1.2 DATA TRANSMISSION TERMINOLOGY

The word "terminology" is made from "term" and "analogy". It means the terms which are used to decribe the analogy of any subject. Here data transmission terminilogy explains the terms which are mandatory to illustrate the meaning of "data transmission".

Some specific terms are very common in case of data transmission or communiction system such as

(1) **Bit rate**

(2) **Channel Capacity**

(3) **Bandwidth**

(4) **Signal Strength**

(5) **Signal to Noise Ratio (SNR)**

(1) Bit Rate :

Bit rate is the rate of bit transmission from one station to another station. It is defined as the number of bits send in 1 sec. and its unit is bits per second (bps). There is another term known as band rate but it is quite different from bit rate as bit rate defines the rate of data element sent in 1 sec. while band rate defines the rate of signal element sent in 1 sec.

(2) Channel Capacity :

Channel defines the number of bits a transmission channel can send over a time. It is defined as the maximum possible information transmitted per second. It is given as

$$C = B \log_2 \left(1 + \frac{S}{N}\right) \text{ bits/sec.}$$

Where C is channel capacity,

B is Bandwidth.

S/N is signal to Noise ratio.

It signifies that channel capacity should always be greater than the bit rate otherwise the data sent overflows than the channel capacity and may be lost.

(3) Bandwidth :

It is the range of frequencies available for data transmission. The wider the bandwidth of a communication system the more data it can transmit in a given period of time. It is expressed in bits per second. It determines the rate at which information can be sent through a communication channel. It is expressed by the difference between two frequencies. For example if signal ranges from 4000 to 5000 Hz. Then Bandwidth is given as (5000 – 4000) Hz. = 1000 Hz.

(4) Signal Strength :

Signal strength defines the strength of the signal in terms of voltage current or power. We can also call the signal strength as signal amplitude and any of these three parameters can be used to measure it.

Fig. 1.1

Thus it shows how much power the signal has.

(5) SNR (Signal To Noise Ratio) :

Due to noise power the signal power reduces till it reaches the destination so we need to consider that how much noise is present in how much signal. This is determined by the parameter known as signal to noise ration (SNR), is defined as

$$\boxed{\mathrm{SNR} = \frac{\textbf{average signal power}}{\textbf{average noise power}}}$$

It is actually the ratio of what is wanted (signal) to what is not wanted (noise). A high SNR means the signal is less corrupted by noise and a low SNR means the signal is more corrupted by noise. It is often describede in decibel units, $\mathrm{SNR}_{\mathrm{dB}}$ defined as $\boxed{\mathrm{SNR}_{\mathrm{dB}} = 10 \log_{10} \mathrm{SNR}}$ figure shows the idea of SNR.

oxygen absorption in the neighbourhood of 60 GHz, frequencies in the 40-70 GHz region are not used by active systems. However, multi frequency radiometers operating in the 50-60 GHz range are used for retrieving the atmospheric temperature profiles from radiometric observations. Radars are operated for remote sensing in the 32-36 GHz region, and some military imaging radars are around 95 GHz. Radio astronomy bands exist at 31.4, 37 and 89 GHz and these are also used by microwave radiometers for remote sensing as well.

Microwave region extends throughout UHF, SHF and EHF bands from 0.3 to 300 GHz (1 m to 1mm in wavelength).

1.5 ANALOG AND DIGITAL TRANSMISSION

The cost advantages of digital transmission over analog transmission become apparent when transmitting over a long distance. Consider, for example, a system that involves transmission over a pair of copper wires. As the length of the pair of wires increases, the signal at the output is attenuated and the original shape of the signal is increasingly distorted. In addition, interference from extraneous sources, such as radiation from radio signals, car ignitions, and power lines, as well as noise inherent in electronic systems result in the addition of random noise to the transmitted signal. To transmit over long distances, it is necessary to introduce **repeaters** periodically to compensate for the attenuation and distortion of the signal, as shown in Fig. (1.6). Such signal reconditioning is fundamentally different for analog and digital transmission.

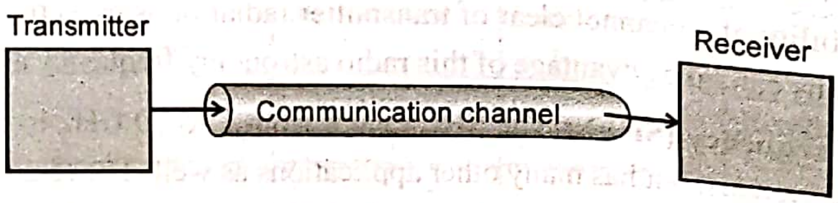
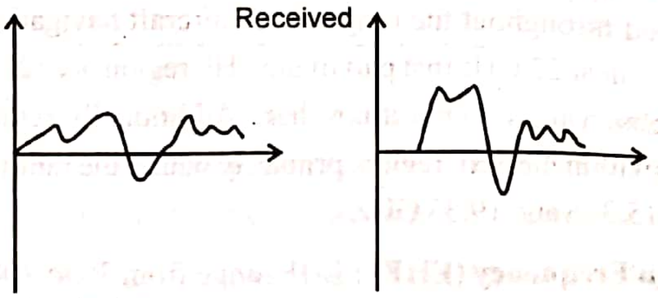
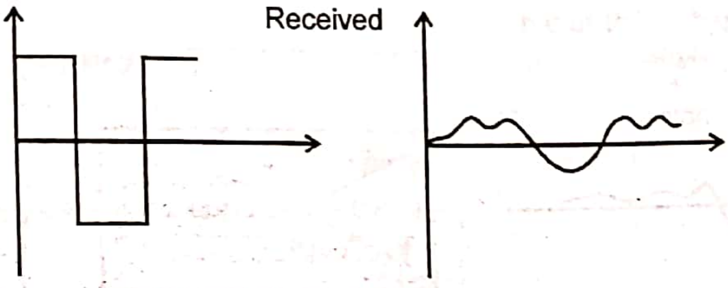


Fig. 1.5 : General Transmission System



Examples: AM, FM, TV transmission

Fig. 1.6(a) : Analog transmission requires an accurate replica of original signal



Examples: digital telephone, CD audio

Fig. 1.6(b) : Digital Transmission Reproduces Discrete Levels

In an analog communication system, the task of the repeater is to regenerate a signal that resembles as closely as possible the signal at the input of the repeater segment. Figure 1.6 shows the basic functions carried out by the repeater. The input to the repeater is an attenuated and distorted version of the original transmitted signal plus the random noise added in the segment. At the transmitter the original signal is much higher in power than the ambient noise. If the signal is attenuated too much then the noise level can become comparable to the desired signal. The function of the repeater is to boost the signal power before this occurs. First the repeater deals with the attenuation by amplifying the received signal. To do so the repeater multiplies the signal by a factor that is the reciprocal of the attenuation a. The resulting signal is still distorted by the channel.

The repeater next uses a device called an **equalizer** in an attempt to eliminate the distortion. The source of the distortion in the signal shape has two primary causes. The firt cause is that different frequency components of the signal are attenuated differently. In general, high-frequency components are attenuated more than low-frequency components. The equalizer compensates for this situation by amplifying different frequency components by different amounts. The second cause is that different frequency components of a signal are delayed by different amounts as they propagate through the channel.

