

Advance Communication Engineering

Topics

1. Radar & Navigation Aids.
2. Satellite Communication.
3. Optical fiber communication.
4. Telecommunication system
5. Data Communication
6. Wireless Communication.

Data Communication (Chptr-1) Unit-5

Chptr-1

Basic Concept of Data Communication:-

Data Comm. is the transfer & flow of data from one place to another place. learn all about how it works & careers in data communication. like human communication in a variety way by speaking, texting & emailing data similarly transfers from one place to another using different medium. This process of moving electronic & digital data is called data communication.

Ex:- Audio, video, msg.

Component of Data Communication:-

- | | |
|----------------|--|
| (i) Message | (iv) Transmission Media (Wireless, Copper wire, Optical) |
| (ii) Sender | |
| (iii) Receiver | (v) Protocol |

i) Protocol: -

The set of rule & regulation that covered the data communication

ii) Message: -

The information transmits from sender of Receiver.

iii) Sender: -

The device / msg is capable to send the data

iv) Receiver: -

The device / msg is capable to received the data.

v) Transmission media: -

It is a basically part the msg will transfer from sender to Receiver

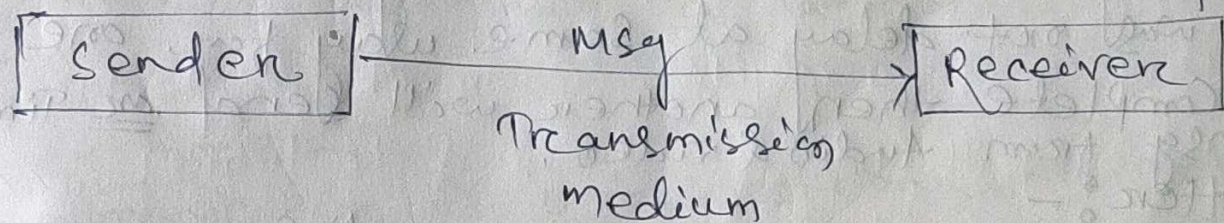
↳ It is basically two types.

(a) wire cable → Co-axial cable, copper wire cable, optical fiber cable,

(b) wireless cable → microwave, mobile comm.

Protocol

Protocol



Characteristics of Data Communication: -

i) Delivery: - Data should be deliver to the correct destination at the correct time & correct users.

ii) Accuracy: - The sender send the msg / information to Receiver that time the information will correct/broken

- ii) Numbers: - The combination of digit like '0 to 9' sends.
- iii) Images: - The image will send by pixels. The image small unit is "pixel".
or the image will be send the pixel bit.
- iv) Audio: - Recorded sound broadcast - audio information. - Audio data non-discrete, continuous.
- v) Video: - Picture & movies broadcast to send is called video.

Data flow

Transmission mode:

Transmission mode is also called Directional mode. It is divided three types

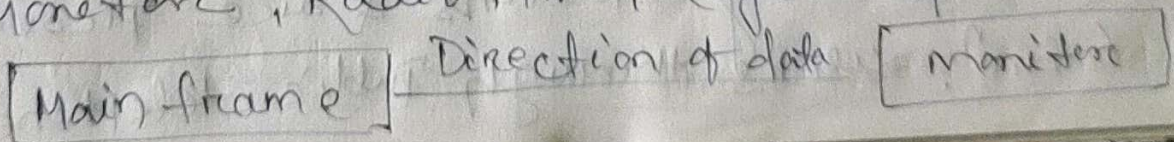
- a) Simple Duplex
- b) Half Duplex
- c) Full Duplex

Def: The way to data transform from one device to another device is known as transmission mode. This mode is also known as communication mode.

modes:

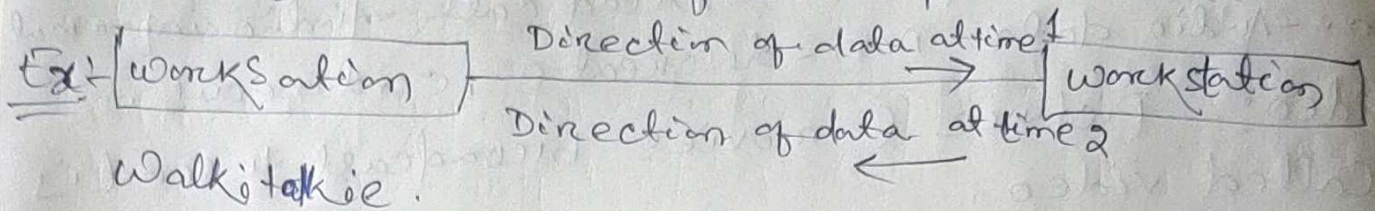
- a) Simplex mode: - The communication is unidirectional. A device can only send data but can't receive it, or it can only receive data but can't send it. The performance of this mode is low as compared to other modes.

Ex: - Monitor, Radio, T.V, Keyboard



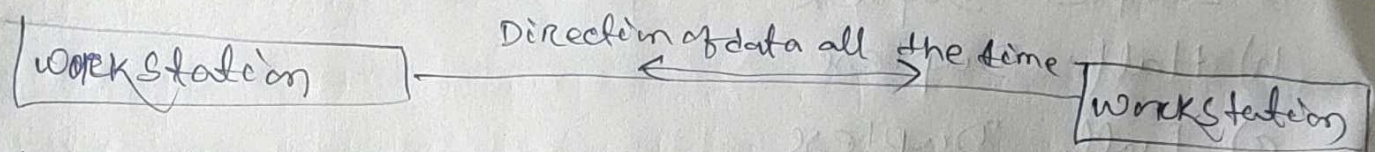
b) Half Duplex:-

The communication data bi-directional (both directions but not at same time). The device can send & receive the data but one at a time. The performance of this mode is better than simplex mode but less than full duplex mode.



c) Full duplex mode:-

The communication is bidirectional. The devices can send & receive the data simultaneously. The performance of this mode is highest as compared to other modes.



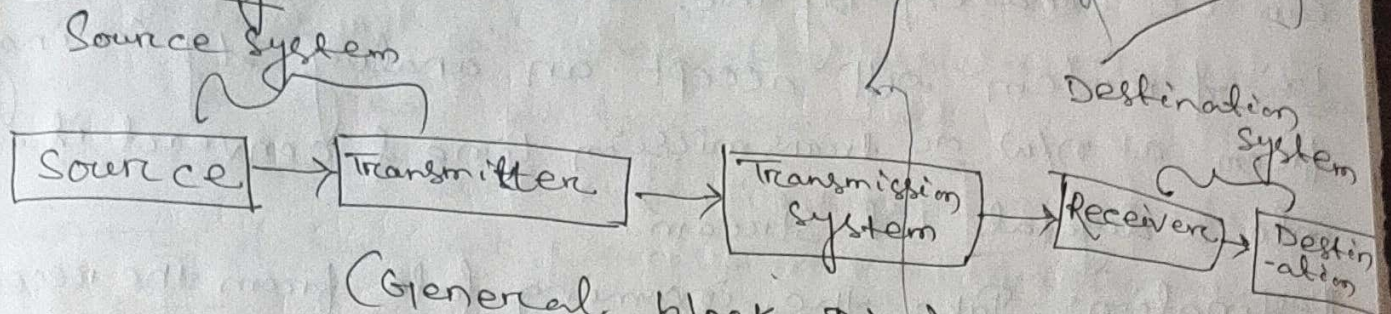
Ex:- video call, Audio call, USB

Chpt-3 Data Communication Circuit:-

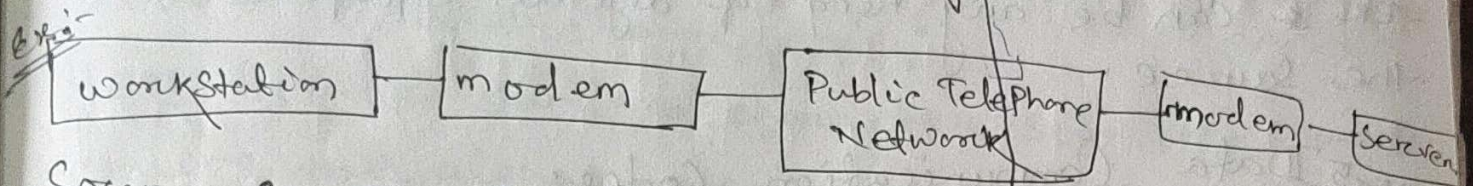
The purpose of a digital comm. ckt is to provide a transmission path betⁿ locations & to transfer digital inf.ⁿ from one station to another using electronic ckt. Data Comm.ⁿ ckt utilize electronic comm.ⁿ equipment & facilities to interconnect digital computer equipment. Comm.ⁿ facilities are physical means of interconnecting stations & are provided to data Comm.ⁿ users through Public telephone network.

(PTN), Public data networks (PDN) & a multitude of Private data Communication systems.

Block Dig:-



(General block Dig)



Source:- This device generates the data to be transmitted. The source equipment provides a means for humans to enter data into system.

Ex:- Main frame Computer, Personal Computer, workstation.

Transmitter:- The transmitter transforms & encodes the information in such a way to produce electromagnetic sig that can be produce across some sort of transmission system.

Ex:- A modem takes a digital bit stream from an attached device such as a personal computer & transforms that bit stream into an analog sig that can be handled by the telephone N/w.

Transmission medium:- The transmission medium carries the encoded sig from the transmitter to the receiver. Different type of transmission (all form of wireless transmission) & Physical facilities such as metallic & optical fiber cables.

Receiver: - The receiver accepts the sig from the transmission medium & converts it into a form that can be handled by the destination device.

Ex:- A modem will accept an analog sig coming from a t/w on transmission line & convert it into a digital bit stream.

Destination: - Take the incoming data from the receiver & can be any kind of digital equipment like the source.

Chpt:-5 Data Communication Codes:-

The data Communication Codes is defined as Prescribed bit sequences. Such as letters, digit & Punctuation marks used for encoding characters & symbols.

Need for codes:-

A binary digit or bit can represent only two symbols as it has only two states '1 & 0'.

But this is not enough for Communication b/w two computer because ~~there~~ we need many more symbol for Communication.

Types of codes:-

There are three most common data communication codes are:

a) Baudot Code

b) ASCII Code

c) EBCDIC code

a) Baudot Code:-

The first fixed length character code developed

only for machines is called Telex code or Baudot code. This baudot code is also fixed length source code or fixed length block code.

↳ This is a five bit character code that used primarily for low speed tele type equipment.

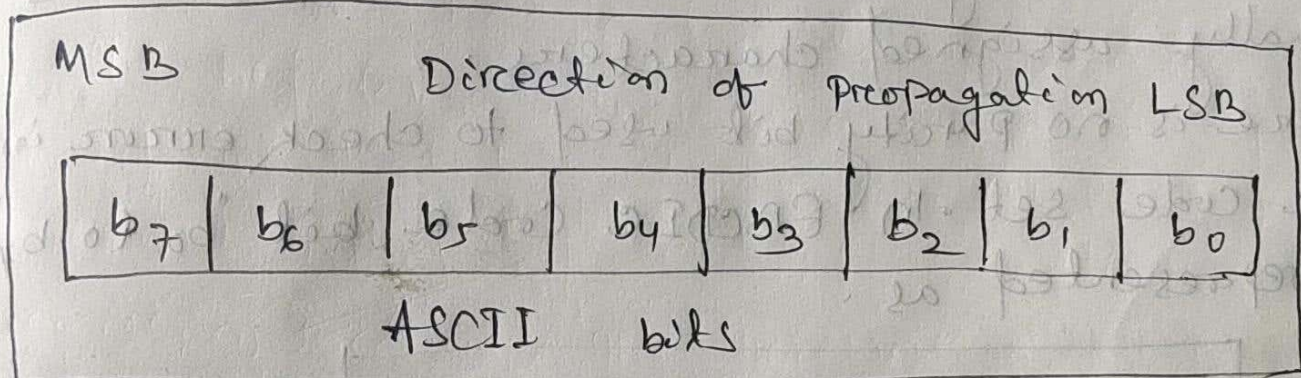
↳ The Baudot code all characters ^{are} represented binary & have the same number of symbols.

b) ASCII (American standard code for information interchange) code: —

ASCII is the standard character set for source coding the alphanumeric character set that human can understand but the computer does not.

↳ It is a 7 bit character code fixed length set with 2^7 i.e. 128 possible combinations.

↳ In ASCII code, the least significant bit (LSB) is designated b_0 & the most significant bit (MSB) is designated b_7 is shown as.

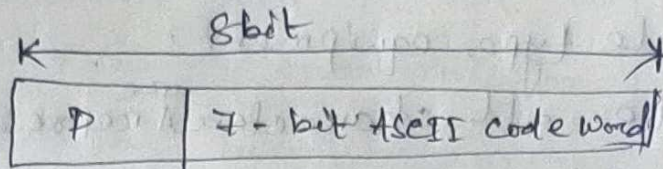


→ In ASCII, the bits can be referred by it's order rather than by it's position.

e.g. → b_0 → zero-order bit
 b_1 → First order bit
 b_7 → Seven order bit

Parity Bit in ASCII Code:-

ASCII is generally a 7-bit code but the 8th bit is often used as a parity bit, which is used to detect errors introduced during transmission.

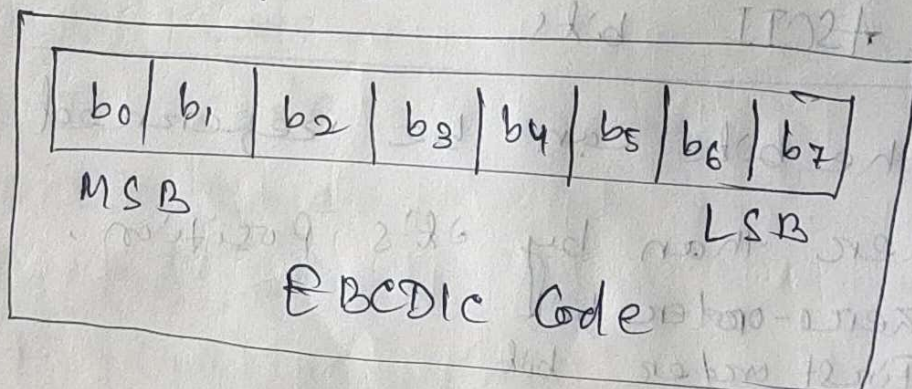


Parity bit in ASCII code.

c) EBCDIC Code :- (Extended Binary Coded Decimal Interchange Code)

The Extended Binary Coded Decimal Interchange Code is an eight bit fixed length character set developed by IBM in 1962.

- ↳ EBCDIC is almost exclusively used in IBM mainframe, computers & peripheral equipment.
- ↳ This code is most powerful because of its 8-bit character code properly 2^8 leads to 256 possible combinations but not all the combinations are used only 139 out of 256 codes are actually assigned characters.
- ↳ There is no parity bit used to check errors in the basic code set. In EBCDIC Code bit 'b₀ to b₇' is represented as.



Architecture, Standard & Protocol:-

The Network architecture, standards & protocols are all related to the design & operation networks. They work together to ensure that devices & systems can communicate & work together.

