host's IP address.

Internet Control Message Protocol (TCMP):

TCMP is concerned with connection services. ICMP provides error control and network layer flow control.

User Datagram Protocol (UDP)

UDP is a connection ten protocol that works at the transport layer. It transports packets but does not acknowledge the receipt. JDP Provides two services.

1. UDP uses a port Address to achieve packet delivery port address in simply a pointer to the process. Port address helps to distinguish different user requests.
2. A checksum capability to verify that the data that has arrived in intact.

Open shortest path first (OSPF):

OSPF is a network layer protocol that address route disarray. It is also known as linestate routing protocol.

Advantages: It requires less network bandwidth. It can handle larger network.

The main disadvantage is complexity, high memory requires.

File Transfer Protocol (FTP):

1. FTP used for file transfer between inter network node.
2. FTP functions at the top three layers of the OSI model. (Application, presentation and session layer.)
3. FTP allows user to initiate processes on the remate host.

Simple Main Transfer Protocol (SMTP):

SMTP in a protocol for routing e-mail message. It works at the application layer to provide message service. SMTP uses TCP/IP to route the mail message over the Internet.

Telnet:

Telnet is used for remate terminal emulation. It enables users to access host-based application by emulating one of the hosts terminals and function at the top three layers of the OSI model. (Application, presentation & session).

SLIP (Serial Line Internet Protocol):

The SLIP is using for dial up connections to the internet. If you connect to the internet from your home computer chances are that you are using one of these protocols. It functions only at Physical Layer. It does not provide error control.

Point-to-Point Protocol (PPP):

PPP was developed as an improvement to SLIP. It functions both physical and data link layer. PPP has addition functions like error control, security, dynamic. Ip addressing and supports multiple protocol.

How TCP/IP Works:

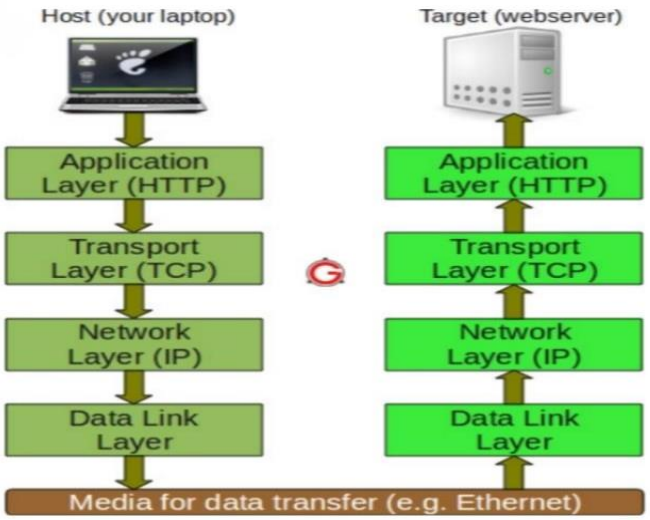
The internet works by using TCP/IP. TCP/IP allows one computer via the internet, by sending packets of data to right location.

TCP/IP uses the clint-server model of communication.

TCP/IP functionality is divided into four layers. Each layer includes specific protocol.

- Application Layer: This layer provides data exchange. Its protocol is including the HTTP, FTP, POST office protocol (POP), SMTP.
- The Transport Layer: It is responsible for end-to-end communication across the network. It provides floe control, multiplexing. This layer includes TCP and UDP protocol.

- Network Layer: It is also called an internet layer. It deals with packets across the network. It includes the ICMP protocol which is used to error reporting.
- The physical layer: It is also known as the network interface layer or datalink layer. It is operating only on a link. It includes the RARP and ARP protocol. It used Ethernet for LAN.



Basic protocol functions:

Basic functions of protocol are

- Encapsulation
- Fragmentation and reassembly
- Connection control
- Ordered delivery
- Flow control
- Error control
- Addressing
- Multiplexing
- Transmission services

Encapsulation: In protocol data unit (PDU) data are transmitted in blocks. Each PDU contains data and control information. Some PDU consists of only control information not data. Control information fall into three categories.

- Address: The address of sender/ receiver indicated.
- Formation detecting code: some frame check square in frequently included for error detection.
- Protocol control: Additional information in included to implement the protocol function.

Fragmentation and reassembly:

Protocol in concerned with exchanging data between two entities. Faster can be consisting of sequence of PDU.

A protocol may need to divide a block received from higher layer into multiple blocks of smaller size is called Fragmentation. the counterpart of fragmentation is reassembly.