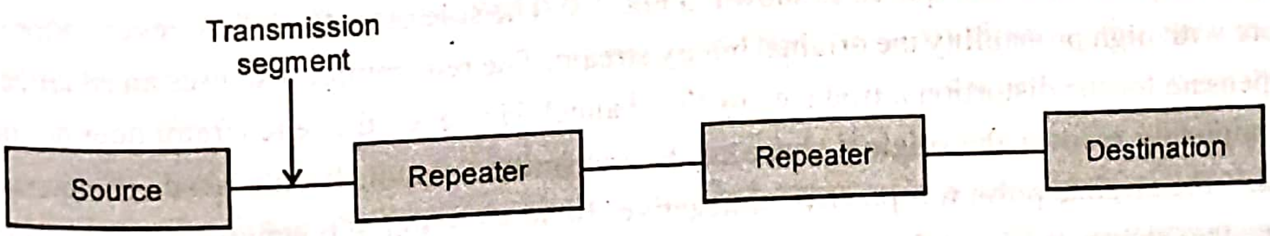


Fig. 1.7 : Typical long-distance link

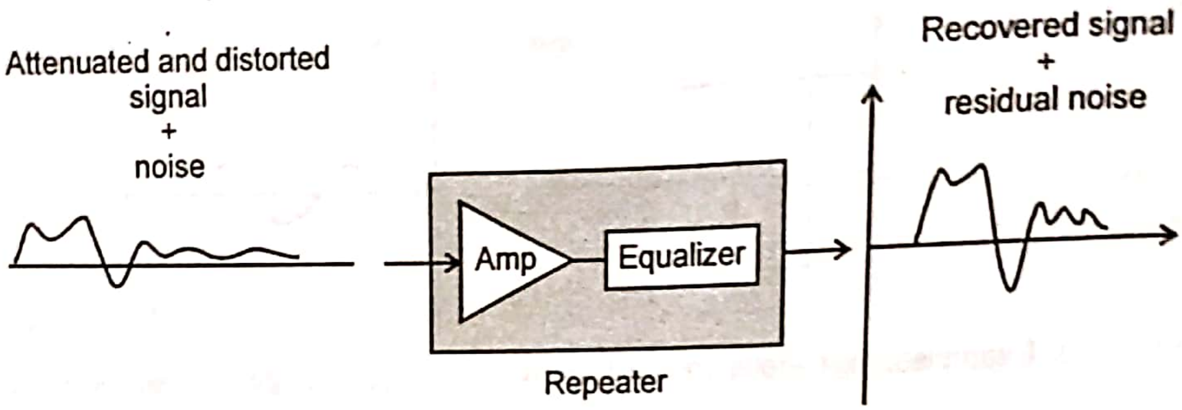


Fig. 1.8 : An analog repeater

The equalizer attempts to provide differential delays to realign the frequency components. In practice it is very difficult to carry out the two functions of the equalizer. For the sake of argument, suppose that the equalization is perfect. The output of the repeater then consists of the original signal plus the noise.

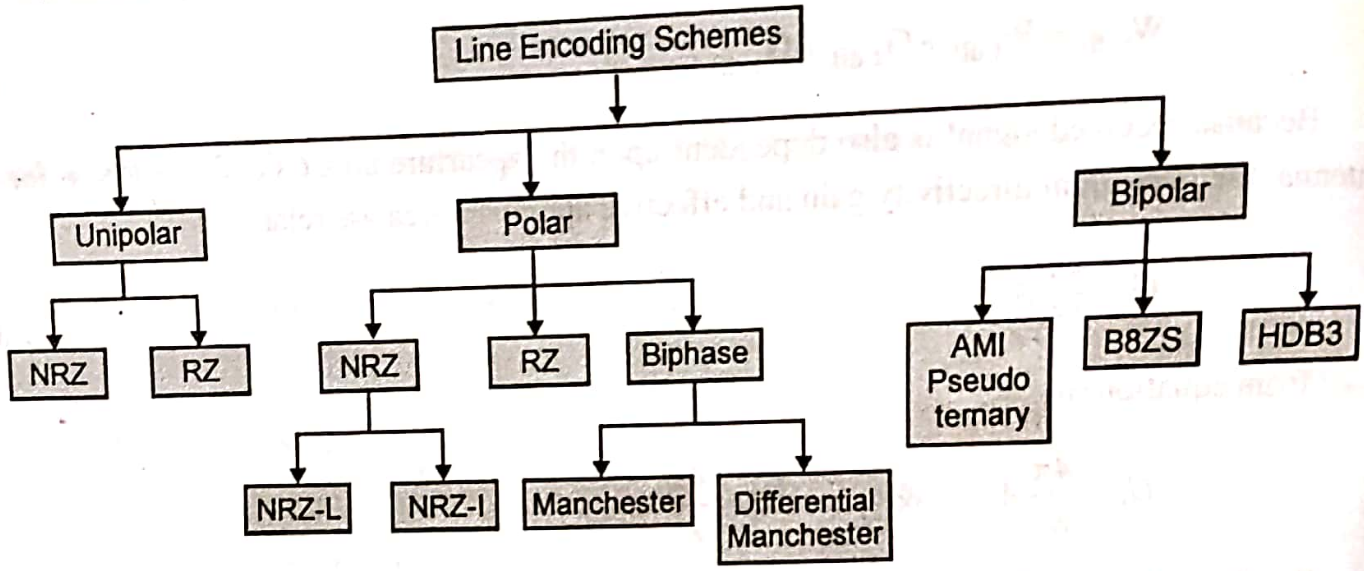
In the case of analog signals, the repeater is limited in what it can do to deal with noise. If it is known that the original signal does not have components outside a certain frequency band, then the repeater can remove noise components that are outside the signal band. However, the noise within the signal band cannot be reduced and consequently the signal that is finally recovered by the repeater will contain some noise. The repeater then proceeds to send the recovered signal over the next transmission segment.

The effect on signal quality after multiple analog repeaters is similar to that in repeated recordings using analog audiocassette tapes or VCR tapes. The first time a signal is recorded, a certain amount of noise, which is audible as hiss, is introduced. Each additional recording adds more noise. After a large number of recordings, the signal quality degrades considerably. A similar effect occurs in the transmission of analog signals over multiple repeater segments.

Next consider the same copper wire transmission system for digital communications. Suppose that a string of 0s and 1s is conveyed by a sequence of positive and negative voltages. As the length of the pair of wires increases, the pulses are increasingly distorted and more noise is added. **A digital regenerator** is required as shown in Fig. 1.9. The sole objective of the regenerator is to restore with high probability the original binary stream. The regenerator also uses an equalizer to compensate for the distortion introduced by the channel. However, the regenerator does not need to completely recover the original shape of the transmitted signal. It only needs to determine whether the original pulse was positive or negative. To do so, a digital regenerator is organized in the manner shown in Fig. (1.9).

1.14 LINE ENCODING SCHEMES

We can divide line encoding schemes in following categories :



1.14.1 Unipolar

In a unipolar scheme, all the signal levels are on one side of the time axis, either above or below. It uses only one polarity either positive (1) or negative (0) hence called unipolar.

(a) Unipolar Non Return to Zero (NRZ) : The positive voltage defines bit 1 and zero voltage defines bit 0. It is called NRZ because signal does not return to zero at the middle of the bit.

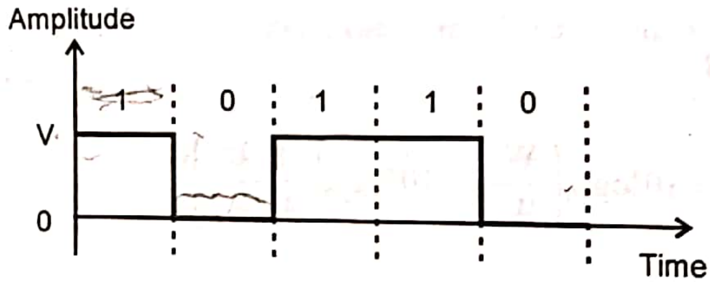


Fig. 1.46 : Unipolar NRZ scheme

(b) Unipolar Return to Zero (RZ) : In this code '1' is represented by a positive pulse of half symbol width and a '0' is represented by no pulse.