Network Architecture:-

Network architecture means network layout that tells us how computers are arranged & how task are allocated to the computer.

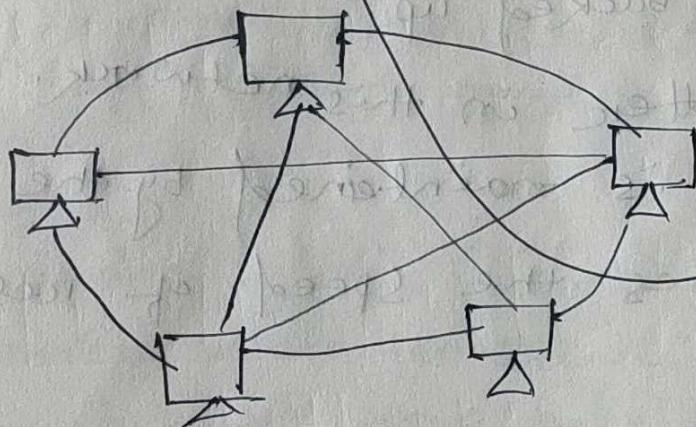
Types of Architecture:-

(*) There are two types of network Architecture.

a) Peer-to-Peer Architecture:-

Peer ~~to~~ Peer network also known as point to point network in which all the computers are directly linked together with equal ^{equal Responsibility} privileges & responsibilities for sharing the data.

↳ There is no server in it.



Advantages:-

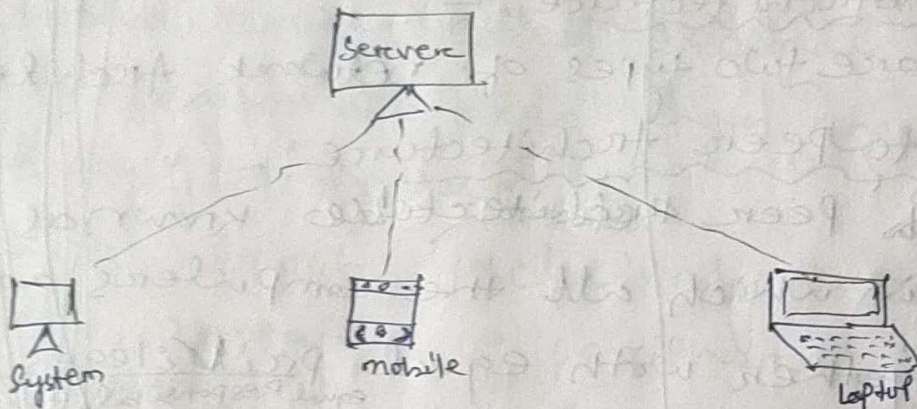
- i) It is a cheaper network as it has no server.
- ii) If one computer stops working it will have no effect on the other computer.
- iii) Its setup & maintenance is also easy.

Dis-advantages:-

- 1) Security Issues.
- 2) We connect backup the data because there is no server in this network.

Client Server Architecture:-

Client server architecture also known as request responsible architecture. In this architecture client makes a request to the server and server will fulfill the response.



Advantages:-

It has a centralized system from which data can be easily backed up.

Security is better in this network.

Entire system is maintained by the server.

It also increases the speed of resource sharing.

Disadvantages:-

In case of server failure entire network will be failed.

Server maintenance cost is high.

Protocols :-

It consists set up logical rules that govern data communication.

- ↳ It defines how data is sent, received & processed
- ↳ It can include standards for how data is transmitted, formatted & secured.

Key elements of Protocol :-

a) Syntax :-

Syntax refers to the structure or the format of the data that gets exchanged betⁿ the devices. Syntax of the message includes the type of data, composition of the message & sequencing of the message. The starting 8 bits of data are considered as the address of the sender. The next 8 bits are considered to be the address of the receiver. The remaining bits are considered as the message itself.

b) Semantics :-

Semantics defines data transmitted betⁿ devices. It provides rule & normal for understanding message, or data elements values & action.

c) Timing :-

Timing refers to the synchronization & coordination betⁿ devices while transferring the data. Timing ensures at what time data should be sent & how fast data can be sent.

Ex:- If a sender sends 1 Gbps but the receiver can only handle 1 Mbps, the receiver will overflows & lose data loss, collisions & other timing-related issues.

(d) Sequence control :-

Sequence control ensures the proper ordering of data packets. The main responsibility of sequence control is to acknowledge the data while it gets received & the transmission of lost data. Though this mechanism, the data is delivered in correct order.

(e) Flow control :-

Regulates device data delivery. It limits the sender's data or asks the receiver if it's ready for more. Flow control prevents data congestion & loss.

(f) Error control :-

Mechanisms detect & fix data transmission faults. They include error detection codes, data resend, & error recovery. Error control detects & corrects noise, interference & other problems to maintain.

(g) Security :-

Network security protects data confidentiality, integrity & authenticity, which includes encryption, authentication, access control & other security procedures. Network communications privacy & trustworthiness are protected by security standards.

Types of Protocol :-

a) Network Layer Protocols :-

Network layer protocols operate in the network layer which is also known as the layer 3 of the network architecture. Network layer protocols are responsible for packet routing, forwarding & addressing of data.

Packets throughout the network "IP & ICMP" are the network layer protocols.

b) Transport Layer Protocols: -

Transport layer protocols work in the transport layer which provides end-to-end service ensuring data transfer across apps on different device. "TCP & UDP" are the most popular transport layer protocols.

App Layer Protocol: -

App layer protocol working in the app layer of the network architecture provides commⁿ betⁿ app's running on different device. The app layer protocols enable cross-device commⁿ. They format exchange & interpret appⁿ data. Ex:- HTTP, FTP & SMTP.

Wireless Protocols: -

wireless protocols, basically used in wireless commⁿ which enables data transfer through wireless H/W. Ex:- Bluetooth, Wi-Fi & LTE protocols etc.

Routing Protocols: -

Routing protocols establishes the best/optimal n/w pathways throughout the n/w for fastest data transmission. Routers share information to develop & maintain routing tables. Ex:- RIP, OSPF, BGP.

Security Protocols: -

Security Protocol protects data confidentiality, integrity & authenticity while transmission of data over the network. They include "SSL & TLS"

encryption methods & authentication protocols for providing data security.

Important protocols used in computer N/W:-

IP (Internet Protocol) :-

IP identifies devices uniquely. IP provides data comm. through routing & forwarding data packets from one device to another by unique addressing scheme.

TCP (Transmission Control Protocol) :-

Ensures data is sent & received accurately by breaking it into packets, sending them & reassembling them at the destination.

HTTP/HTTPS (Hyper Text Transfer Protocol / Secure) :-

HTTP used for transferring web pages on the Internet. When you browse a website, your browser uses HTTP to request & display web pages & HTTPS is a secure version of HTTP that encrypts data to protect it from being intercepted.

FTP (File Transfer Protocol) :-

Used for transferring files betⁿ computers on a n/w. It allows users to upload & download files.

SMTP (Simple Mail Transfer Protocol) :-

Used for sending emails. It transfers emails from a client to a server or betⁿ servers. SMTP (POP & IMAP) all these protocols work with help of TCP/IP.

DNS (Domain Name System) :-
It is used to translate human-readable domain name (like www.example.com) into IP addresses that computers used to identify each other on the N/W.

DHCP (Dynamic Host Configuration Protocol) :-
Automatically assigns IP addresses to devices on a n/w, ensuring each device has a unique address.

SSH (Secure Shell) :-
Provides a secure way to access & manage devices over a n/w. It encrypts the data, making it safe from eavesdropping.

SNMP (Simple Network Management Protocol) :-
Use for managing & monitoring n/w devices like routers, switches & servers. It collects & organizes information about these devices.

* Standard :-
Standards are the set of rules for data comm. that are needed for the exchange of information among devices.

OR An association of organizations, governments, manufactures & users from the standard organizations & are responsible for developing, coordinating & maintaining the standards. The internet is that all data comm. equipment manufactures & users comply with these standards.

a) ISO (International Standard Organization)

ISO is the international organization for standardization on a wide range of subjects. It is comprised mainly of members from the standards committee of various govt. throughout the world. It is even responsible for developing models which provides high level of system compatibility, quality enhancement, improved productivity & reduced costs. The ISO is also

responsible for endorsing & coordinating the work of the other standards organizations.

b) ITU-T (International Telecommunications Union) Telecommunications Section

ITU-T is one of the four permanent parts of the International Telecommunications Union based in Geneva, Switzerland. It has developed three sets of specifications: The 'V' series for modem interfacing & data transmission over telephone lines, the 'X' series for data transmission over ^{Public} digital ^{Network} email & directory services; the 'I' & 'Q' services for Integrated Services Digital Network (ISDN) & its extension Broadband ISDN. ITU-T membership consists of govt authorities & representatives from many countries & it is present standards organization for the United Nations.

c) IEEE (Institute of Electrical & Electronics Eng.)

IEEE is an international professional organization founded in United States & is comprised of electronics, computers & communications engineers. It is currently the world's largest professional society with over 2,000,000 members. It develops comm. & Inf. processing standards with the underlying goal of advancing theory, creativity & product quality in any field related to electrical engineering.

d) ANSI (American National Standards Institute)
ANSI is the official standards agency for the United States & is the U.S. voting representative for ISO. ANSI

is a completely private, non-profit organization. Comprised of equipment manufacturers & users of data processing equipment & services. ANSI membership is comprised of people from professional societies, industry associations, governmental & regulatory bodies & consumer groups.

e) EIA (Electronics Industry Association)

EIA is a non-profit U.S. trade association that establishes & recommends industrial standards. EIA activities include standards development, increasing public awareness & lobbying & it is responsible for developing the RSC (recommended standard) series of standards for data & communications.

f) TIA (Telecomm. Industry Association)

TIA is the leading trade association in the comm. & inform. technology industry. It facilitates business development opportunities through market development, trade promotion, trade shows & standards development. It represents manufacturers of comm. & inform. technology products & also facilitates the convergence of new comm. n/w.

g) IAB (Internet Architecture Board)

IAB earlier known as Internet Activities Board is a committee created by ARPA (Advanced Research Projects Agency) so as to analyze the activities of ARPANET, whose purpose is to accelerate the advancement of technologies useful for U.S. military. IAB is a technical advisory group of the Internet Society & its responsibilities are:

- i) Oversees the architecture protocols & Procedures used by the Internet.
- ii) Manages the Processes used to create Internet Standards & also serves as an appeal board for Complaints regarding improper execution of standardization process.
- iii) Responsible for administration of the various Internet assigned numbers.
- iv) Acts as a representative for Internet Society interest in Liaison relationships with other organizations.
- v) Acts as a source of advice & guidance to the board of trustees & officers of Internet society concerning various aspects of Internet & it's technologies.

(b) IETF (Internet Engineering Task Force)

The IETE is a large international community of New designers, operators, vendors & researchers concerned with the evolution of the Internet architecture & smooth operation of the Internet.

(i) IRTF (Internet Research Task Force)

The IRTF Promotes research of importance to the evolution of the future Internet by creating focused long-term & small research groups working on topics related to Internet protocols, app'n, architecture & technology.

Chpt-6

Error Control

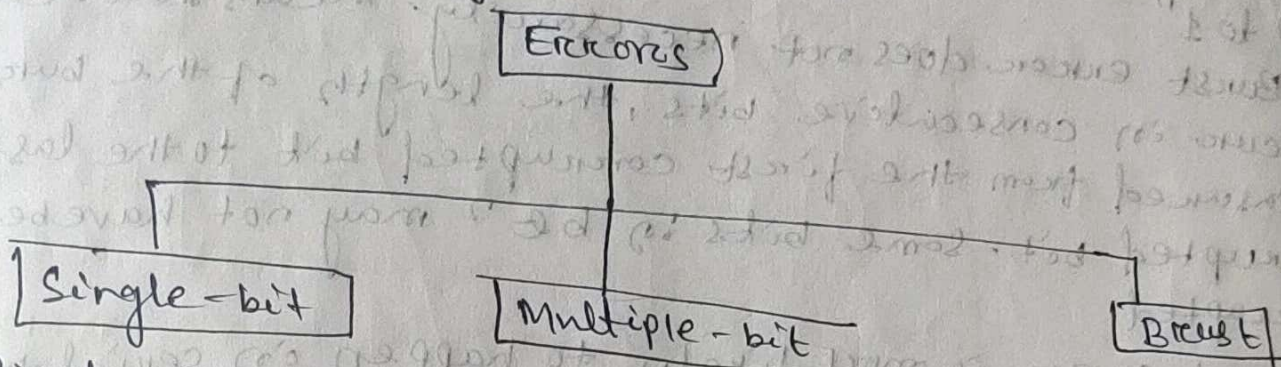
Network must be able to transfer data from one device to another with Complete accuracy. Data Can be corrupted

during transmission. For reliable comm, errors must be detected & corrected. Error control can be divided into two general categories.

- a) Error Detection
- b) Error Correction.

Error detection & error correction are implemented either at the data link layer or transport layer of the OSI model.

Types of Errors



Single Bit Error?

0 changed to 1

0 0 0 0 0 1 0

sent

0 0 0 0 1 0 1 0

Received

Single bit errors are the leasts likely types of error in serial data transmission because the noise must have a very short duration which is very rare. However this kind of errors can happen in parallel transmission.

Multiple Bit Error?

