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@ Define physical and logical address.

Answer:

Physical Address —

The physical address, also known as the link address, is the address of a node as defined by its LAN or WAN. It is included in the frame used by the data link layer. It is the lowest-level address. The physical addresses have authority over the network (LAN or WAN). The size and format of these addresses vary depending on the network. For example, Ethernet uses a 6-byte (48-bit) physical address that is imprinted on the network interface card (NIC). LocalTalk (Apple), however, has a 1-byte dynamic address that changes each time the station comes up.

Logical Address —

Logical Addresses are necessary for universal communications that are independent of underlying

physical networks. Physical Addresses are not adequate in an internetwork environment where different networks can have different address formats. A universal addressing system is needed in which each host can be identified uniquely, regardless of the underlying physical network. The logical addresses are designed for this purpose. A logical address in the Internet is currently a 32-bit address that can uniquely define a host connected to the Internet. No two publicly addressed and visible hosts on the Internet can have the same IP address.

(b) Define Physical layer. When data is sent over physical medium which signals it is converted into?

Answer: Physical layer in the OSI model plays the role of interacting with actual hardware and signalling mechanism. Physical layer is the only

layer of OSI network model which actually deals with the physical connectivity of two different stations. This layer defines the hardware equipment, cabling, wiring, frequencies, pluses used to represent binary signals etc. Physical layer provides it services to Data-link layer. Data-link layer hands over frames to physical layer. Physical layer converts them to electrical pulses, which represent binary data. The binary data is then sent over the wired or wireless media.

When data is sent over physical medium, it needs to be first converted into electromagnetic signals. Data itself can be analog such as human voice, or digital such as file on the disk. Both analog and digital data can be represented in digital or analog signals.

• Digital Signals : Digital Signals are discrete in nature and represent sequence of voltage pulses. Digital signals are used within the circuitry of a computer system.

• Analog Signals: Analog signals are in continuous wave form in nature and represented by continuous electromagnetic waves.

Q What are the possible reasons for data to deteriorate? Explain.

Answer: When signals travel through the medium they tend to deteriorate. This may have many reasons as given:

1) Attenuation: For the receiver to interpret the data accurately, the signal must be sufficiently strong. When the signal passes through the medium, it tends to get weaker. As it covers distance, it loses strength.

2) Dispersion: As signal travels through the media, it tends to spread and overlaps. The amount of dispersion depends upon the frequency used.

3) Delay distortion: Signals are sent over media with pre-defined speed and frequency. If the signal speed and frequency do not match, there are possibilities that signal reaches destination in arbitrary fashion. In digital media, this is very critical that some bits reach earlier than the previously sent ones.

4) Noise: Random disturbance or fluctuation in analog or digital signal is said to be Noise in signal, which may disort the actual information being carried. Noise can be characterized in one of the following class:

i) Thermal: Noise Heat agitates the electronic conductors of a medium which may introduce noise in the media. Up to a certain level, thermal noise is unavoidable.

ii) Intermodulation: When multiple frequencies share a medium, their interference can cause noise in the medium. Intermodulation noise occurs if

two different frequencies are sharing a medium and one of them has excessive strength or the component itself is not functioning properly, then the resultant frequency may not be delivered as expected.

iii) Crosstalk: This sort of noise happens when a foreign signal enters into the media. This is because signal in one medium affects the signal of second medium.

iv) Impulse: This noise is introduced because of irregular disturbances such as lightening, electricity short-circuit or faulty components. Digital data is mostly affected by this sort of noise.

(d) Define transmission media and its two forms.

Answer: The media over which the information between two computer systems is sent, called transmission media. Transmission media comes in two forms:

1) Guided Media: All communication wires/cables are guided media, such as UTP, coaxial cables, and fiber Optics. In this media, the sender and receiver are directly connected and the information is send (guided) through it.

2) Unguided Media: Wireless or open air space is said to be unguided media, because there is no connectivity between the sender and receiver. Information is spread over the air, and anyone including the actual recipient may collect the information.

[2]

(a) Define channel capacity. Which factors it depends on?

Answer: The speed of transmission of information is said to be the channel capacity. We count it as data rate in digital world. It depends on numerous factors such as:

1) Bandwidth: The physical limitation of underlying media.

2) Error-rate: Incorrect reception of information because of noise.

3) Encoding: The number of levels used for signaling.

(b) Explain multiplexing and switching.

Answer:

Multiplexing:-

Multiplexing is a technique to mix and send multiple data streams over a single medium.

This technique requires system hardware called multiplexer (MUX) for multiplexing the streams and sending them on a medium, and a de-multiplexer (DMUX) which takes information from the medium and distributes to different destinations. Multiplexing techniques are mainly used in communication, and these are classified into three types. The 3 types of multiplexing techniques include the following.