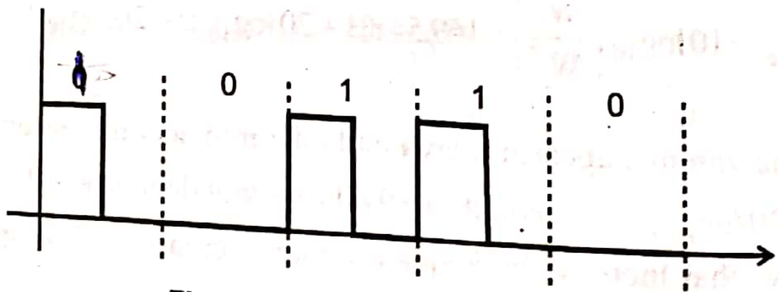


Fig. 1.47 : Unipolar RZ Scheme

Example : ***Unipolar NRZ and RZ formats have been shown for a binary message***

$$S(t) = 10110100.$$

Sol. According to example the binary sequence is given as :

$$S(t) = 1\ 0\ 1\ 1\ 0\ 1\ 0\ 0$$

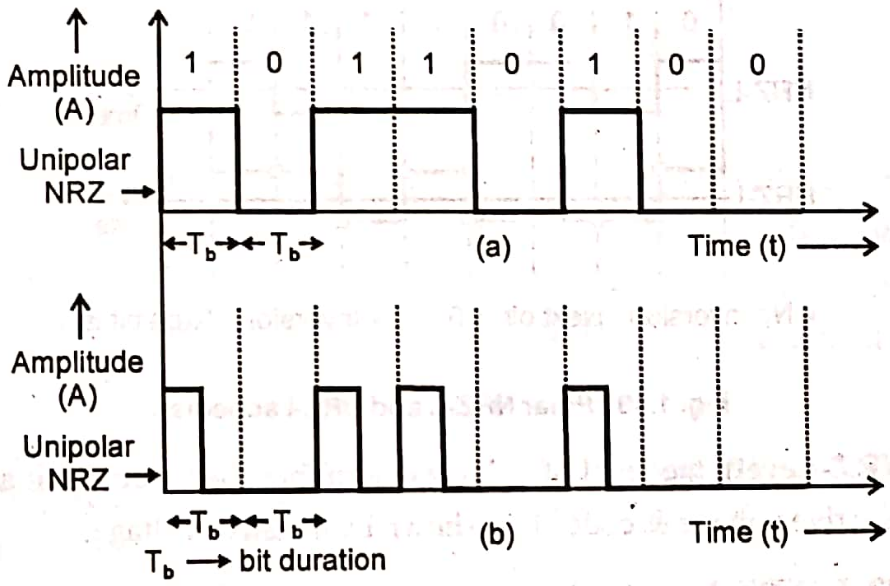


Fig. 1.48 : Different formats, (a) Unipolar NRZ format (b) Unipolar RZ format

Disadvantages of Unipolar format :

(i) **DC Component :** Average amplitude of this signal is non zero so it has some average dc value which does not carry any information.

(ii) **Synchronization :** Which signal is not varying (i.e. either continuous '0' or continuous '1'), the receiver can not determine the beginning and ending of each bit. So to control synchronization of unipolar transmission it has to use a separate parallel line that carries a clock pulse and allows the receiving device to resynchronize its timer to that of signal.

Comparison between Unipolar NRZ and RZ format :

(i) In NRZ format pulse does not return to zero on its own but only when signal is '0' while in RZ it returns to zero on its own.

(ii) NRZ pulse width is more so it has more energy.

(iii) Internal computer waveforms are usually of unipolar NRZ type.

1.14.2 Polar

In this scheme, waveform has two polarity i.e. positive and negative both. Due to this the average voltage level on this line is reduced and the DC component problem of unipolar format is removed.

(a) NRZ (Non Return to Zero) :

It uses two levels of voltage positive and negative for either '0' or '1'. It has two versions : NRZ-L and NRZ-I as shown in fig. (1.49)

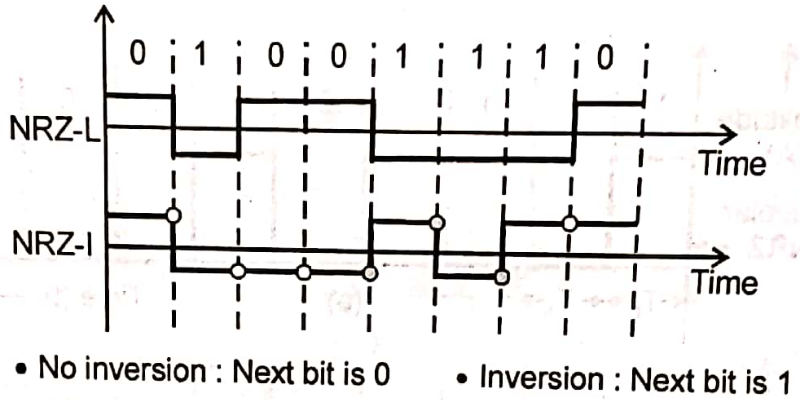


Fig. 1.49 : Polar NRZ-L and NRL-I schemes

In **NRZ-L (NRZ-Level),** the level of voltage determines the value of bit as in the fig. shown code '0' is given positive voltage & code '1' is shown by negative voltage.

While in **NRZ-I (NRZ-Invert),** the change or lack of change in the level of the voltage determines the value of the bit. If there is no change, the bit is 0 ; if there is a change, the bit is 1.

Comparison between NRZ-L and NRZ-I :

S.No.	NRZ-L	NRZ-I
1.	For long sequence of 0s and 1s baseline wandering is severe.	Baseline wandering occurs only for long sequence of 0s.
2.	Synchronization problem occurs due to long sequences of both 0s & 1s.	Less severe than NRZ-L as only due to long string of 0s.
3.	A sudden change in polarity can interpret all 0s as 1s and all 1s as 0s.	It can clearly distinguish because it does not depend on voltage level but depends on change.
4.	Average signal rate N/2 Bd.	Same
5.	Most energy concentrated in frequencies between 0 & N/2 so have DC component problem.	Same

Advantages of NRZ codes :

(i) They efficiently use bandwidth.

(ii) It is easy for engineers to work on.

Limitations :

(i) It has DC component problem so cannot pass through the media which does not allow low frequency to pass.

(ii) It lacks synchronization in case of long string of 0s or 1s.

(b) Return to Zero (RZ)

NRZ encoding has main problem of synchronization where receiver does not know when one bit has ended and the next bit is starting. One solution to this is **Return to Zero (RZ)** scheme which uses **three Values : positive, negative and zero.** In RZ, the signal does not changes between bits but during the bit. Fig. 1.45 shows that the signal goes to 0 in the middle of each bit and remains there until the beginning of next bit.

Its main **disadvantage** is that it requires two signal changes to encode a bit and therefore occupies great bandwidth. It also has the problem due to sudden change of polarity but there is no DC component problem. As it uses three voltage levels, it is more complex to create & understand. So it is not used nowadays but has been replaced by better performing schemes.

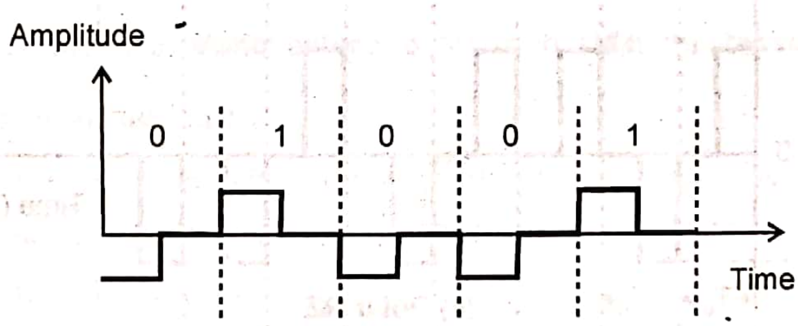


Fig. 1.50 : Polar RZ Scheme

Advantages of RZ format :

(i) Average DC value is minimum.

(ii) Signal changes during the bit not between the bits.

Disadvantages of RZ format :

(i) Since it uses three voltage levels, more complex.

(ii) It uses greater bandwidth as it requires two signal changes to encode one bit.