Two errors

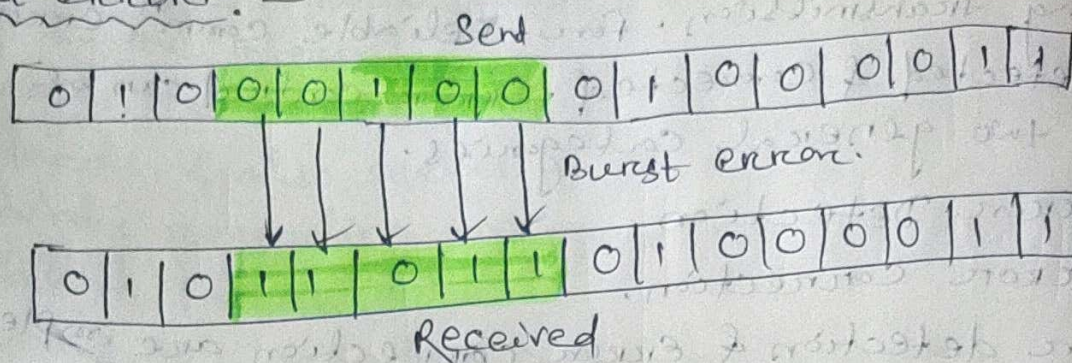
0 1 0 0 0 0 1 0

sent

0 0 0 0 1 0 1 0

Received

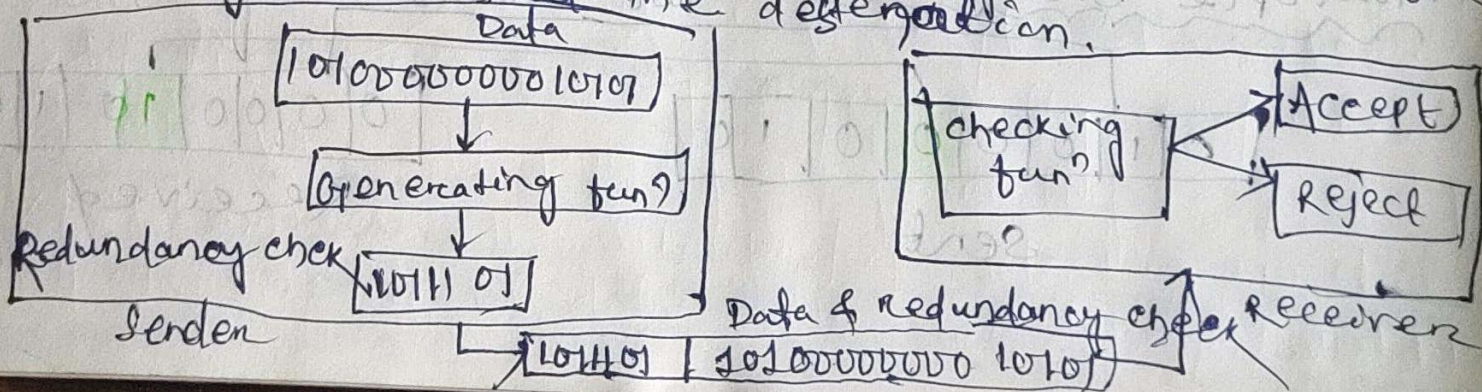
Burst error:-



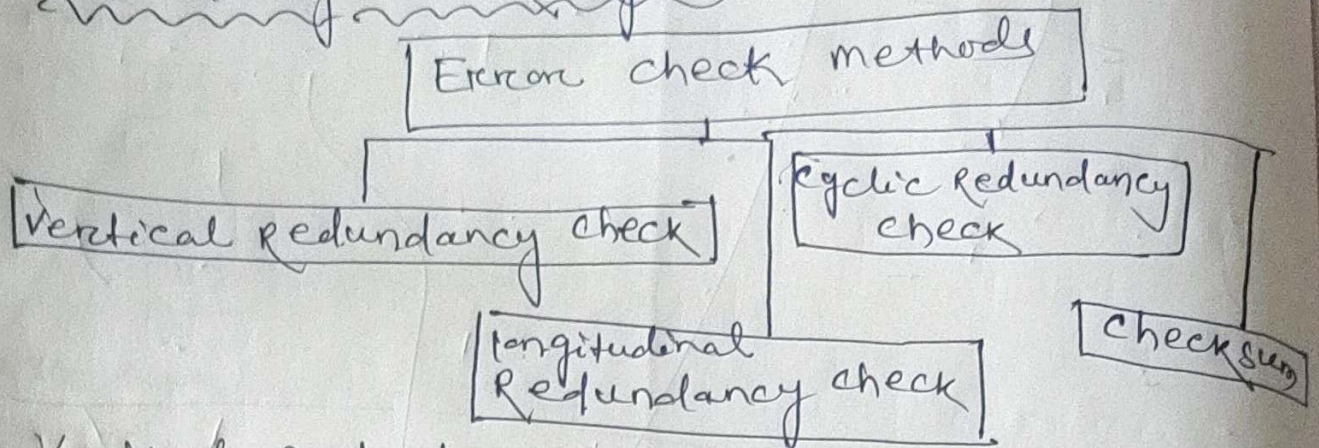
- i) The term burst error means that two or more bits in the data unit have changed from "1 to 0" or from "0 to 1".
- ii) Burst error does not necessarily mean that the errors occur in consecutive bits, the length of the burst is measured from the first corrupted bit to the last corrupted bit. Some bits in betⁿ may not have been corrupted.
- iii) Burst error is most likely to happen in serial transmission since the duration of noise is normally longer than the duration of a bit. The number of bits affected depends on the data rate & duration of noise.

Error Detection:-

Error Detection means to decide whether the received data is correct/not without having a copy of the original msg. Error detection uses the concept of redundancy, which means adding extra bits for detecting errors at the destination.



Redundancy check Types:-



Vertical Redundancy check (VRC)

VRC is also referred to as character parity with character parity, each character has its own error-detection bit called the parity bit. The Parity bit is considered as a redundant bit. An n -character message would have n redundant parity bits.

- ↳ It can detect single bit error.
- ↳ It can detect burst errors only if the total no. of errors is odd.

Longitudinal Redundancy check (LRC):-

LRC is also referred to as msg parity since it is used to check error occurred within a msg with LRC each bit position has a parity bit. LRC is the result of XORing the bits present in all the characters present in a msg whereas VRC is the result of XORing the bits within a single character.

- ↳ In LRC even parity is generally used, whereas with VRC odd parity is generally used.
- ↳ LRC increases the likelihood of detecting burst errors.
- ↳ If two bits in one data units are damaged of two

bits in exactly the same positions in another data unit are also damaged, the LRC checker will not detect an error.

checksum:-

The characters within a msg are combined together to produce an error checking character called a checksum, which can be as simple as the arithmetic sum of the numerical values of all the characters in the msg. The checksum is applied to the end of the msg.

The receiver replicates the combining operation & determines its own checksum. The receiver's checksum is compared with transmitter checksum appended with the msg & if they are the same, it is assumed that no transmission errors have occurred.

Cyclic Redundancy Check (CRC):-

It's a most reliable redundancy checking technique for error detection is a convolution coding scheme called cyclic Redundancy Check (CRC). Given a K -bit frame or msg, the transmitter generates an $(n-K)$ bit sequence, known as a frame check sequence (FCS) $\equiv$ Block Check Code (BCC). So the resulting frame, consisting of 'n' bits, is exactly divisible by some predetermined number. The receiver then divides the incoming frame by the same no. & if there is no remainder, assumes that there was no error.

~~Part-7~~ MODEM & its basic Block dig. & common features Voice Band Modem:-

Modulator - Demodulator (Modem):

Modems are used for data transfer from one computer N/w to another computer N/w through telephone line. The computer N/w works in digital mode, while analog technology is used for carrying msg across phone line. The device which performs modulation is called a modulator & the device which recovers the information signal from the modulated carrier is called a demodulator. In data transmission, we usually come across devices which perform both modulation as well as demodulation fun's & these devices are called modems.

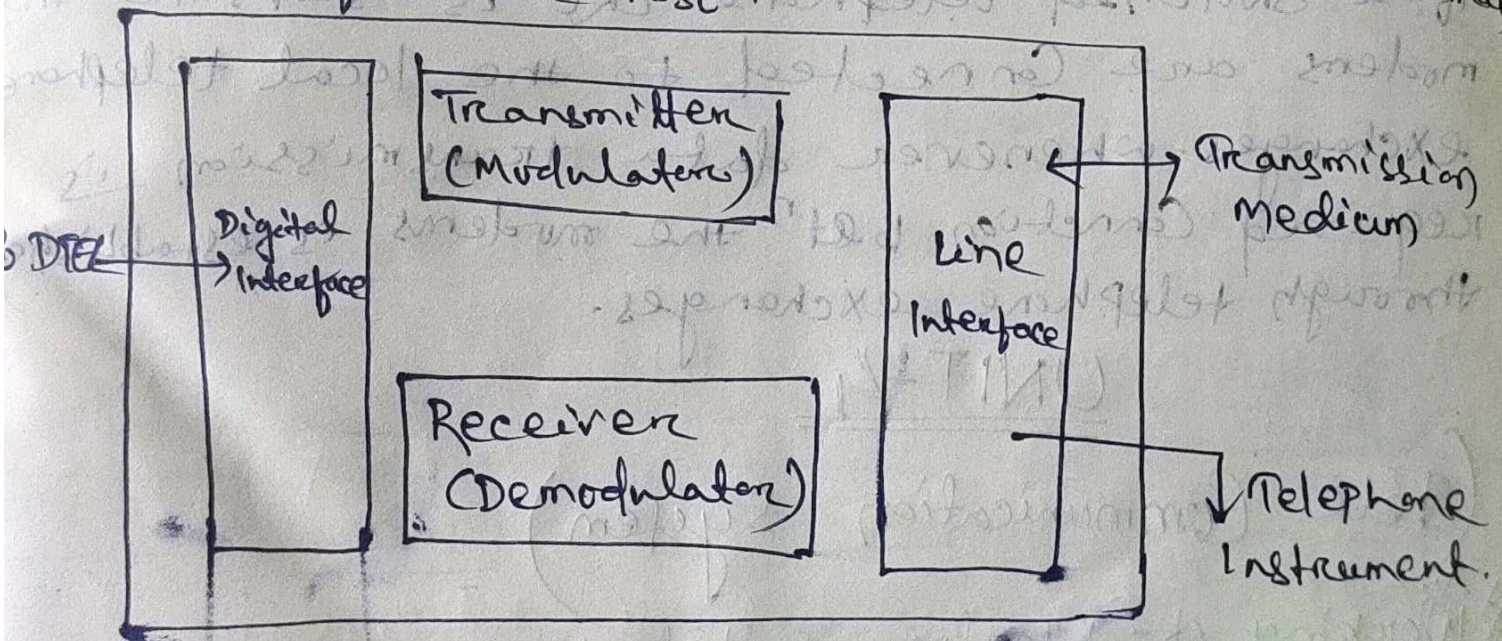
→ When data is to be transmitted over long distances, modems are needed. In a modem, the ~~ip~~ sig modulates a carrier which is transmitted to the distant end. At the distant end, another modem demodulates the received carrier to obtain the digital sig. Thus, a pair of modems is always required. The term 'modem' is derived from the words, modulator & Demodulator.

→ Modulator converts information from digital mode to analog mode at the transmitting end & demodulator converts the same from analog to digital at receiving end. The process of converting analog sig of one computer N/w into digital sig of another computer N/w so they can be processed by a receiving computer is referred to as digitizing. A modem contains a modulator as well as a demodulator.

→ Nearly all the modems are designed for utilizing the analog voice band service provided by the telecommunication N/w. Thus, the modulated carrier produced by a

modem fits into the 300-4000 Hz bandwidth of the speech channel. The fig. shows a typical data connection set up using modems. The digital terminal devices exchange digital sig & are known as Data Terminal Equipment (DTE). Two modems are always needed, one at each end. At the transmitting end, the modem converts the digital sig from the DTE into an analog sig by modulating a carrier. At the receiving end, the modem demodulates the carrier & hands over the demodulated digital sig to the DTE.

or A dedicated leased ckt or a switched telephone ckt can be used as transmission medium betⁿ the two modems. In the latter case, modems are connected to the local telephone exchanges. Whenever data transmission is needed, connection betⁿ the modems is established through the telephone exchanges, which are also within a building to connect terminals which are located at distances, more than 15 meters from the host.



A block diag. of a modem is shown in the above fig. which comprises a transmitter, a receiver & two interfaces. The digital sig. to be sent is given to the transmitter. The modulated carrier i.e. received from the distant end is given to the receiver. The digital interface connects the modem to the DTE which produces & receives the digital sig. In order to transmit it & receive the modulated sig. the line interface connects the modem to the DTE which produces & receives the digital sig. In order to transmit it & receive the modulated sig's the line interface connects the modem to the transmission channel. Modems connected to telephone exchanges have additional provision for connecting a telephone instrument which enables establishment of the telephone connection.

The transmission medium betⁿ the two modems can be dedicated ckt or a switch telephone ckt. If a switched telephone ckt is used, then the modems are connected to the local telephone exchanges. Whenever data transmission is required connection betⁿ the modems is established through telephone exchanges.

UNIT-4

(Tele Communication System)

Working of Electronic Telephone System? -

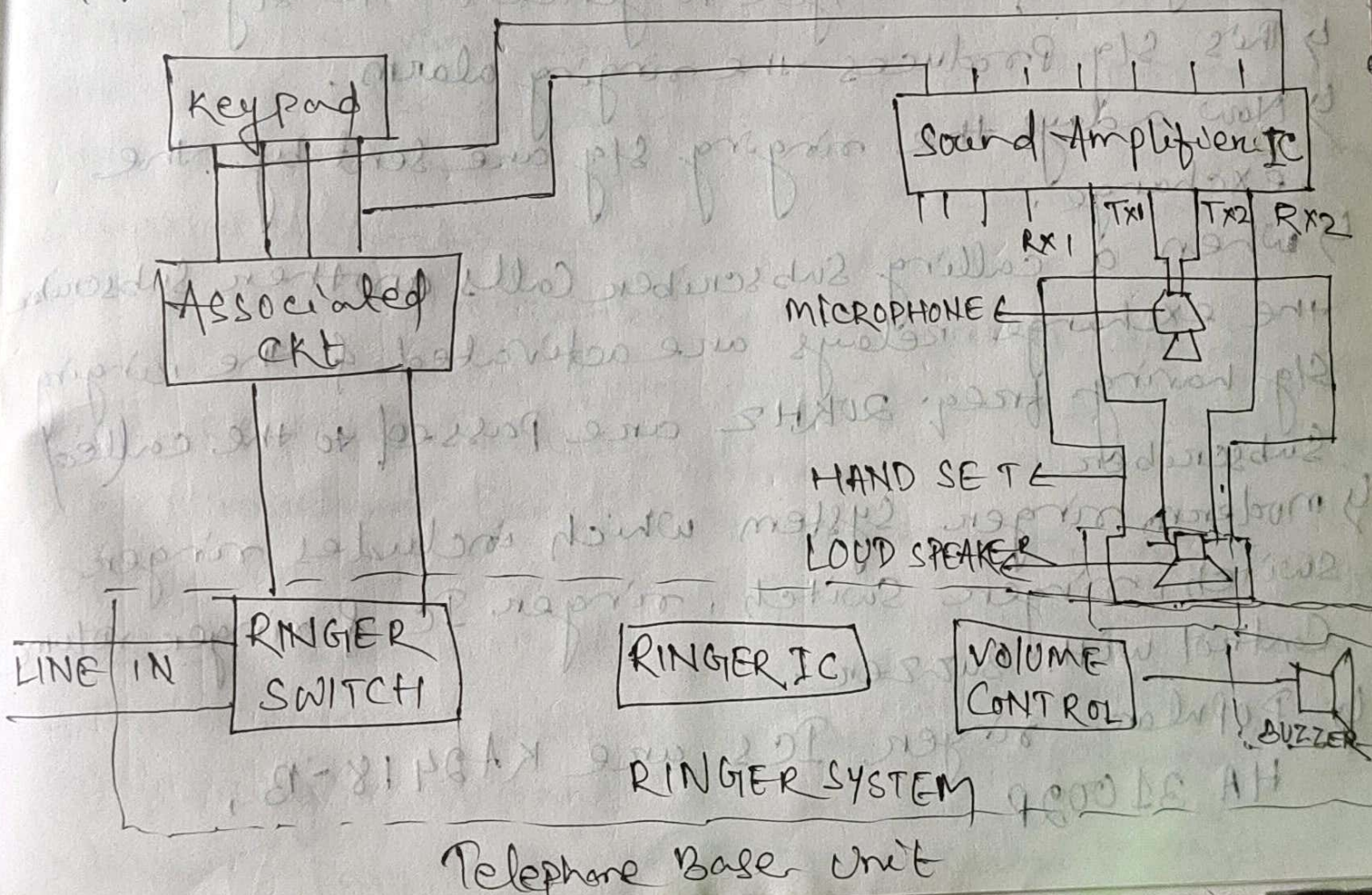
Introduction:-

The telephone system provides the means to pass the information from one terminal (calling, subscriber) to other terminal (called subscriber). The telecomm? system broadly comprises of following basic elements.