Connection control:

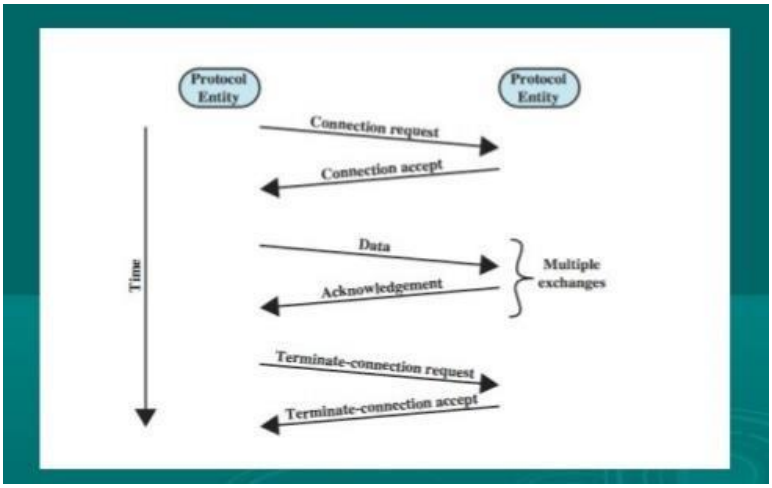
Connection less transfer: Data transfer from sender to receiver in such a way that each PDU in treated independently. Connection oriented transfer: if a station anticipates a lengthy exchange of data between sender and receiver. A connection in established between the entities. This connection has three phases.

- Connection established
- Data transfer
- Connection termination

Connection establishment: in this phase sender, receiver agree to exchange data. On station issue connection request. The receiving end either accept or reject the request.

Data transfer occur when both sender and receiver agreed.

Finally, either or side withes to terminate, them transmit terminate request.



User access control: Each network will have its own user access control techniques.

Connection, connectionless: individual networks may provide connection oriented or

Internet- internet used within single organization.

Addressing level: Addressing level refers to the level in the communications architecture at which an entity in named. A unique address in associated with each end

Addressing scope: it is also related to the address of an end system or intermediated system. It is referenced to the global address.

Connection identifier: For a connectionless data transfer, a global identifier in used

- Reduced over head

Alternatively, a control authority forcibly terminates a connection.

Error recovery: The interwork service should not depend on nor be interfered of the individual networks error recovery capabilities.

Status reporting: Different networks report status and performance differently.

Routing Techniques: In trancework routing may depend on fault detection and congestion control techniques to each network.

connectionless (data from) service.

system and each intermediated system. with

each data transmission.

Advantage of connection identifier:

- Routing
- Multiplexing

Addressing mode: Addressing mode in two types

1. Unicast: Address refer to a single system or port in unicast.
2. Multicast: Addressing for specific subset of entities in multicast.
3. Broadcast: An address for multiple recipients for all entries within a domain.

Principles of Internetworking:

The overall requirements for an internetworking facility are as follow:

- Provide a link between networks.
- Provide for the routing and delivery of data between processes a different network.
- Provide an accounting service.
- Different addressing schemes.
- Different maximum packet size.
- Different network access mechanism.
- Different time out.
- Error recovery.
- Status reporting.
- Routing techniques. - User access control.
- Connection, Connectional.

Different addressing Schemes: The network uses different end point names and address.

Different Maximum packet size: Packets from one network may broke into smaller pieces for another.

Different network access method: The network access mechanism between station and network may be different from one network to another (Ex: N1 maybe frame relay n2 may be Ethernet.)

Different Timeouts: A connections-oriented transport services will await an ACK until a timeout expires, at which time it will retransmit its block of data.

Ordered Delivery: If a file in transferred between two systems, we assessed that the records of the received file are in same order became they may travel in different paths through the network.

Flow Control: Flow control is a function performed by a receiving entity to limit the amount of data rate in sent by a transmitting entity.

Error Control: Error control techniques are needed to guard against loss a damage of data and control information. Error control in implemented as two separate functions.

- Error detection.
- Retransmission

Multiplexing: Multiplexing means multiple connections into a single system. Ex- frame relay, there can be multiple data link connections terminating in a single end system.

Transmission Services: Three common example of transmission services are

- Priority: Priority could be assigned on a message basic.
- Quality of services.
- Security: Security mechanism, restricting access.

Addressing: The concept of addressing covers a number of issues.

- Addressing level.
- Addressing scope.

- Connection identifies.
- Addressing mode.