Example : ***Draw waveform corresponding to data stream, S(t), 10110100 when scheme are Polar NRZ-L, NRZ-I and RZ.***

Sol. According to example the representation of binary stream in following scheme is as :

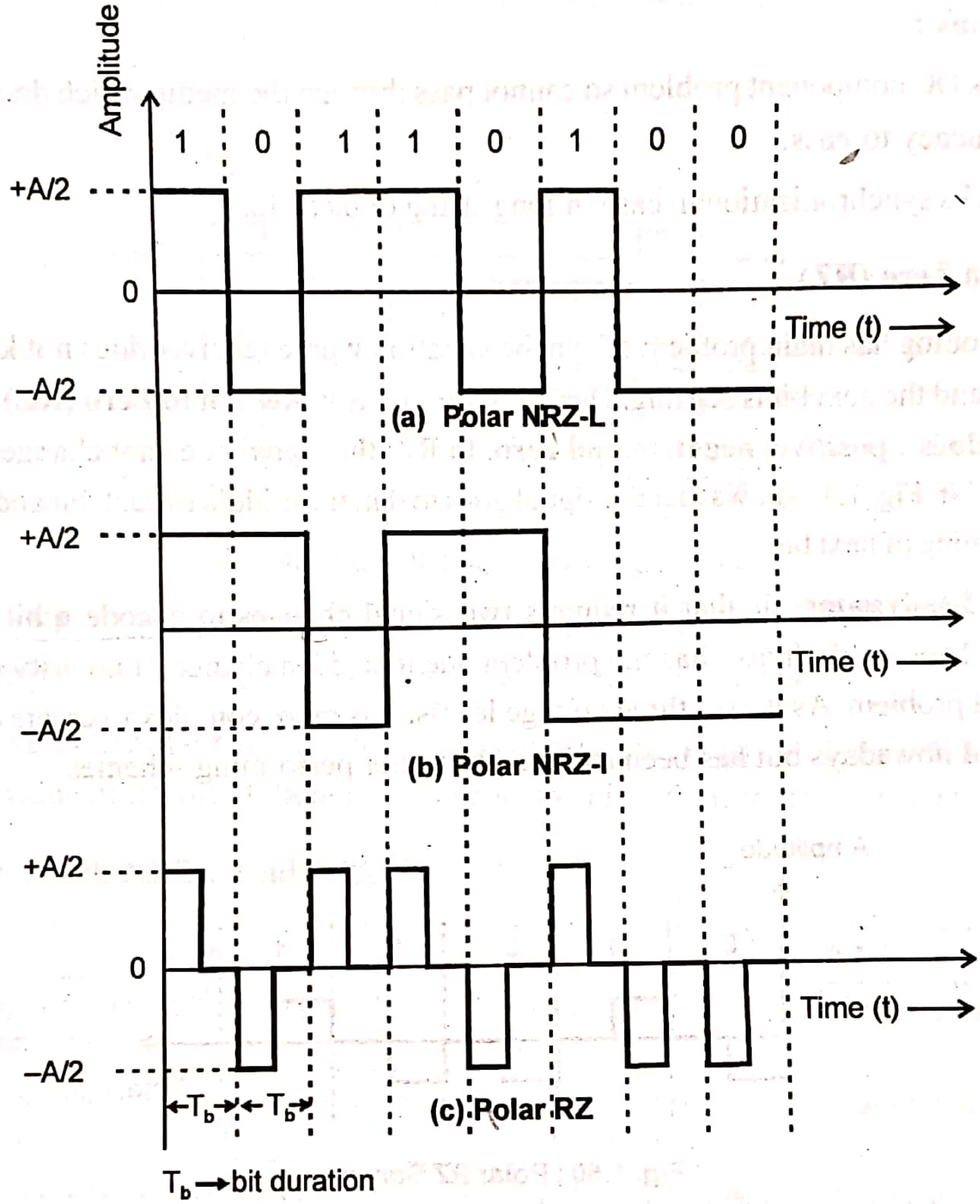


Fig. 1.51 : Different formats (a) Polar NRZ-L (b) Polar NRZ-I (c) Polar RZ

(c) Biphase :

This technique solves the problem of synchronization in NRZ. In this method, the signal changes at the middle of the bit interval but does not return to zero and continues to opposite polarity. Due to these frequent transitions, timing circuit at receiver can maintain synchronization with transmitting end. There are two types of biphase encoding techniques : Manchester and Differential Manchester.

- The idea of RZ (transition at middle of the bit) and idea of NRZ-L are combined into the **Manchester Scheme**. The duration of the bit is divided into two values. The voltage remains at one level during the first half and moves to other level in the second half. The transition at the middle of the bit provides synchronization.

Scanned with CamScanner

- **Differential Manchester** combines the idea of RZ and NRZ-I. There is always a transition at the middle of the bit, but the bit values are determined at the beginning of the bit. If the next bit is 0, there is a transition; if the next bit is 1, there is none. Fig. (1.52) shows both types of biphase encoding.

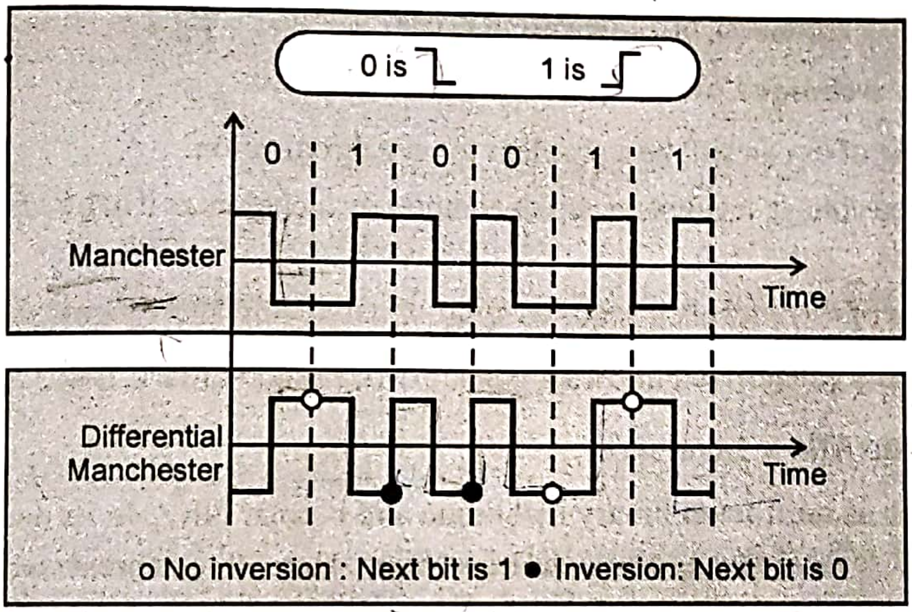


Fig. 1.52 : Polar biphase : Manchester and differential Manchester schemes

Advantage of biphase techniques are :

(i) **Synchronization :** Due to transition during each bit, the receiver can synchronize on that transition and that is why these codes are also known as **self clocking codes**.

(ii) **No DC Component :** They have no dc component because each bit has a positive and negative voltage contribution.

(iii) **Error Detection :** The absence of an expected transition can be used to detect errors. Noise on the line would have to invert both the signal before and after the expected transition to cause an undetected error.

The only **draw back** of this technique is that it has double the signal rate from that of NRZ because there is always one transition at the middle of the bit and may be one transition at the end of each bit.

1.14.3 Bipolar

This type of coding uses three voltage levels as positive, negative and zero. Zero level is used to represent binary 0 and 1s are represented by alternating positive and negative voltage. If first 1 bit is represented by positive pulse then second by negative and third by positive and so on even if the 1s are not consecutive.

Advantages of this technique are :

(i) Each 1 introduces a transition so there is no loss of synchronization for long string of 1s.

(ii) There is no dc component as 1 alternate between positive and negative voltage.

(iii) Bandwidth required is less than NRZ.

(iv) Due to pulse alteration, error detection is easy.

Drawbacks of this technique are :

(i) Long string of 0s can still be a problem for synchronization.

(ii) It uses three voltage levels so receiver complexity increases as it has to distinguish between three levels.

(iii) Due to use of three levels it requires approximately 3dB more signal power than NRZ.

They are basically categorized into four types: AMI, Pseudoternary, B8ZS and HDB3.

(a) AMI (Alternate Mark Inversion) :

It is also known as multilevel binary technique and bipolar NRZ. In its name 'Mark' comes from telegraphy and so AMI means alternate 1 inversion. Here '0' is represented by no signal and '1' is represented by alternating positive and negative voltages. Long string of 0's pose synchronization problem.