- End Instrument or Telephone set
- Transmission system or Connecting cables
- Switching system or Exchange.
- Signaling

The end instruments are responsible for transmitting & receiving the audio sig or data. The end instrument may be telephone handset or Computer system.

Telephone Handset:-



The telephone is basically a trans-receiver. The transmitter of telephone converts the audio sig to an equivalent electrical sig & the receiver converts the electrical sig into audio sig.

The modern telephone set consists of

- i) Keypad along with dialer IC
- ii) Sound Amplifier IC
- iii) Associated ckt
- iv) Ringer IC
- v) Buzzer Volume Control
- vi) Buzzer
- vii) Ringer Switch

Ringer

↳ Ringer is a device that alerts the called subscriber. The original equipment includes an electromagnet & a ringer to generate AC sig.

↳ This sig produces the ringing alarm.

↳ Now a days the ringing sig are sent by the exchange.

↳ When a calling subscriber calls another subscriber the exchange relays are activated & the ringing sig having freq. 20KHz are passed to the called subscriber.

↳ Modern ringer system which includes ringer switch, ringer switch, ringer IC & ringer volume control with buzzer.

↳ Popular ringer ICs are KA2418-B, HA 31002P

Handset :-

The handset connected to the sound amplifier IC can be broadly divided into two parts.

a) Transmitter Section

b) Receiver Section

a) Transmitter :-

↳ The transmitter section consists of a carbon microphone.

↳ One side of the enclosure is flexible & connected to a mechanical diaphragm.

↳ When the sound wave impinges this diaphragm it oscillates on vibrates resulting in an uneven distribution of the carbon granules. This in turn changes the resistance of the carbon microphone.

↳ If a voltage is applied to the microphone, this variation in resistance will vary the current through the ckt proportionally.

↳ Hence, the variation in current is proportional to the resistance of carbon microphone which is further proportional to the vibration of the diaphragm in turn proportional to the audio sig.

↳ The voltage required to charge the carbon granules is provided from the exchange which comes from the central battery system.

↳ The minimum current is required for the proper operation of carbon microphone 23mAmp if a voltage level maintain is 42 to 60 volts (48 volt practically).

↳ The central battery provides the following

1) Fe ringing voltage for buzzer.

2) Metallic path to provide charge to carbon granules

a) Generates the pulsating DC current during dialing.

b) Receiver :-

↳ The varying sig from the calling subscriber is coupled to the receiver of called subscriber.

↳ The receiver is an electromagnet with attached magnetic diaphragm.

↳ The diaphragm is made of cobalt iron & slightly conical in shape in order to provide a uniform pressure distribution on the ear drum.

The dialing Unit :-

There are two dialing method used in telephone system.

1) Pulse dialing

2) Multi freq. dialing

↳ In pulses dialing a rotary dial is used in this system a train of pulses is used to represent a sig digit of the called subscriber no.

↳ In multi freq. dialing pair of tones is attached to each digit being dialed. It is also called as Touch tone dialing or dual tone multi freq. dialing (DTMF)

Sound Amplifier :-

↳ The two wires of transmitter & receiver are connected to the sound of speech IC for effective transmission & receiving of audio sig.

↳ This IC performs the following fun.

a) Automatic gain control

b) Dial tone

c) Biasing.

Funⁿ of Switching system & call procedures:

The Switching office performs the following funⁿ:

- I) Identification of the calling subscriber
- II) Addressing.
- III) Finding & setting of the path betⁿ calling subscriber & called subscriber
- IV) Busy Testing
- V) Inter connection
- VI) Testing
- VII) Supervision
- VIII) Clear down
- IX) Billing.

① Identification of calling subscriber:-

- ↳ The local switching centre must to a calling sig from subscriber & must be able to receive information to identify the destination terminal.
- ↳ The calling sig is sometimes called as Seize.

② Addressing:-

- ↳ The switching system must be able to identify the called subscriber from the infⁿ from calling subscriber.
- ↳ The address may be of same local exchange or some other exchange.
- ↳ If the terminal (called subscriber) on the trunk is busy then a suitable sig must be returned to the calling subscriber.

③ Finding & setting of the path:-

Once the calling subscriber destination is identified & the called subscriber is available, an accepts sig

is passed to the switching system & calling Subscriber.

(IV) Busy testing:-

If the no. dialed by the calling Subscriber is wrong or the called Subscriber is busy or the terminal may be free but no response is received then a switching system has to pass a corresponding voice msg or a busy tone after waiting for a certain interval of time.

(V) Interconnection:-

For a call betⁿ two Subscribers, three connections are to be made,

i) from local exchange & called Subscriber.

ii) from local exchange to other Exchange.

iii) from calling Subscriber to local exchange.

(VI) Alerting:-

Once the connection was made, the system sends a sig to alert the called Subscriber to pick up the hand set.

(VII) Supervision:-

Once the path betⁿ Calling Subscriber & Called Subscriber is established, it should be supervised in order to detect the commⁿ; f. clear down conditions for recording the billing information.

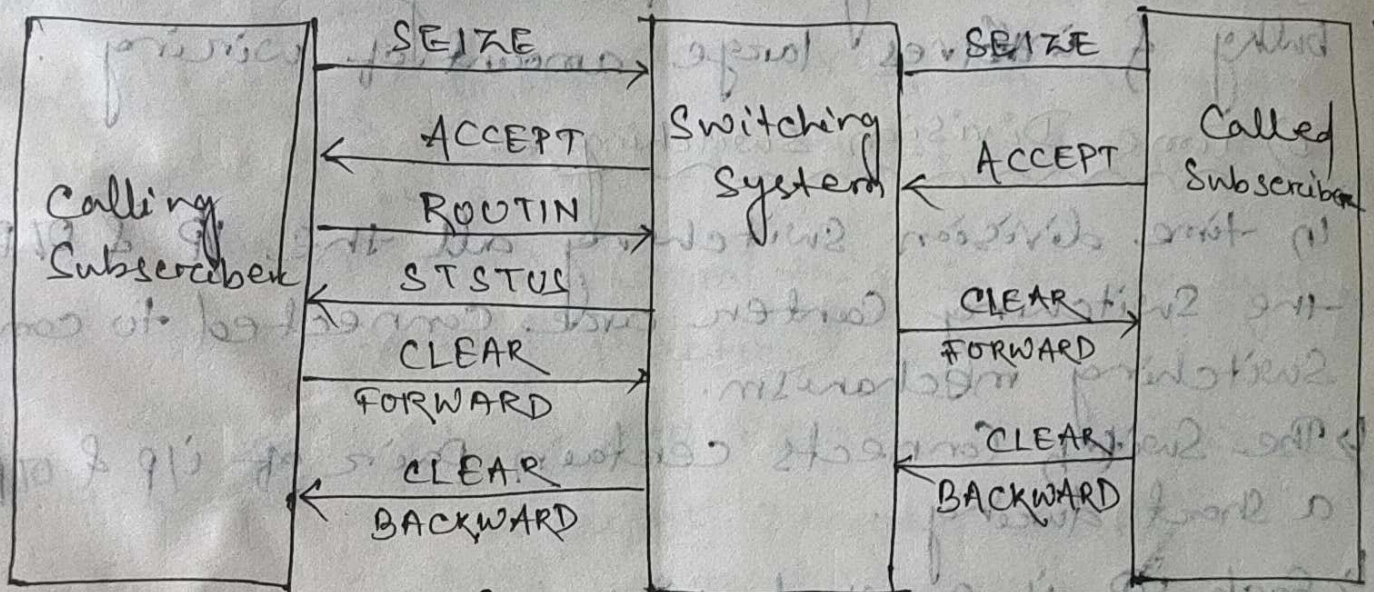
(VIII) Clear down:-

When the call established is completed, the path betⁿ the calling Subscriber should be disconnected.

- ↳ If the calling subscriber keeps the handset off the stg called clear backward stg is passed to the switching system.
- ↳ By receiving this clear down stg, the switching system disconnects the path betⁿ the calling subscriber & the called subscriber.

(IX) Billing:-

- ↳ A switching system should have a mechanism to monitor & count the no. of units made during the conversation.
 - ↳ The cumulative no. of units made for a particular direction by the calling subscriber is calculated.
 - ↳ This information is ~~sent~~ for billing purpose to the calling subscriber.
- The Function of an exchange for providing a call betⁿ two subscribers.



(Call Procedure)

Space & time switching

Types of switching:-

There are three classes of switching system based on the division of information time & freq. domain. Accordingly there called as

a) Space division Switching

b) Time division Switching

c) Freq. division Switching

a) Space division switching:-

The space division method provides a fixed path for the entire duration of call.

The advantages of space division switching are

(i) Simple Configuration

(ii) Unlimited bandwidth

(iii) Limited crosstalk probability

But this switching method is very slow to operate bulky & involves large amount of wiring.

b) Time Division Switching:-

In time division switching all the IP & OP of the switching center are connected to common switching mechanism.

↳ The switch connects certain pair of i/p & o/p for a short duration.

↳ Each i/p is sampled to change the connecting pattern hence the switching is fast & compact is used the ckt becomes simple to operate.

↳ The various switching elements used for time division

switching are

- (i) Conventional relay
- (ii) Two motion selector

(iii) Reed relays

(iv) Uni-sections

↳ The conventional relays are simple electrical or electro mechanical relays used for switching.

↳ To perform switching the relays acts as a cross point.

↳ The reed relays are electro mechanical switches used in modern switching equipment. They are faster than conventional relays but they required a large current to operate.

↳ Mercury wetted reed relays & dry reed relays are mostly used in the modern common system.

(c) Freq. Division Switching:-

↳ In this switching system the incoming sig is modulated with different carrier frequencies.

↳ The switching is achieved by using the demodulators operating at different freq. band at receiver side.

↳ Other than radio comm this switching system does not have any practical appl.

↳ The switching system is also used in certain application of satellite common system.

Unit of power Measurement:-

↳ In the telephone common system normally the logarithmic scale is the measure of power consumed & the units expressed in 'dB' or 'dBm'.

$$P_{dB} = 10 \log \frac{(P_2) \text{ watts}}{(P_1) \text{ watts}}$$

$$P_{dbm} = 10 \log \frac{(P_2) \text{ watts}}{(P_1) \text{ m watts}}$$

There is also another unit called Neper for Power measurement.

$$1 \text{ nep} = 8.69 \text{ db}$$

For any switching system if the i/p power is 16watt & o/p is 30m watt. Find the power in decibel db & neper.

$$\text{i/p } P_1 = 16 \text{ watt} = 16 \times 10^{-6} \text{ watt}$$

$$\text{o/p } P_2 = 30 \text{ m watt} = 30 \times 10^{-3} \text{ watt}$$

$$P_{db} = 10 \log \frac{30 \times 10^{-3}}{16 \times 10^{-6}} = 32.73 \text{ db}$$

$$1 \text{ nep} = 8.69 = 3.76$$

$$P_{dbm} = 10 \log \frac{(P_2) \text{ watts}}{(P_1) \text{ m watts}} = 62.7 \text{ dbm}$$

Q An amplifier has an i/p resistance of 600Ω & a resistive load of 75Ω when it has an i/p voltage 100 mV rms. The o/p current is 20 mA rms find the gain of the amplifier in db.

Ans:- i/p voltage = $100 \text{ mV} = 100 \times 10^{-3} \text{ V}$

$$\text{i/p current} = 20 \text{ mA} = 20 \times 10^{-3} \text{ A}$$

$$\text{i/p Resistance} = 600 \Omega$$

$$\text{o/p Resistance} = 75 \Omega$$

$$\text{i/p Power} = \frac{V_{in}^2}{R} = \frac{(100 \times 10^{-3})^2}{600} = 0.016 \times 10^{-3}$$

$$\text{AP Power} = I^2 R = (20 \times 10^{-3})^2 \times 75 = 0.03 \text{ watt}$$

$$\text{Dbm} = 10 \log \frac{P_2 \text{ watt}}{P_1 \text{ m watt}} = 10 \log \frac{0.016 \times 10^{-3}}{0.03} = 32.7 \text{ dB}$$

Working Principle of PBX & EPABX

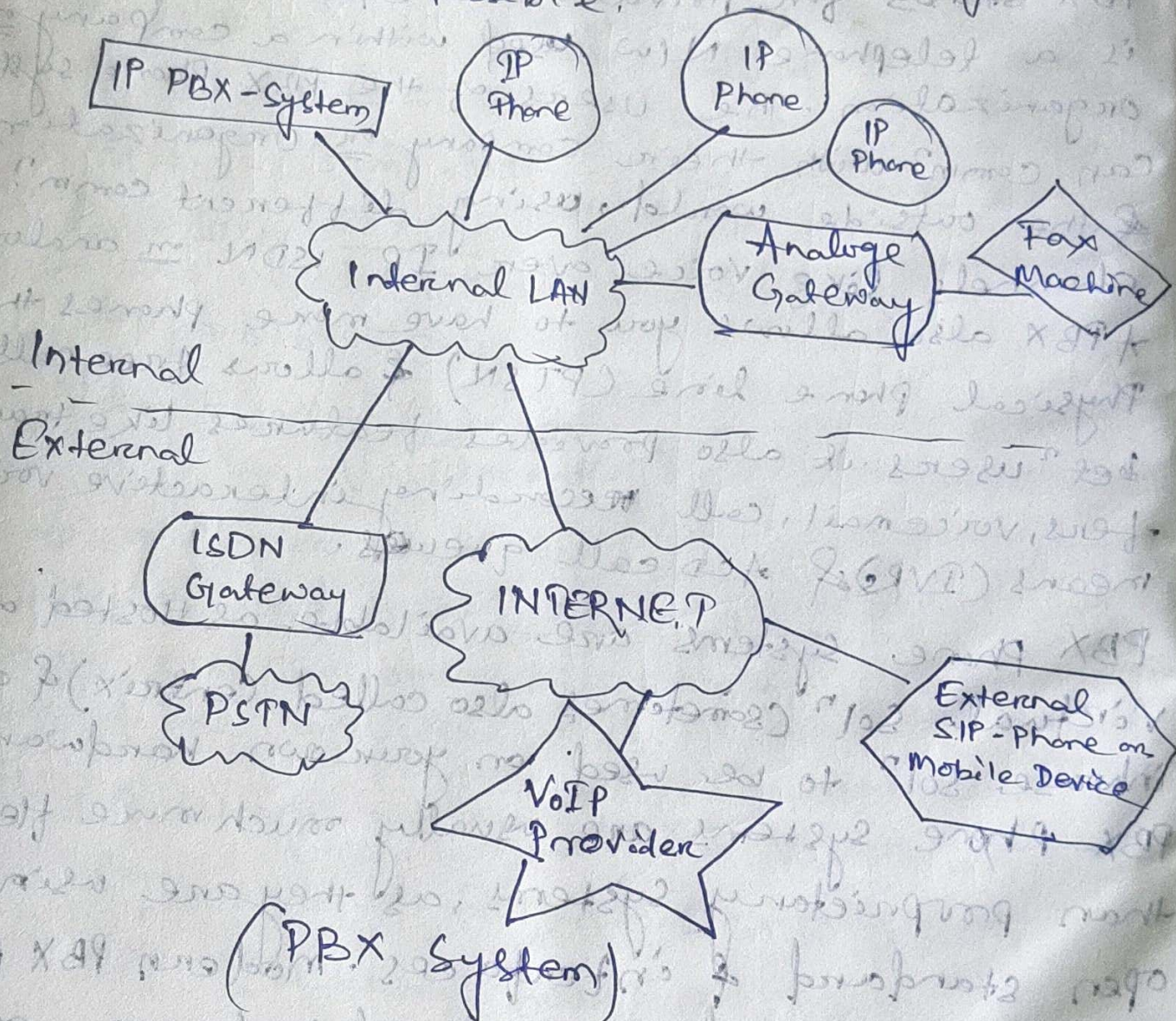
Operation PBX & Digital EPABX

PBX stands for Private Branch Exchange, which is a telephone NW used within a company or organization. The users of the PBX phone system can comm? with their company or organization & the outside world, using different comm? channels like voice over IP, ISDN or analog. A PBX also allows you to have more phones than physical phone line (PSTN) & allows free calls betⁿ users. It also provides features like transfers, voicemail, call recording, interactive voice means (IVR) & ACD call queues.