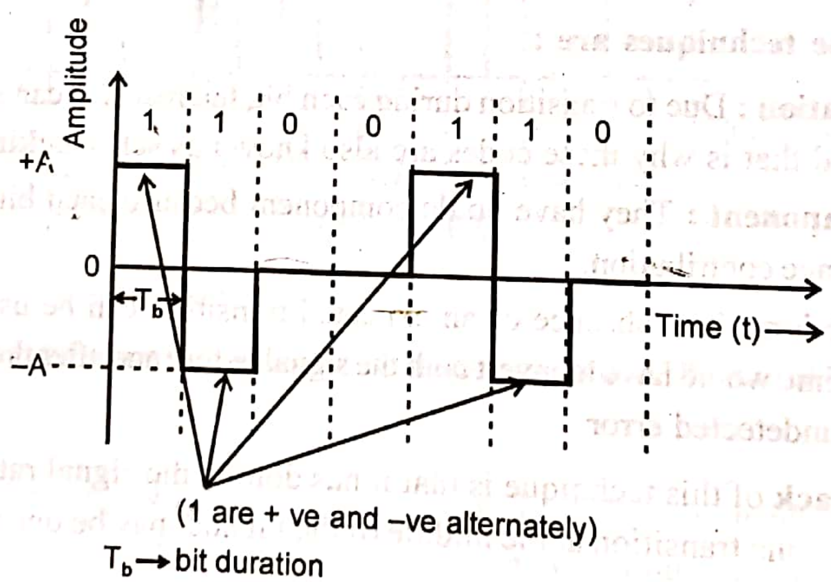


Fig. 1.53 : Bipolar AMI format

(b) Pseudoternary :

It is a variation of Bipolar AMI technique as code '1' is represented by no signal and code '0' alternates between the positive and negative voltage. Here long string of 1's cause synchronization problem.

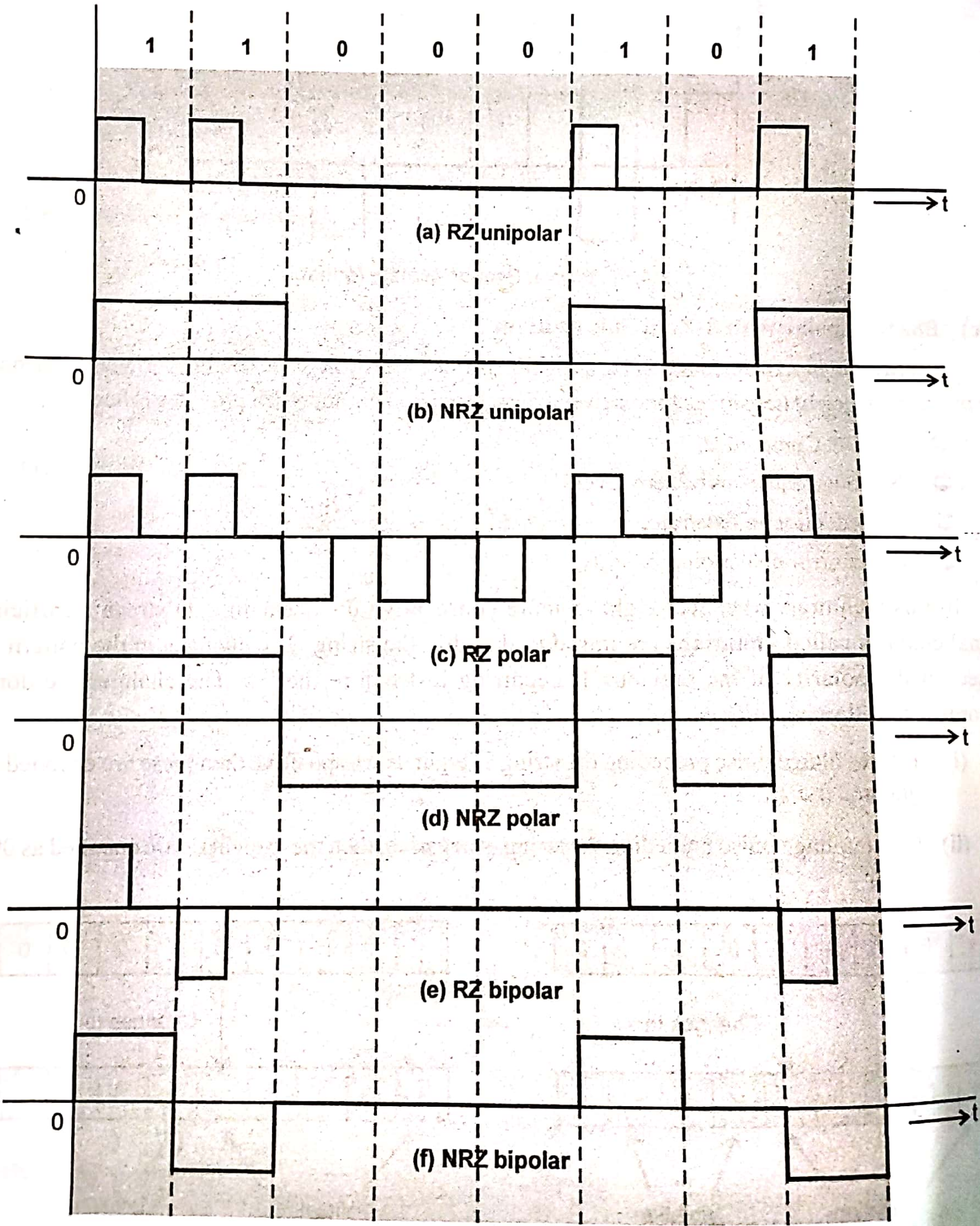


Fig. 1.56(a) : Line coding

1.15 CONCEPT OF BIT PERIOD

It is also known as Bit interval and Bit Rate. Most digital signals are aperiodic and period or frequency is not appropriate terms to use. So two new terms-bit interval (instead of period) and bit rate (instead of frequency) are used to describe digital signals. The bit interval is the time required to send one single bit. The bit rate is the number of bit intervals per second. This means that the bit rate is the number of bits sent in one usually expressed in bits per second (bps). See figure (1.58)

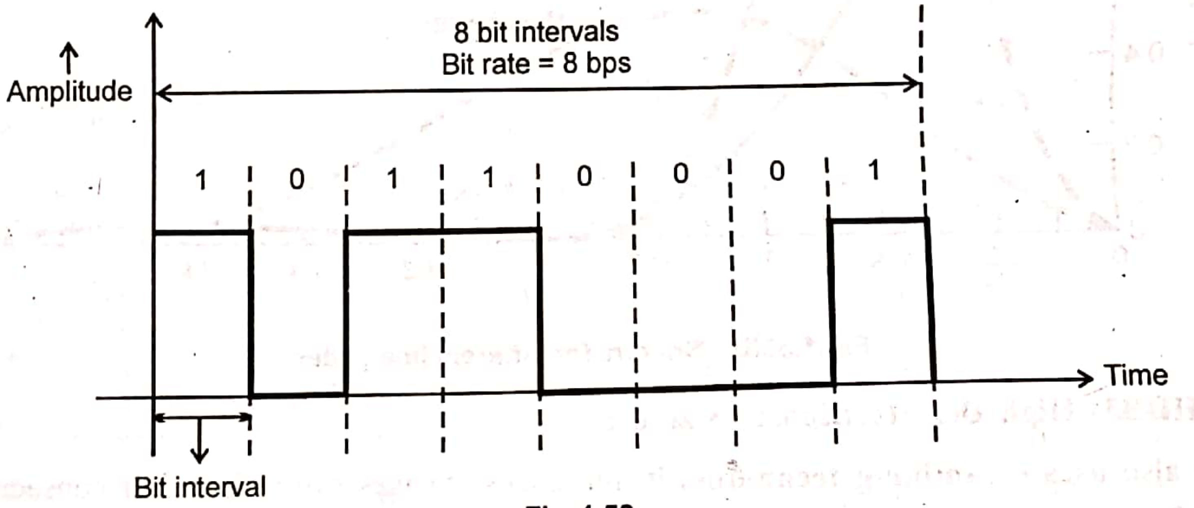


Fig. 1.58

Example : ***A digital signal has a bit rate of 2000 bps. What is the duration of each bit (bit interval)?***

Sol. The bit interval is the inverse of the bit rate.

$$\text{Bit interval} = \frac{1}{\text{bit rate}} = \frac{1}{2000} = 0.000500 \text{ seconds}$$

$$= 0.000500 \times 10^6 \ \mu s = 500 \ \mu s \quad \textbf{Ans.}$$

1.16 EFFECT OF CLOCK SKEW

All logic operation in a synchronous machine occur in synchronism with a clock, the system clock becomes the basic timing unit. The system clock must provide a periodic waveform that can be used as a synchronizing signal. Clock could simply be a series of positive or negative pulses as shown in fig (1.59)

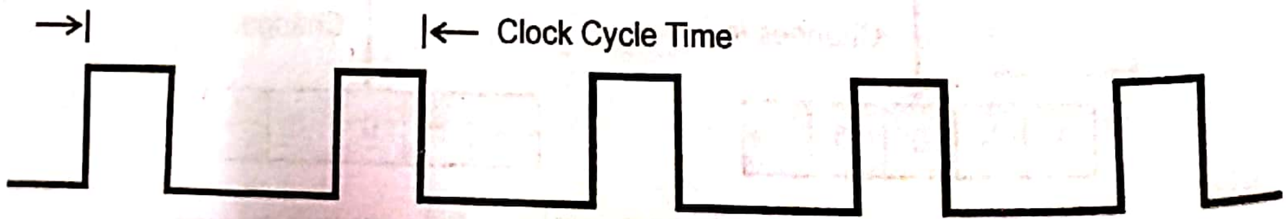


Fig. 1.59

Clock defines a basic timing interval during which logic operations must be performed. This basic timing interval is defined as a clock cycle time and is equal to one period of the clock waveform. Thus all logic elements, flip-flops, gates and so on must complete their transitions in less than one clock cycle time.

Example : ***What is the clock cycle time for a system that uses a 500-KHz clock?***

Sol. The clock cycle time is equal to one period of the clock. Therefore, the clock cycle time for a 500 KHz clock is

$$\frac{1}{500\times10^3} = 2\mu s \quad \textbf{Ans.}$$

1.16.1 Clock Rate Differences and Their Effect on Transmission

Most application have a normal clock frequency that is known to the transmitter and receiver for example, 8KHz for telephone speech, 44 KHz for audio and 27 MHz for television. This clock frequency dictates the rate at which samples are to be played out. However, it is extremely unlikely that the clock at the receiver will be exactly synchronized to the clock at the transmitter. Figure 1.55 shows the effect of differences in clock rate. Figure 1.55 shows the times at which the information blocks were produced and the arrows indicate the total delay that was encountered in the network. When the receiver clock is slow relative to the transmitter clock. The receiver will play its samples at a rate slower than they were produced. Over a period of time the receiver buffer will be full, eventually leading to loss of information due to buffer overflow.

When the receiver is fast, the receiver buffer will gradually empty and the playout procedure will be interrupted due to lack of available samples.

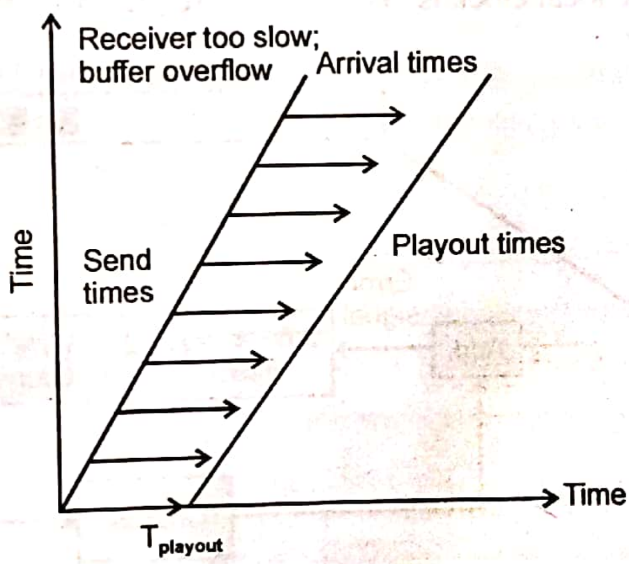


Fig. 1.60

1.18.1 Introduction to OSI Model

Need of OSI Model :

Computer network users are now prevailed all around the world. The basic requirement is to establish a nation wide and worldwide data communication system which shows compatible features with international standard.

Development of OSI Model :

International Standards Organization (ISO) developed a **frame work** which works on **n layer protocol.** In *n* layer protocol, layer *n* on one machine (source) carries on conversation with layer *n* on another machine (destination). The **frame work** over which ISO works is called **OSI model.**

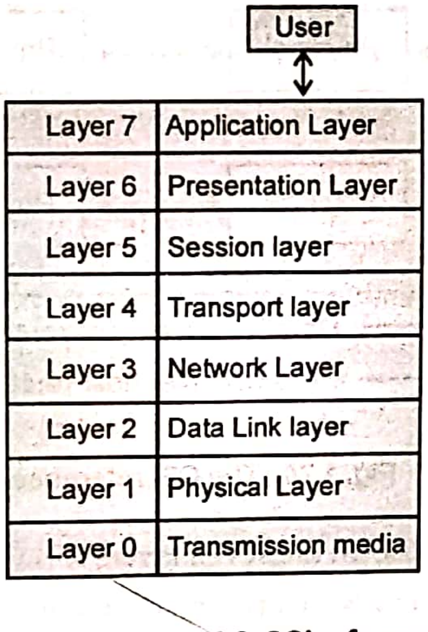


Fig. 1.69 : A seven layer ISO-OSI reference model.

Figure 1.63 shows the seven layer architecture of ISO-OSI reference model. OSI model governs seven layers. Physical layer is the lowest layer (layer1) and highest one is called application layer (level/layer 7).

The model in figure 1.63 does not contain any physical medium. This model was proposed by International Standards Organization (ISO), it is called ISO-OSI (Open system Interconnection) reference model because it is designed for the systems which are open for communication with other systems.

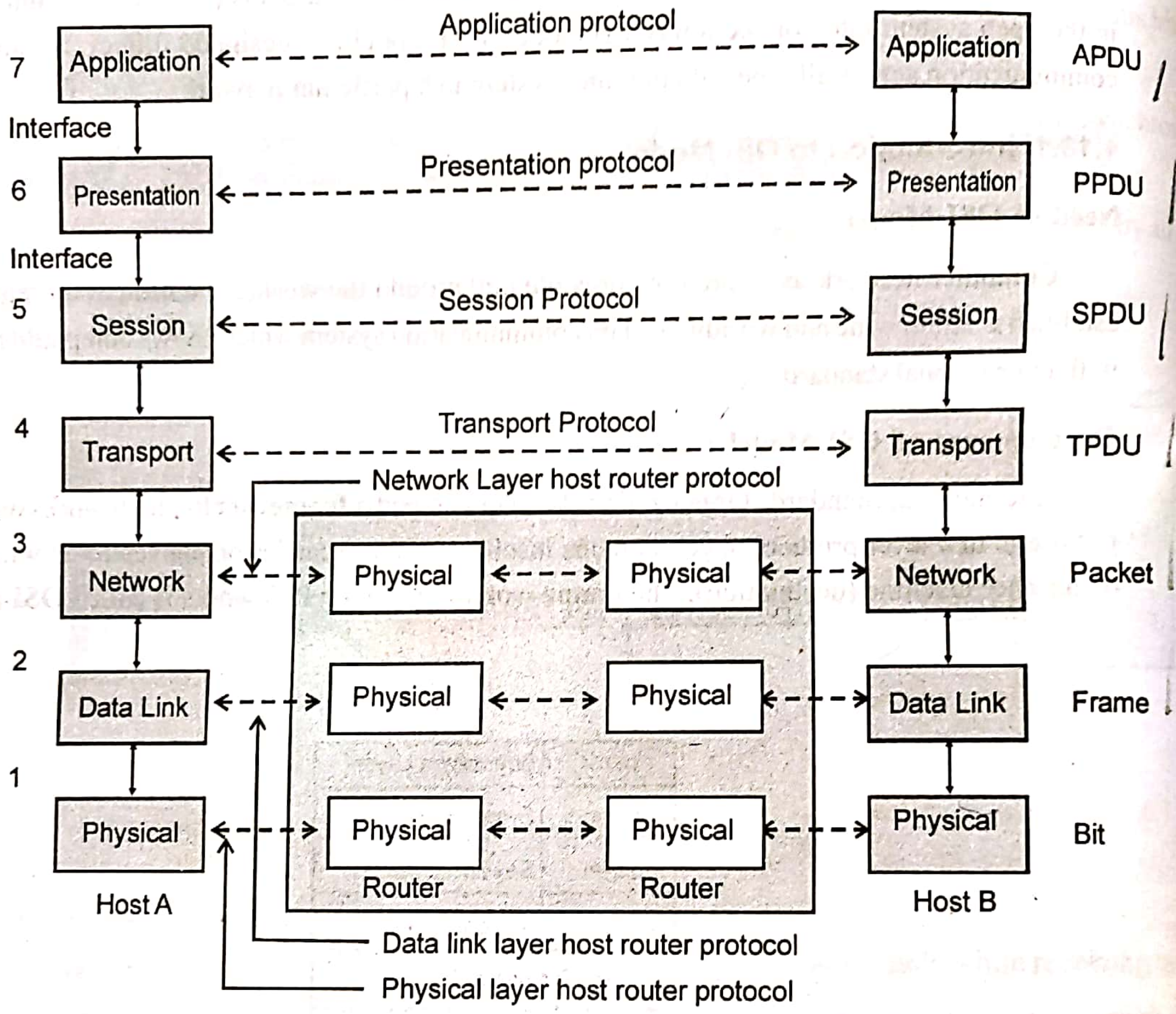


Fig. 1.70 : The OSI reference model

All applications need not use all the seven layers shown in Fig. (1.70). The lower three layers i.e. (1) Physical (2) Datalink (3) Network layer are enough for most of the applications. Each layer is manufactured by some electronic circuit on software and has its seperate existence from remaining layers.