PBX phone systems are available as hosted or virtual solⁿ (sometimes also called, Centrix) & as inhouse solⁿ to be used on your own hardware. PBX phone systems are usually much more flexible than proprietary systems, as they are using open standard & interfaces. Modern PBX phone systems are based on standard hardware, which is cheaper & can easier be replaced than a close system.

Switching to an IP PBX offers many benefits, with

in an IP phone system all your internal telephone calls are routed through the existing LAN (Local Area Network). This way a separate HW for temporary is not required. Even though the internal telephone is routed through the LAN, it is also possible to connect your IP-PBX via gateways to the PSTN of course. VoIP (Voice over IP, telephony via the Internet) is also possible.



Since IP telephony is mostly using the open SIP Standard, an IP Phone System gives you a lot more freedom in your choice of phones. Basically, an SIP compatible

phone (VoIP Phone) will work with an IP PBX. Furthermore, an IP PBX doesn't limit the growth of a company.

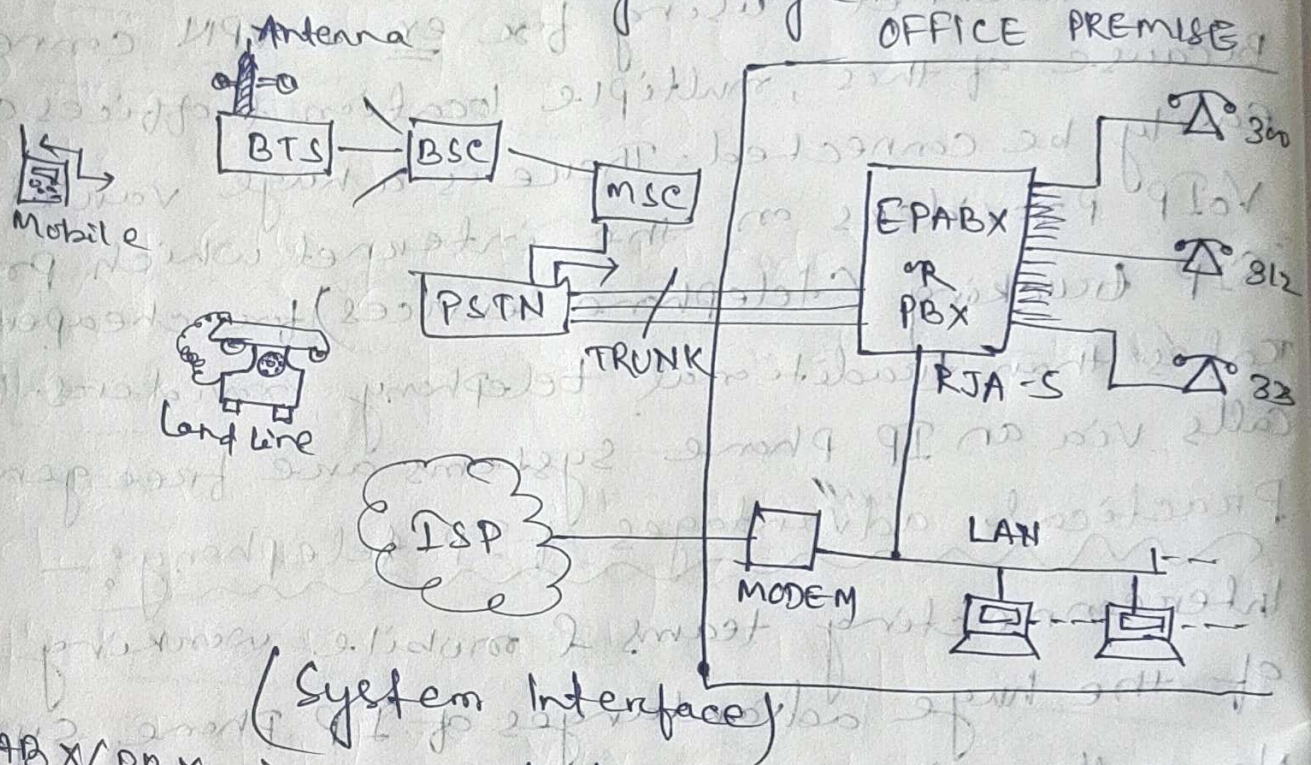
Since VoIP phones don't have to be connected physically to the phone system, it doesn't require a free port in the phone system like it used to be with traditional phone systems. IP phones can't only be connected via the LAN but also the internet, using for ex. a VPN connection. Because of this, multiple locations & offices can easily be connected. There is a huge variety of VoIP providers on the internet which provide SIP trunking (telephone services) for cheaper call rates than traditional telephony providers. Internal calls via an IP phone system are free.

Practical advantages of IP telephony:

Interconnecting teams & mobile working is one of the huge advantages of IP phone systems. No matter if team members are on the road, are located in a different country or work from home, they can connect via IP desk phone, smart phone or laptop to the PBX in the office. This way all calls within the company are free & clients will not realize if an employee is in the office or somewhere else around the world. The same also applies for conferences; these can be hosted directly on the own IP PBX with as many participants as required. This saves traveling time & money.

Digital EPABX: -

As shown in the fig. EPABX/PBX facilitates use of one external telephone line by many internal users in the office premises. In the office, each employee is provided one telephone set & all the telephone are connected with PBX. All the employee within the office premises can communicate using 3 or 4 digit number programmed in EPABX/PBX without any charge.



(System Interface)
EPABX/PBX is connected to PSTN (Public Switched Telephone Netw) via trunk lines, hence all can use one external voice line in time shared basis. PSTN is connected with MSC (Mobile Switching Center) of Cellular NW's. Such as GSM/CDMA/UMTS. By this mobile cell phone user can connect to any telephone set in the office premises using extension number. Similar to voice line EPABX/PBX can be used for

Data applⁿ. As shown in fig, Data Port of PBX is connected to LAN where so many PCs are connected & are using same external Internet connection line from ISP via Modem/router. The same facility of PBX can be extended for WLAN users too.

chpt-4 [Numbering Plan of telephone N/w (National Schemes of International Numbering)] Telephone Numbering System:-

It is a type of numbering scheme used in telecommunication to allocate a specific number to each subscriber so that the telephone call can be routed from calling subscriber to called subscriber through the telephone n/w.

→ There are basically two types of numbering plans.

1) Closed numbering plans

2) Open numbering plans.

↳ The closed numbering plan is used for the telephone system normally deployed for house hold application.

↳ They are having a fixed length number allocated to each user.

↳ The open numbering plan is a variable length numbering system generally used for large office or organization using the PBX or EPBX system.

↳ A dial plan establishes the expected no. of pattern of digits for a telephone number.

(a) Country code (b) Area code
(c) local part code.

(a) Local part code:-

The Public Switch telephone n/w (PSTN) system uses a 10-digit dial Plan including 3-digit area code & 7-digit telephone number.

↳ The PSTN system follow E:164 standards which includes.

(a) Country Calling Code (ISD code)

(b) Area code (STD code)

(c) Local number

(a) Country Calling Code (ISD code)

↳ It is necessary only when dialing to phone ^{other} countries.

↳ In international use, the telephone no's are prefixed with the country code along with a '+' sign with spaces in place of hyphen.

Ex:- Tel + [xx yyy zzz]

↳ This format allows the user to choose the exchange code need to dial from it's location.

↳ For GSM network '+' is an actual character that may be used internally as the international access code.

Area code:-

↳ These are known as numbering Plan area (NPA) & finally known as STD codes.

- ↳ These are necessary only when dialed number is from outside the area code.
- ↳ These usually indicate geographical area within one country that covers 100's of in the dial string by the national access code (04 India & 1 for USA) on the international access code & local number.
- ↳ The local no. on subscriber no. must always be dialled entirely.
- ↳ The 1st few digits indicates the local telephone exchange no. followed by the subscriber no.
- ↳ For short range calling, the subscriber need not include the area code on country code in the dialed no. string which enables shorter digital string.

Working Principle of Internet Telephone)

Internet Telephony:

Internet telephony also known as voice-over IP, replaces & complements the existing ckt-switched public telephone n/w with a packet-based infrastructure.

- ↳ One of the strengths of Internet telephony is the ability to be media-neutral, i.e. almost the entire infrastructure does not need to change if a conversation includes video, shared appⁿ on text chat.

- ↳ Internet telephony supports Commⁿ services such as voice, facsimile, and/or voice-messaging appⁿ that are transported via the Internet, rather than the Public Switching Telephone N/w (PSTN).

→ The basic steps involved in originating an Internet telephone call are conversion of the analog voice sig to digital format & compression / Translation of the sig into Internet Protocol (IP) packet for transmission over the Internet; the process is reversed at the receiving end.

↳ More technically, Internet telephony is the real-time delivery of voice & possibly other multimedia data types betⁿ two/more parties, across n/w's using the Internet Protocols & the exchange of information required to control this delivery.

↳ In this system the call goes over the local PSTN n/w ~~to~~ the nearest gateway server, which digitizes the analog voice sig, compresses it into IP packet & moves it through the internet gateway for transporting to the receiving end.

↳ It supports computer to telephone calls, telephone to computer calls & telephone to telephone calls.

↳ It offers tremendous cost saving as compared to the PSTN system for long distant calls.

↳ It finds the problem of less reliable data commⁿ & lower sound quality due to limited bandwidth operation & current data compression techniques used.

↳ The first widely used standardized signaling protocol was provided by ITU in 1996 in the H.323 family of protocols.

Working Principle of Internet Protocol Telephony

Internet Protocol (IP) Telephony :-

IP telephony is the ^{subset} of Internet telephony, as it refers to all telephony services over IP, rather than just those carried across the Internet.

↳ In IP telephony, streaming media requires synchronous data delivery where the short-term average delivery rate is equal to the native media rate but streaming media can often be buffered for significant amounts of time, up to several seconds, without interfering with the service.

↳ In IP telephony, the source is generally a human being & more importantly, there is bidirectional real-time media interaction betⁿ the parties.

↳ In the area of IP telephony, 3GPP, the 3rd Generation Partnership project, has been driving the standardization for third generation wireless n/w^s using "based on evolved GSM core net-works & the radio access technologies that they support". It consists of a number of organizational partners including ETSI. A similar organization, 3GPP2 deals with radio access technologies derived from the North American CDMA (ANSI/TIA/EIA-41) System; it inherits most higher layer technologies, such as those relevant for IP telephony from 3GPP.

Unit-2

CAPT-2

SATELLITE COMMUNICATION

Satellite orbital patterns & Elevation (LEO, MEO, GEO Categories)
Satellite is an electronic repeater placed above the ground to enhance the data communication.

⇒ Depending on the shape of the orbit, the satellite orbit can be broadly classified into two categories.

(1) Circular orbit satellite.

(2) Elliptical orbit satellite.

⇒ Depending on the placing of the orbits with respect to the latitude of the earth, the satellite can be classified into the following three categories.

(1) Equatorial satellite.

(2) Polar satellite.

(3) Inclined satellite.

⇒ Depending on the height of the satellite above the ground level the orbit of the satellite divided into 3 categories.

(1) Low earth orbit satellite (LEO)

(2) Medium earth orbit satellite (MEO)

(3) Geo Stationary orbit satellite (GEO)

(i) Low earth orbit (LEO) satellite :-

The LEO satellites typically at a height (less than 2000 km.) have been launched to provide mobile communication link.

⇒ They follow an elliptical path.

Example of - LEO satellite is Iridium satellite system.

⇒ The system covers the whole world with 72 [66 + 6 stand by] Polar orbiting satellites.

↳ It provides up to 10 spot beams (the best part of the satellite is divided into spot beams, which facilitates the reuse of freq.)

↳ The orbital period for this satellite system is about 100 minutes.

↳ The modulation pattern used is QPSK (Quadrature Phase Shift Keying)

↳ The freq. for data comm used is given below.

23 GHz for Satellite to Satellite link.

29 GHz for uplink

19 GHz for downlink

↳ The satellite system can handle voice, data, fax etc.

(ii) MEO (Medium Earth Orbit Satellite)

↳ The MEO satellite system generally orbits at an altitude of 10,000 km generally used for commercial satellite telephone service.

↳ It offers a sig propagation delay of about 70 msec.

↳ It also provides up to "60 spot" beams. An example of MEO satellite system is Glob star, which comprises of "48 satellite" (44 + 4 stand by) aimed at polar regions of earth.

↳ The orbital planes are inclined at 50° to equator & concentrate on 70° north & south latitude.

(iii) GEO (Geo Stationary orbit satellite)

↳ The GEO satellite orbit around the earth at an altitude about 36,000 km.