Layers are assigned such as to transmit message or data above it. This message passing is done by protocols. Each layer takes data from adjacent layer below it, handles it according to protocol rules and then passes to the next layer above it.

Open system interconnection (OSI) model is a way of specifying communication protocols to make communication easy to design and show compatibility among different systems.

Functions of Different Layers :

1. **Layer1 / Level 1 Physical Layer :**

   Functions of Physical Layer are as follows :

   (i) To activate, maintain and deactivate the physical connection.

   (ii) To convert digital bits into electrical signal

   (iii) To define voltages and data rates needed for transmission.

   (iv) To decide whether the transmission is simplex, half duplex or full duplex.

2. **Layer 2 / Level 2 Data Link Layer**

   Functions of Data link layer are as follows :

   (i) Data link layer works for synchronization and error controlling of information passing over a physical link (wires, cables etc.)

   (ii) To enable error detection it adds error detection bits to the data which has to be transmitted.

   (iii) It encodes data and passes to physical layer in form of digital bits.

   (iv) The error detection bits are used to correct error on the other side

   (v) Data link layer assemble outgoing messages into frames.

3. **Layer 3 /Level 3 Network layer :**

   Functions of network layer are as follows :

   (i) This layer provides a routing system through various channels.

   (ii) This layer act like a network controller by deciding which route data should take.

4. **Layer 4 / Level 4 Transport Layer :**

   The functions of transport layer are listed below :

   (i) It decides, if data transmission should take plan on parallel or serial path.

   (ii) It does the functions of multiplexing, segmenting on the data.

   (iii) Transport layer guarantees transmission from one end to other.

   (iv) This layer breaks long data into small parts (modules) which shows its features of modularity.

5. **Layer 5/ Level 5 Session Layer :**

   Functions of session layer are given below :

   (i) Session layer is the level at which the user will establish system to system connection.

   (ii) It controls connection ON/OFF, user ID and time period of connection.

   (iii) During transmission at session layer data are marked and resynchronized properly to avoid data loss.

6. **Layer 6/ Level 6 Presentation Layer :**

Presentation layer functions in following ways :

(i) Presentation layer is like a translation medium.

(ii) "Translation medium" means it translate the information to user in such form that user system can understand and use it.

(iii) Persentation layer translates ASCII to EBCDIC and vice versa.

7. **Layer 7 /Level 7 Application layer :**

The functions of application layer are listed below :

(i) Application layer is on the top of OSI model, so this layer is responsible for manipulation and retransforming the files.

(ii) Application layer distributes the result to the user who is sitting above it.

(iii) Function of password checking entered by user to access the system is also done in application layer.

Advantages of OSI Model :

(i) OSI model clearly distinguishes services, interfaces and protocols.

(ii) Protocols in OSI model are better hidden.

(iii) This model support both connection oriented as well as connectionless services.

(iv) Protocols can be replaced easily as the technology changes in this layer.

Disadvantages of OSI Model :

(i) Session and Presentation layers are of not so much use.

(ii) Practically, problems appear while fitting protocols into OSI model because this model was deviced before the protocols were invented.

Summary of Functions of Layers in OSI Models :

S.No.	Name of Layer	Main Function in brief
1.	Application layer	It connects the applications to the network.
2.	Presentation layer	It presents data to user in standard usable format.
3.	Session layer	It manages sessions of connections among application.
4.	Transport layer	This layer provides end to end error detection and correction.
5.	Network layer	This layer is responsible of connecting network to higher layers.
6.	Data link layer	This layer provides safe communication over physical media like cables, wires etc.
7.	Physical layer	This layer defines the physical characteristics of network.

1.18.2 The TCP / IP Reference Model

The TCP/IP reference model consists of four layers :

(1) **Host - to -network layer**

(2) **Internet layer**

(3) **Transport layer**

(4) **Application layer**

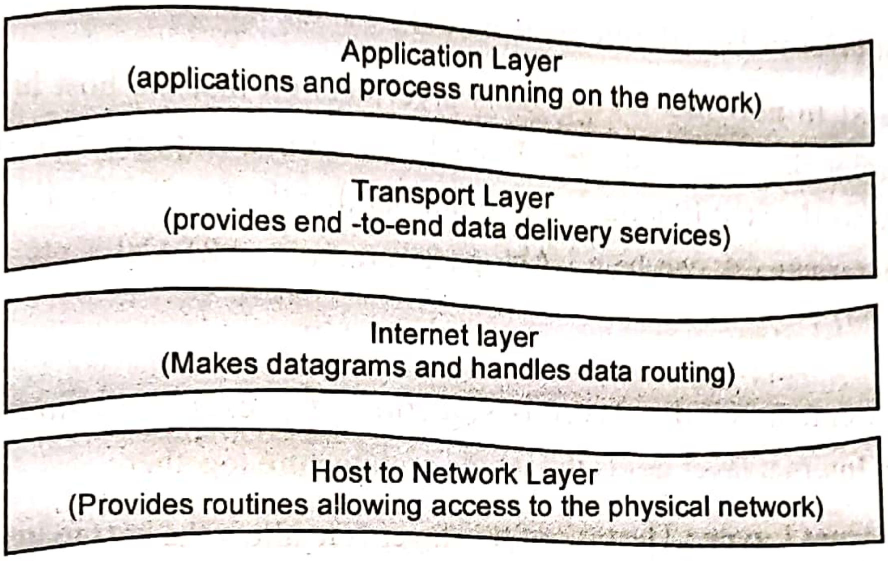


Fig. 1.71 : Layers of TCP / IP Model

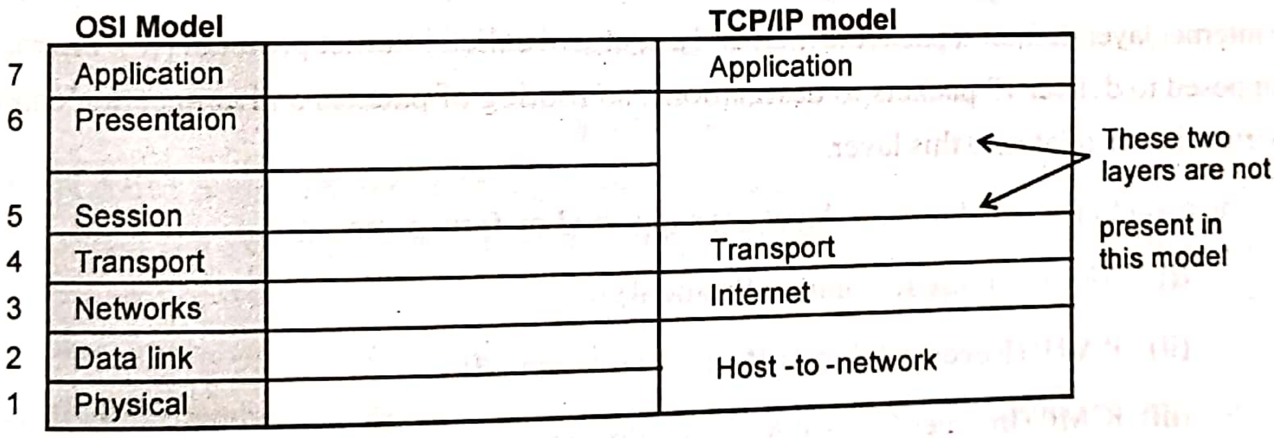


Fig. 1.72 : TCP/IP reference Model

Protocol Distribution in TCP/IP layers :

Name of layer	Protocol/Protocols
Application layer	TELNET, FTP, SMTP, DN, HTTP, MNTP
Transport	TCP, UDP
Internet (network)	IP
Host-to-network	ARPANET, SATNET, LAN, packet radio

Description of TCP/IP reference Models :

As shown in figure 1.67 TCP/IP model has only four layers :

(1) Host to Network Layer :

This is the lowest layer in TCP/IP reference model.