- ↳ The orbit around the equator circle & having circular shape.
- ↳ There are three satellites required for total global coverage.
- ↳ The sig propagation delay offered by this satellite system is about 250 ms.
- ↳ It provides up to 150 spot beams.
- ↳ Few ex^{ts} of Geo satellites are Asia cellular system, Kuraya etc.
- ↳ Asian cellular system satellites provide coverage from India to Indonesia & Australia.
- ↳ The Kuraya system connects 50 countries from west Asia to India sub continent positioned at 44° east longitude in Indian Ocean.
- ↳ The Geo stationary satellite are synchronous to the earth rotation. The orbital velocity of the satellite is equal to the velocity of a point on earth equator.
- ↳ Let ' M & m ' be the mass of earth & satellite respectively.
- ↳ Let ' R & R_e ' be the radius of satellite orbit & earth respectively.
- ↳ If ' ω ' be the angular velocity of the satellite in radians/second then the centrifugal force acting on the satellite is given by

$$F_{cl} = mR\omega^2 \quad \text{--- (i)}$$

↳ The centripetal force equal to the gravitational force acting the Satellite given Newton's gravitational law.

$$F_{cp} = \frac{GMm}{R^2} \quad \text{--- (ii)}$$

↳ where, 'G' is the gravitational constant

$$= 6.672 \times 10^{-11} \text{ m}^3/\text{kg}/\text{sec}^2.$$

$$M = \text{mass of the Earth} = 5.974 \times 10^{24} \text{ kg}$$

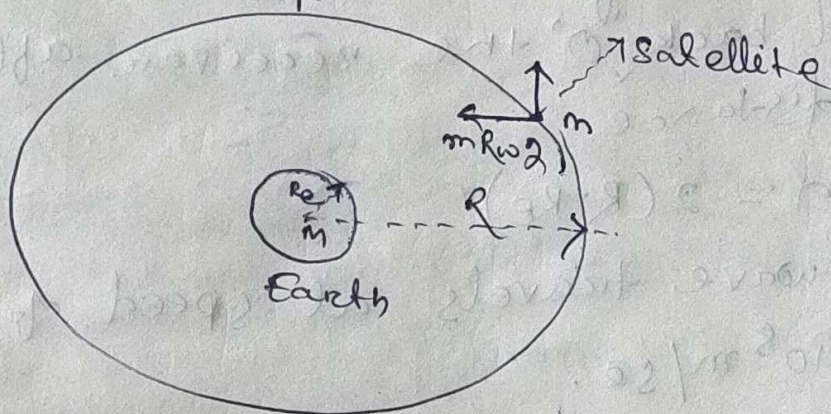
$$R_g = 6370 \text{ km}$$

↳ At the earth surface the gravitational force is given by

$$F_g = mg \quad \text{--- (iii)}$$

where, $g = \text{Acceleration due to gravity} = 9.8 \text{ m/s}^2$

Satellite orbit



(Satellite orbit)

↳ Hence $\frac{GMm}{R^2} = mg \quad \text{--- (iv)}$

Comparing eqⁿ (i) & eqⁿ (iv) we have

$$mR\omega^2 = \frac{GMm}{R^2} = mg \frac{R_e^3}{R^2}$$

$f = \text{Rotation rate of the satellite in revolution/day}$

Value $f = 1$

Hence $R = (g R_e^2 / \omega^2)^{1/3} = 42,208 \text{ km}$

Hence the height of the satellite from the earth surface is given by $R - R_e = 42208 - 6370$
 $= 358.38 = 36000$

from Kepler's law for circular orbit the time period of rotation is given by

$$T = 2\pi (R^3 / GM)^{1/2}$$

Putting the value of R we have

$$T = 2.3 \text{ hour } 56 \text{ minutes } 4 \text{ sec} = 24 \text{ hr.}$$

The satellite velocity for circular orbit is given $v = (GM/R)^{1/2}$

The sig transmitted to satellite is returned back to the receiver after travelling a distance.

$$d = 2(R - R_e)$$

The EM wave travels at speed of light i.e. $3 \times 10^8 \text{ m/sec}$.

The time delay for the sig reception given by $T_d = d/c = 250 \text{ msec}$.

Basic Satellite Transponder & Kepler's laws:
Kepler's law for orbits:-

So far, we have assumed that satellite travel in ckt. orbits but this is not necessarily true in

practice. Newton's laws can be used to derive the exact form of a satellite's orbit.

However, a simpler approach is to look at Kepler's laws, which summarize the results of the full derivations. Kepler's law (1609 for 1, 2, 1619 for 3) were based on observations of the motions of Planets.

- i) All Planets travel in elliptical orbits with the Sun at one focus (defines the shape of orbits)
- ii) The radius from the Sun to the Planet sweeps out equal areas in equal times (determines how orbital position varies in time)
- iii) The square of the period of a planet's revolution is proportional to the cube of its semi major axis (suggests that there is some systematic factor at work)

Satellite Freq. Bands:

<u>Band</u>	<u>Up Link freq. Band (MHz)</u>	<u>Down link freq (MHz)</u>
1. UHF Military	292 - 312 MHz	250 - 270 MHz
2. C-Band Commercial	5925 MHz - 6425	3700 - 4200
3. X-Band Military	7900 - 8400	7250 - 7750
4. Ku-Band Commercial	14,000 - 14,500	11,700 - 12,200
5. Ka-Band Commercial	27,500 - 30,000	17,700 - 21,200
6. Ka-Band Military	43,500 - 45,500	20,200 - 21,200

In addition to all these bands, for meteorological satellites the following bands are used.

- (1) 16.68.4 to 16.70 MHz

(ii) 1670 to 1690 MHz

(iii) 1690 to 1700 MHz

(iv) 1700 to 1710 MHz

(v) 7450 to 7550 MHz

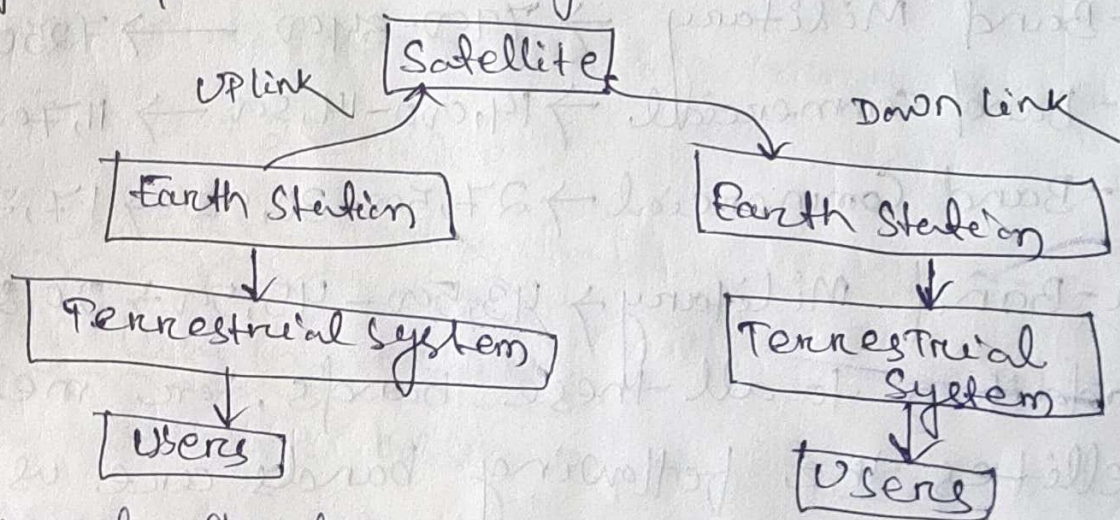
↳ The uplink & down link frequencies used is the Satellite are made different in order to avoid interference betⁿ the uplink & down link sig.

↳ The downlink sig freq. is made lesser than the uplink freq. in order to avoid bulky ckts, high power requirement & high maintenance requirement at the Satellite Station in order to reduce the cost with high reliability of satellite operation.

General Structure of Satellite Link System
(Uplink, down link, Transponder, cross link)

General Structure of Satellite Link System:

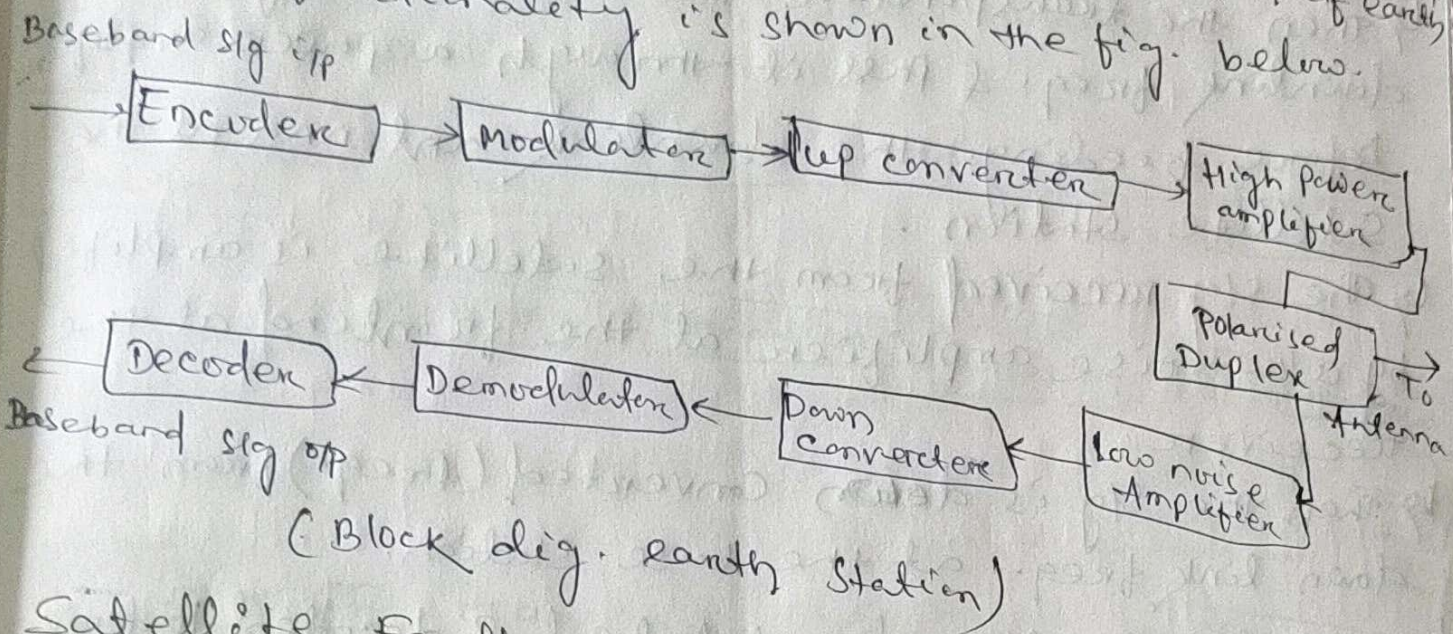
↳ The Satellite Commⁿ system consists of a satellite in space that links many earth/base stations on the ground.



(General Structure of Satellite Link)

rest of the signal is connected to the base stations through terrestrial network which may be telephone switch or dedicated link to the base station.

The user generates the base band low freq. sig. ie. processed & transmitted to the satellite at the base station. The block level representation of earth station functionality is shown in the fig. below.



Satellite Earth Station:-

- It is broadly a combination of a transmitter section & receiver section coupled to a common antenna through duplex.
- The terrestrial n/w which multiplexes the base band sig. received from the user & does the necessary formatting. Then it is fed to the transmitter section.
- The earth station or base station first encodes the sig. followed by modulation. This modulated encrypted sig. is freq. translated to the uplink freq. band by the up converter.
- Then the sig. is amplified by the high power amplifier & directed to the appropriate polarization part of the antenna feed.

↳ The satellite antenna receives the uplink sig & buffers before any process.

↳ The sig is decoded in the transponder & checked for the recipient address & re-again encodes the sig.

↳ Then the transponder translates the sig freq. to downlink freq. & pass it through a power amplifier before feeding the downlink antenna at the satellite station.

↳ The sig received from the satellite is amplified by a low noise amplifier at the front end at the receiver.

↳ Then the sig is ~~down~~ converted (freq.) from the down link freq. at the base station.

↳ Further the sig demodulated & decoded to derive the original base band sig.

↳ Critical components must be installed with redundancy with automatic switch over in the event of failure. So that uninterrupted operation is maintained at the satellite.

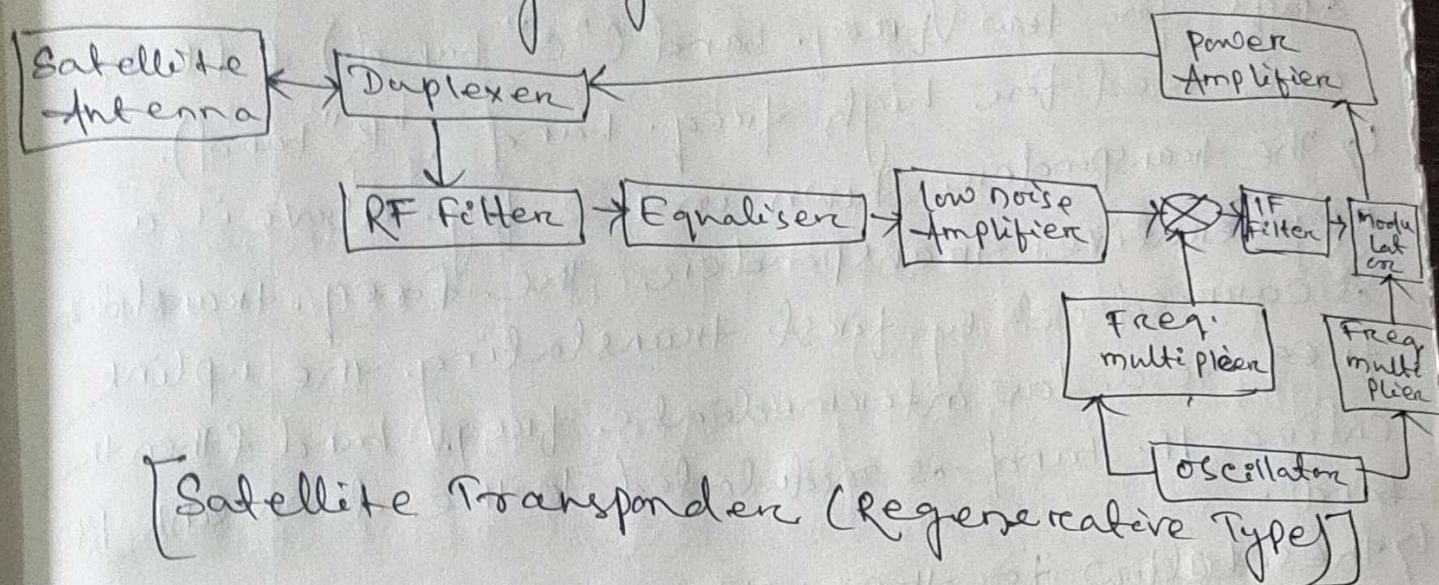
↳ There may be interference caused by side lobes of adjacent satellites other sources of interference include ground microwave relay links, sun transit effect & inter modulated product generated in the transponder & on earth station.

Satellite Transponder -

↳ The transponders are the repeaters at the satellite which performs the basic two functions.

a) The amplification of the sig from an i/p power of the range (-100db) in watt to an o/p power of 100db (w) so about 110db gain is provided by the transponder.

b) The freq. down conversion that avoids the interference betⁿ high amplitude transmitted sig & the weak incoming sig.



↳ The transponders having additional provision of detection & demodulation process are known as regenerative transponders.

↳ The satellite antenna receives the uplink sig & passes it to the front end of the transponder through the duplexer.

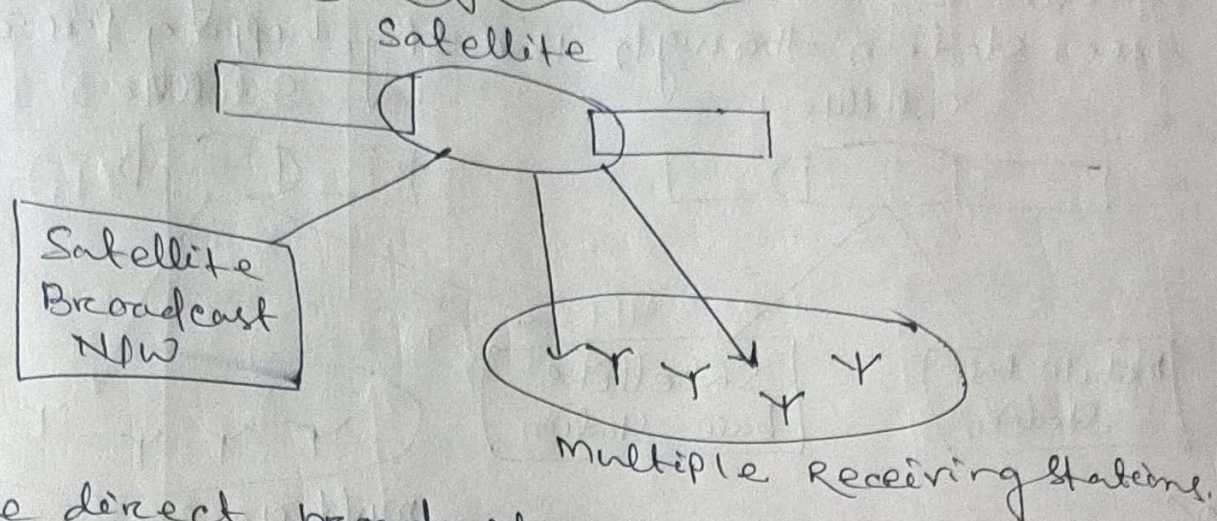
↳ The duplexer isolates the transmission & receiver sig in order to utilizing a sig. antenna for both transmission & reception purpose.

↳ The front end of the transponder comprises of RF filter, equalizer & low noise amplifier stage.

↳ The RF filter are generally band pass or low pass waveguide - II wave filter used for achieving

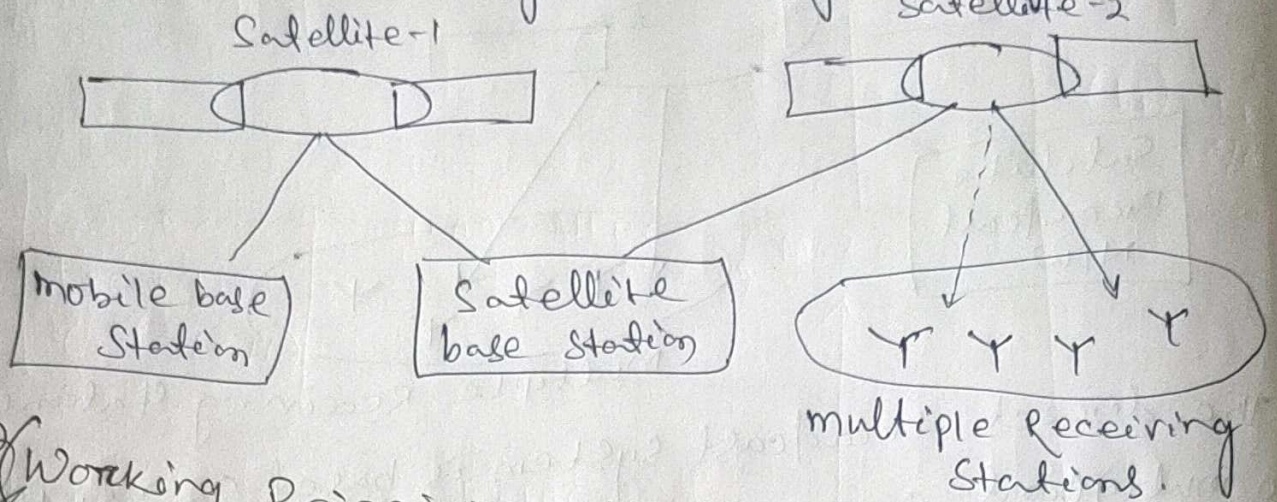
- desired masking, noise rejection & equalization they also contribute towards the ckt noise.
- ↳ The equalizer is used to cancel out the delay produced by the RF filter.
 - ↳ The low noise amplifiers are having very high gain. Generally tunnel diodes are used at this stage for low freq. band ("C" band) & FETs are used for high freq. band ("K" band).
 - ↳ The transponder shown in the fig. above is a regenerative transponder. The freq. translation is carried out by first translating the uplink freq. to a low intermediate freq. band & then the entire IF band is modulated to the downlink RF band.
 - ↳ These allow for the uplink commands transmitted with the carrier modulation to be recovered during the demodulation & satellite telemetry to be inserted into the base band for down link modulation.
 - ↳ After freq. translation the power amplifier usually consists of TWTs commonly used as high gain broad band amplifier. It provides a max gain of about 55 db. Then the sig is passed to the antenna through the diplexer unit for retransmission.

Working Principle of direct broadcast system) Direct Broadcast System (DBS) :-



- ↳ The direct broadcast system is based on one point to multipoint connectivity feature of the satellite commⁿ system.
- ↳ The above fig. shows the broad mechanism of a DBS.
- ↳ The system takes full advantage of inside area coverage of one transmitting system / Base station & many receive only stations as shown in fig.
- ↳ The program is to telecast is beamed up to the satellite via uplink antenna from the studio having base stations antenna system.
- ↳ In case of earth station or base station & uplink antenna is remotely located, the program to be telecast is 1stly collected by a mobile base station & transmitted to the nearby base station through the satellite link or terrestrial link.
- ↳ Then the base station activities the normal broadcast station.
- ↳ The downlink sigⁿ is received at each receiving station & distributed among the users by terrestrial link.

In case of wide area broad casting, multiple Satellites can be utilized linking different base station through the slg hopping process.



Working Principle of GPS Receiver, APPL

Global Positioning System (GPS): —

- ↳ The GPS systems are used as means of navigation for ships & aircrafts & also for surveying & many other appl.
- ↳ The main features of GPS are,
 - a) It consists of 24 satellites at MEO orbit at an altitude of 20,200km with 55° orbital inclination providing navigation & timing information.
 - b) The satellites are grouped into four called constellation, each separated by 60° longitudes.
 - c) The orbital period of each satellite is 1hr & 58 minutes. At any base station.
- ↳ The GPS provides the following information
 - i) Extremely accurate three dimensional position information.

- ii) Extremely accurate velocity information
- iii) Precise timing service.
- iv) Continuous real time information.

↳ The world wide GPS Satellite control system consists of 5 monitoring stations & four ground antennas.

↳ The monitoring stations use GPS receivers to passively track the navigational signals of all the satellites.

↳ Information from the monitoring system is then processed at the master control system which sends updated navigation information to GPS satellites through ground antenna operating in 'S' band.

↳ The GPS Satellites broadcast signals on two different frequencies which can correct for distortion effect due to ionosphere.

↳ The signal takes 35-65 sec. to reach from satellite to earth station.

↳ Horizontal position accuracy can be achieved up to 7-10 meters.

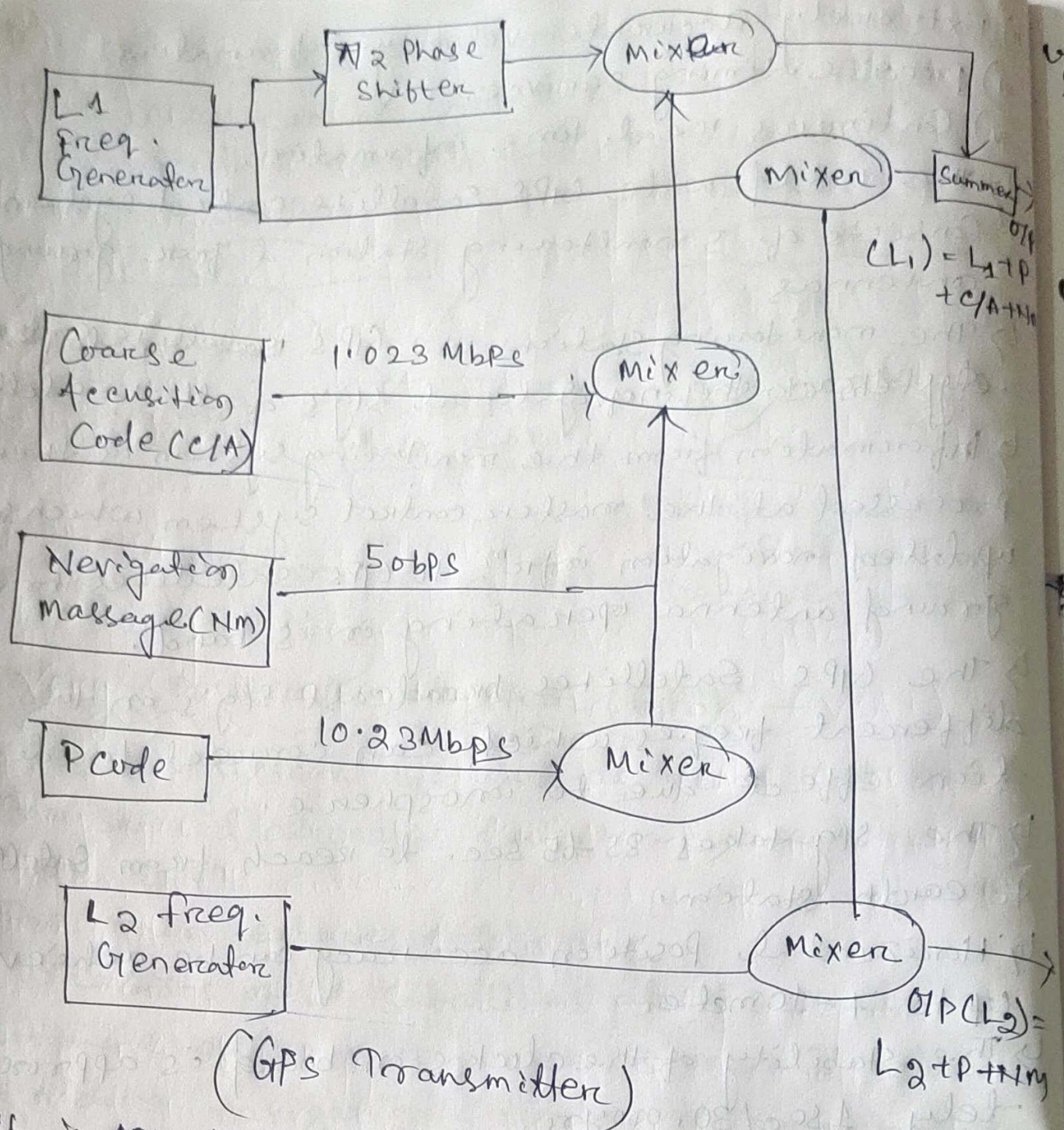
↳ The stability of the clocks on board is approximately 1 sec/30,000 yrs.

GPS Transmitter:

↳ The transmission by GPS satellite is based on the Pseudo random sequence codes.

↳ The Generation of L1 & L2 signals is shown in fig.

↳ All the satellites in the GPS system transmit the coarse acquisition (C/A) codes & at freq. 1575.42 MHz using BPSK modulation techniques.

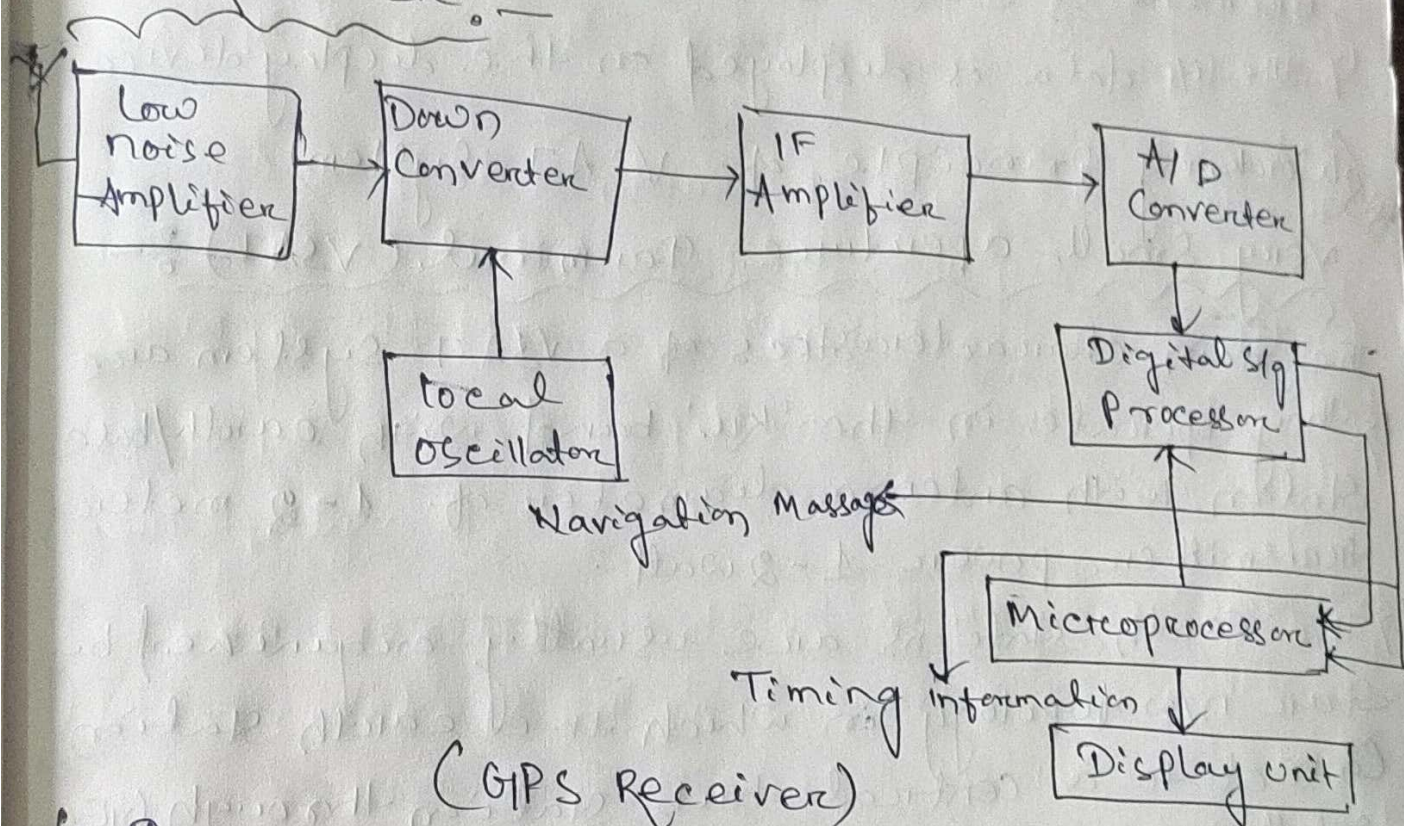


- ↳ It is 154 times more than the master clock freq. (10.23 MHz)
- ↳ The pseudo random sequence code lasts exactly 1 msec as 1023 bit sequences are transmitted at 1.023 MHz freq.
- ↳ The transmission of positional code uses BPSK modulation technique at L₂ carried freq. (127.6 MHz at 4 carriers in phase quadrature with coarse acquisition code)

↳ The coarse accusation code & positional code transmitted from all GPS satellites are overlaid in L1 & L2 freq. band, making the GPS system (DSSS) direct sequence spread spectrum system.