Main tasks of host to network layer : This layer decides that the host has to connect to network using some protocol, so that it can send IP packets over it. This protocol varies from host to host and network to network. TCP/IP model only point out that the host connection has happen. A network in a TCP/IP internetwork can be a LAN, packet radio or ARPANET etc.

(2) Internet Layer :

Destination requirements of this layer is selection of packet switching network using connectionless service. Internet layer holds the whole architecture together

Main tasks of Internet Layer : The task of this layer is to allow the host to insert packets into any network and then make them independent to travel towards any destination.

The sequence of packets received can be different from the sequence in which they were sent. The internet layer defines a packet format and a protocol called internet protocol (IP). Internet layer is supposed to deliver IP packets to destinations, so routing of packets and connection control are important issues related to this layer.

The main functions of internet layer are supported by **four** protocols :

(i) ARP (Address Resolution Protocol)

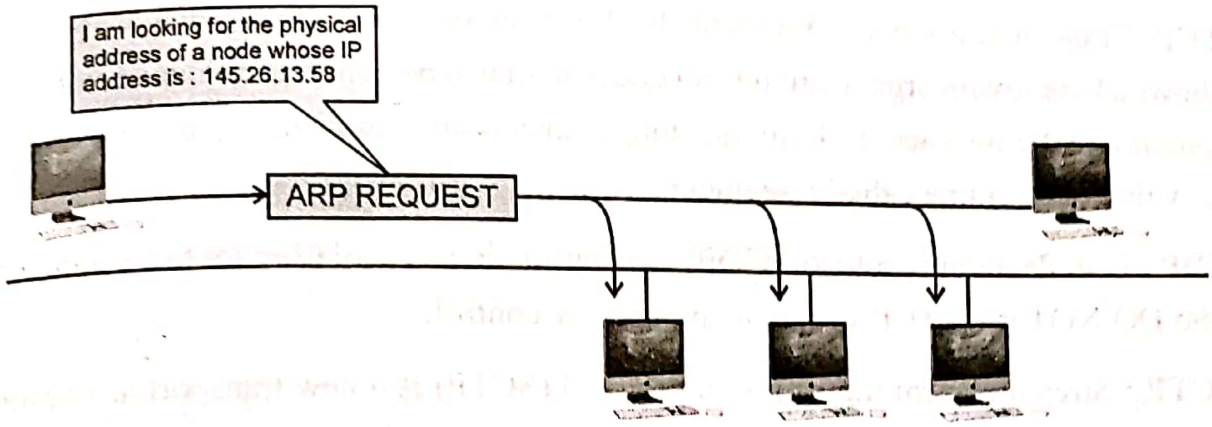
(ii) RARP (Reverse Address Resolution Protocol)

(iii) ICMP (Internet Control Message Protocol)

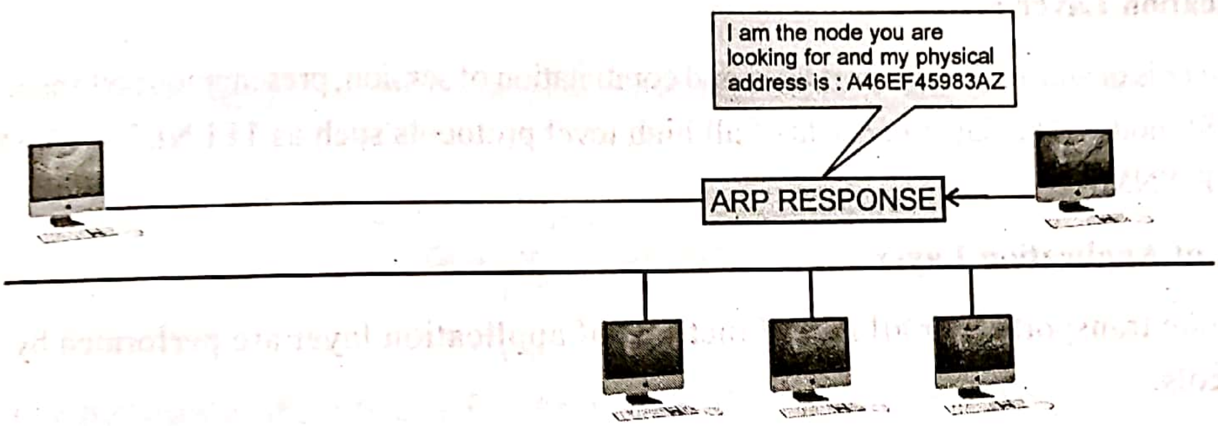
(iv) IGMP (Internet Group Message Protocol)

(i) **ARP :** The Address Resolution Protocol (ARP) allows a host to find the physical address of a target host on the same physical network, using only the target's IP address. Physical address can be changed but IP address cannot be changed. ARP is generally used to find physical address of node when its IP address is known.

(ii) **RARP :** The Reverse address resolution protocol (RARP) is just reverse of ARP. It allows a host discover its IP address when it knows only its physical address.



A. ARP request



B. ARP response

Fig. 1.73 : ARP

(iii) ICMP : Internet Control Message Protocol, allows internet protocol (IP) to inform a sender if a datagram in undeliverable. It is a well known fact that IP is an unreliable and connectionless protocol. ICMP in general is a mechanism used by hosts and routers to send notification of datagram delivery problems back to sender.

(iv) IGMP : Internet Group Message Protocol (IGMP) has been designed to help a multicast router to identify the hosts in a LAN that are members of a multicast group. Thus it is helpful for IP protocol in multicasting communication where mutlicasting is a phenomenon in which same message can be sent to a large number of receivers simultaneously.

(3) Transport Layer :

Transport layer is designed for "transportation" of application layer messages between the client and server sides of an operation.

Main task of transport layer : All main functions of transport layers are carried by some protcols such as TCP, UDP, SCTP. Its function are some as those of a transport layer in OSI model.

(i) **TCP :** Transmission Control Protocol (TCP) is a reliable connection oriented protocol that allows a byte stream organization from one machine to be delivered without error on other machine in the internet. TCP divides long transmissions into small parts (modules) and pack them into frame called a segment.

(ii) **UDP :** User datagram protocol (UDP) is a unreliable protocol used for those applications who DO NOT want TCP's sequencing or flow control.

(iii) **SCTP :** Stream control transmission protocol (SCTP) is a new transport layer protocol devised for new applications support. SCTP combines good features of UDP and TCP.

(4) Application Layer :

This layer is on the top of transport layer and combination of session, presentation and application layers in OSI model. This layer consists of all high level protocols such as TELNET, FTP, SMTP, DNS, HTTP, SNMP.

Main Task of Application Layer :

Same like transport layer all main functions of application layer are performed by high level protocols.

(i) **TELNET :** TErminal NETwork is a client server application program. By using TELNET user can log ON to a remote computer.

(ii) **FTP :** File Transfer Protocol (FTP) is a standard mechanism provided by TCP/IP for copying a file from one host to another.

(iii) **SMTP :** TCP/IP protocol that supports electronic mail (e-mail) on the internet is called **Simple Mail Transfer Protocol** (SMTP). Using SMTP we can send a message to one or more recipients. Message to be sent can be text, voice, video or graphic.

(iv) **DNS :** Due to human tendency of preferring names over address, through domain name system (DNS) we can map address to a name and conversely name to address.

(v) **SNMP :** The Simple Network Management Protocols (SNMP) is a frame work for managing, monitoring and maintaining operations of devices working in an internet.

(vi) **HTTP :** The Hyper Text Transfer Protocol (HTTP) is a protocol use mainly to access data on world wide web (www). This protocol can transfer data in form of plain text, hyper text, audio, video etc. through out the world. HTTP also uses the concept of uniform resources locators (URL).