↳ At the receiver the sig from individual GPS satellites are separated using knowledge of the unique coarse accusation code i.e. allocated to each satellites.

GPS Receiver: -



(GPS Receiver)

↳ The schematic of a coarse accusation code GPS receiver.

↳ The antenna is circularly polarized which receives the downlink sig from the satellites.

↳ The low noise amplifier selects the desired freq. band & amplifies the sig.

↳ The super heterodyne receiver consisting of freq. down converter & local oscillator generates an

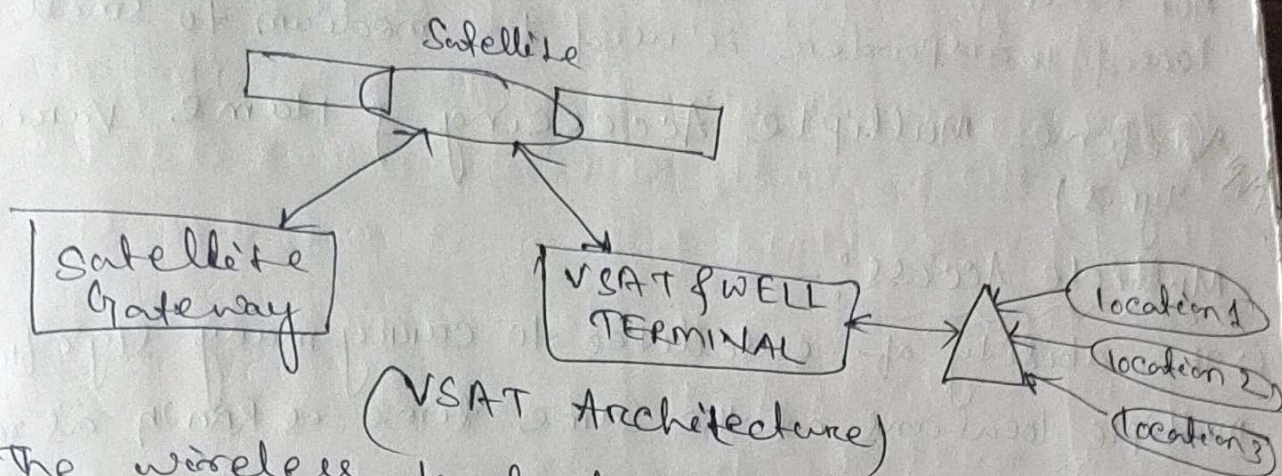
- intermediate freq. sig of a band with about 2MHz.
- ↳ This analog sig is digitalized by the A/D to converter which consists of a sampler & quantizer.
 - ↳ The digital sig processing unit processes the digital portion of received sig which consists of a coarse acquisition code generator & a correlator which select the code sequence.
 - ↳ The microprocessor carries out the timing measurement & calculates the receiver position.
 - ↳ The OP data is displayed on the display device.

Working principle of VSAT System)

Very Small aperture Terminal (VSAT) :-

- The main characteristics of a VSAT system are
- ↳ They operate in the 'Ku' band with earth/base station with antenna diameter of 1-2 meters & transmitter power 1-2 watt.
 - ↳ The earth stations are usually organized by star n/w topology in which the earth station connect to a central hub station through GEO satellites.
 - ↳ Data rate on this link is from a few 1000 bits/sec to 256 kbps depending on the traffic requirement.
 - ↳ The VSAT systems are used to link business of stores to a central computer system so that the sale transaction can be completed more rapidly than by using telephone & modem. Hence

central offices can rapidly redistribute collected information from a large no. of locations in a region or country.



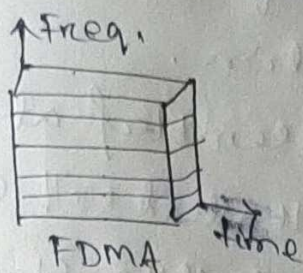
- ↳ The wireless local loop is coupled with VSAT distribution architecture as shown in the fig.
- ↳ The Geo Stationary Satellite links a large no. of VSATs with the main switching centre in a large city.
- ↳ It VSAT acts as a link to the local switching centre in the village or rural community with the final mile of telephone link being carried over with wireless local loop.
- ↳ The characteristics of a VSAT nw are
 - i) It allows multimedia traffic to be broadcast directly to the end user but generally handles only small traffic.
 - ii) The user accesses the satellite in a demand assign multiple access (DAMA) mode. Whenever the data is sent/received a short message about the transaction is replied in due course. Ex- the credit card transaction.

- ii) The commⁿ betⁿ satellites & earth station is completely automatic & transparent to the user.
- iv) Due to the very traffic, dedicated satellites are not used for this purpose instead leased / fractional leased transponder is used for medium to small. H/W
- Q. Define Multiple Accessing & Name various types)

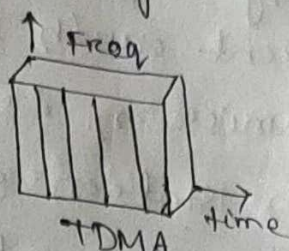
Multiple Access:

- ↳ The ability of satellites to carry many sig's from multiple locations at the same time is known as multiple access.
- ↳ It allows the multiple earth stations to communicate simultaneously to a single satellite so that band-width of the satellite can be effectively used.
- ↳ The basic form of multiple access employed by all commⁿ satellite is the use of multiple transponders.
- ↳ Though freq. reuse with multiple antenna beams & orthogonal polarization the spectrum can be reused several times.
- ↳ The freq. spectrum of the satellite is divided into smaller bandwidths which are allocated to the different transponders.
- ↳ This allows separate commⁿ links to be established through the satellite on the basis of transmitted freq.
- ↳ Depending on the method of allocation of the spectrum access techniques are

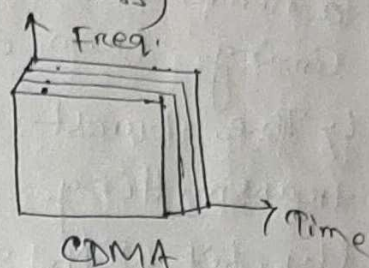
- (I) FDMA (Freq. division multiple access)
- (II) TDMA (Time division multiple access)
- (III) CDMA (Code division multiple access)
- (IV) DAMA (Demand assign multiple access)



FDMA



TDMA



CDMA

(Multiple Access Techniques)

FDMA :-

- ↳ It is the first multiple access technique used in satellite comm. system.
- ↳ In this system individual telephone channels can be shifted in freq. from baseband to a higher freq. so that they can be stacked into a group of channels using freq. division multiplexing as shown in fig.
- ↳ In this system all users use the satellite at the same time but with a unique allotted freq. band. It can be used both with analog & digital sig's.

TDMA :-

- ↳ In this system a no. of earth station take their turn for transmitting burst of RF sig to a transponder.
- ↳ All the TDMA system are digital. This system allows a single transponder to be shared in time domain betⁿ RF carriers from different earth stations.
- ↳ Here the RF carrier from each earth station sharing a single transponder is sent as a burst at a specific allocated

time.

↳ At the satellite, burst from different earth station arrived sequentially. So the transponder carries a near continuous sig sequence of short burst coming from different earth station.

↳ The burst transmission is assembled at a transmitting earth station so that it will correctly fit with TDMA frame at satellite station.

↳ The frame as a length varying from 125 μ sec to many millise. of the burst from the earth station must be transmitted at the correct time to arrive at the satellite at correct position within the TDMA frame.

↳ This requires synchronization of all earth stations in a TDMA now adding considerable complexity to the equipment at the transmitting station.

↳ The transmission time is to be closely monitored to avoid any data overlapping.

↳ A time overlap of two RF sig is called collision & results in loss of data of both carrier.

↳ High speed TDMA systems operate at a speed of 20 MBPs.

Advantages:-

- i) The data can be easily reconfigured for changing traffic demands due to the use of digital modulation techniques.
- ii) less noise interference.

- 1) can easily handle mixed voice & data traffic.
- 2) Non-linearity effect of the transponder can be overcome as one signal takes the whole bandwidth of the transponder.

Disadvantages:-

- i) All the earth stations need to transmit at high bit rate to occupy the whole bandwidth.
- ii) Due to high bit rate, high transmitter O/P power is required.
- iii) Not well suited for narrow band sig's from earth station.
- iv) Due to digital data, non-linearity characteristics of transponder may cause inter symbol interference. Hence equalizers are required at earth station to minimize this effect.

CDMA:-

- ↳ In this system, a no. of users can occupy all of the transponder bandwidth at all time.
- ↳ CDMA sig are encoded such that information from individual transponder can be recovered by a receiving station i.e. having the code used at the transmitting end.
- ↳ So there is a very less interference betⁿ the encoded sig's in the same band width in the CDMA system.
- ↳ This provides a decentralized satellite n/w as only the pair of earth stations that are

Communicating with each other need to co-ordinate their transition.

- ↳ Each receiving station is allocated a unique CDMA code.
- ↳ Any transmitting station that wants to send data to the desired earth station must use the correct code.
- ↳ These codes having length from few bits to many 1000 of bits are known as chips. To distinguish them from message bits of data transmitted a special sequence is used.
- ↳ The chip rate is always higher than the data rate which increases the speed of the digital transmission of the chip sequence.
- ↳ CDMA is also known as spread spectrum.
- ↳ Direct sequence spread spectrum (DSSS) is the only types of currently used technique in satellite comm.

Advantages:-

- ↳ Hence the energy of the data is spread across a wide bandwidth which makes the sig strength less than that of noise. Hence it can't be detected by any unintended receiver. Hence providing high data security, the receiver having the code of CDMA sig can only recover the data through the process of correlation.

- ↳ The base station is immune to Jamming due to the use of a Pseudo random noise sequence coding.
- ↳ An applⁿ like soft handoff is possible with this technology which is extensively used for mobile Commⁿ.

Dis-Advantages:-

It is less efficient in handling the bandwidth of satellite as compared in TDMA & FDMA.

Satellite APPIⁿ Commⁿ Satellite (MSAT), Digital Satellite Radio)

Commⁿ Satellite:-

- ↳ It is an artificial satellite station in space for the purpose of telecommⁿ.
 - ↳ Modern commⁿ satellite use LEO & GEO.
 - ↳ For fixed point to point services they provide a microwave relay radio technology complementary to that of commⁿ through cable. They are also used for mobile applⁿ such as Commⁿ to ships, vehicles, aircrafts, hand held terminals & for TV & Radio broadcast for which applⁿ of other technologies such as cable TV is impractical or impossible.
 - ↳ The commⁿ satellites are usually composed of following subsystem.
- 1) Commⁿ Pay load, normally composed of transmitters, antennas & switching system.
 - 2) Propulsion systems used to bring the satellite to desired orbit.

Vivo V15Pro
AI Triple Camera

(iii) Station keeping tracking & stabilization subsystem used to keep the satellite in the right orbit with its antenna pointed in the right direction & its power system facing towards the sun.

(iv) Power Subsystem use to power the satellite use to power the satellite system normally composed of solar cells & batteries that maintain the power during solar eclipses.

(v) Command & Control system which maintains communication with ground control stations. The ground control station monitors the satellite performance & controls their functionality during the entire life cycle of the satellite.

↳ Indium system is the 1st communication satellite system launched by USA for long distance international telephone service.

↳ The fixed public switched telephone network (PSTN) relays telephone calls from landline telephone to the earth station where they are transmitted to a GEO satellite.

↳ The down link follows an analogous path.

↳ The use of fiber optic cables reduce the importance of satellite telephoning but still it is extensively used for remote unreachable islands where land line or under water cable system does not exist.

↳ The satellite phones directly connect to the

LEO/GEO Satellite calls are then forwarded to
Satellite teleport connected to the PSTN.
The TV broadcasting is also new uses of the
advantages of satellite comm. The direct
broadcast system provides a major TV services
in North America.

Satellite Digital Radio:

- ↳ The satellite radio sig. i.e. relayed through
one/more satellites & thus can be received in
much wider geographical areas than FM radio
station.
- ↳ Mobile services such as "SARIUS, XM" & world
space allow listeners to roam across the entire
continent, listen to the same audio program
any where they go. Other services such as "MUZAK"
satellite deliver contained, required a fixed
location receiver & dish antenna system.
- ↳ In all cases the antenna must have a
clear view of the satellite i.e. line of sight
comm.
- ↳ In area where tall building, bridges / even
parking areas obscures the sig., repeaters can be
placed to make the sig. available to listeners.
- ↳ The satellite radio uses 2.3 GHz 'S' band in
North America & generally shares the 1.6 GHz
'L' band with local digital audio broadcasting
stations elsewhere.

It is a type of direct broadcasting system which is strong enough that it receives the sig.

The curvature of the earth limits the reach of the sig but due to high orbits of the satellites, the satellites are usually sufficient to provide the radio services.

↳ local repeaters similar to broadcast transmitters and booster enable sig to be available even if the view of the satellite is blocked. For tunnels, repeaters are used.

2. Concept of Geostationary satellite, calculate its height, velocity & Round trip time delay & their Advantages & Dis-Advantages.

Geo-Stationary Satellite:-

A Geostationary satellite orbits at a height of approximately 35,786 km (22,236 miles) above the equator, with a velocity of about 3.07 km/sec. Resulting in a round trip sig delay of roughly 240 milliseconds, while offering advantages like fixed coverage & simple tracking, they also have disadvantages such as high latency & limited bandwidth.

Calculation:-

Height:- A geostationary satellite orbits at a height of approximately 35,786 km (22,236 miles).

above the earth's surface.

Velocity: - To maintain a geostationary orbit the satellite needs to travel at a speed of approximately 3.07 Km/sec (1.91 miles/sec)

Trip Time Delay: - Due to the distance, a round trip sig (from earth to the satellite & back) takes about 240 milliseconds (0.24 sec).

Advantages: -

a) fixed coverage: -

Geostationary satellites provide consistent coverage of a specific region, making them ideal for apps like broadcasting & weather monitoring.

b) Simple Tracking: -

Because they appear stationary from earth, ground antennas don't need to track them, simplifying the infrastructure.

c) Global Coverage: -

With a few satellites, geostationary orbits can provide global coverage especially for latitudes up to 70° .

Dis-Advantages: -

a) High Latency: -