- Frequency Division Multiplexing (FDM)
- Wavelength Division Multiplexing (WDM)
- Time Division Multiplexing (TDM)

Switching

Switching is a mechanism by which data/information sent from source towards destination which are not directly connected. Networks have interconnecting devices, which receives data from directly connected sources, stores data, analyze it and then forwards to the

next interconnecting device closest to the destination. Switching can be categorized as:

1. Circuit Switching
2. Message Switching
3. Packet Switching

@ Explain different types of cables used in transmission. 6

Answer: Cables that are used in transmission of data is given below:

Twisted Pair Cable:

A twisted pair cable is made of two plastic insulted copper wires twisted together to form a single media. Out of these two wires, only one carries actual signal and another is used for ground reference. The twists between wires are helpful in reducing noise (electro magnetic interference) and crosstalk. There are two types of twisted pair cables:

• Shielded Twisted Pair (STP) Cable : STP cables comes with twisted wire pair covered in metal foil. This makes it more indifferent to noise and crosstalk.

• Unshielded Twisted Pair (UTP) Cable: UTP has seven categories, each suitable for specific use. In computer networks, Cat-5, Cat5e, and Cat-6 cables are mostly used. UTP cables are connected by RJ45 connectors.

Coaxial Cable:

Coaxial Cable has two wires of copper. The core wire lies in the center and it is made of solid conductor. The core is enclosed in an insulating sheath. The second wire is wrapped around over the sheath and that too in turn encased by insulator sheath. This all is covered by plastic cover. Because of its structure, the coax cable is capable of carrying high frequency signals than that of twisted pair cable. The wrapped structure provides it a good shield against noise and cross-

talk. Coaxial cables provide high bandwidth rates of up to 450 mbps. There are three categories of coax cables namely, RG-59 (Cable TV), RG-58 (Thin Ethernet), and RG-11 (Thick Ethernet). RG stands for Radio Government. Cables are connected using BNC connector and BNC-T. BNC terminator is used to terminate the wire at the far ends.

Power Lines:

Power Line communication (PLC) is Layer-1 (Physical Layer) technology which uses power cables to transmit data signals. In PLC, modulated data is sent over the cables. The receiver on the other end demodulates and interprets the data. Because power lines are widely deployed, PLC can make all powered devices controlled and monitored. PLC works in half-duplex. There are two types of PLC:

• Narrow band PLC: Narrow band PLC provides lower data rates up to 100s of kbps, as they work at lower frequencies (3-5000 kHz). They can be spread over several kilometers.

• Broad band PLC: Broad band PLC provides higher data rates up to 100s of Mbps and works at higher frequencies (1.8-250 MHz). They cannot be as much extended as Narrowband PLC.

Fiber Optics:

Fiber Optics works on the properties of light. When light ray hits at critical angle it tends to refracts at 90 degree. This property has been used in fiber optic. The core of fiber optic cable is made of high quality glass or plastic. From one end of it light is emitted, it travels through it and at the other end light detector detects light stream and converts it to electric data. Fiber Optic provides the highest mode of speed. It comes in two modes, one is single mode fiber and second is multimode

fiber. Single mode fiber can carry a single ray of light whereas multimode is capable of carrying multiple beams of light.

3

@ How many ways to convert digital data into digital signals? What is Line coding and block coding?

Answer: There are two ways to convert digital data into digital signals. They are:

1. Line coding
2. Block coding

Line coding: A line code is the code used for data transmission of a digital signal over a transmission line. This process of coding is chosen so as to avoid overlap and distortion of signal such as inter-symbol interference.

Properties of Line Coding

Following are the properties of line coding-

- As the coding is done to make more

single
bits transmit on a signal, the bandwidth used is much reduced.

- For a given bandwidth, the power is efficiently used.
- The probability of error is much reduced.
- Error detection is done and the bipolar too has a correction capability.
- Power density is much favorable.
- The timing content is adequate.
- Long strings of 1s and 0s is avoided to maintain transparency.

Block coding: It helps in error detection and re-transmission of the signal. It is normally referred to as mB/nB coding as it replaces each m-bit data group with an n-bit data group (where $n > m$). Thus, it adds extra bits (redundancy bits) which helps in synchronization at receiver's and sender's end and also providing some kind of error detecting capability.

It normally involves three steps: division, substitution and combination. In the division step, a sequence of bits is divided into groups of n-bits. In the substitution, ~~and combination~~ step, we substitute an n-bit group for an n-bit group. Finally, the n-bit groups are combined together to form a stream which has more bits than the original bits.

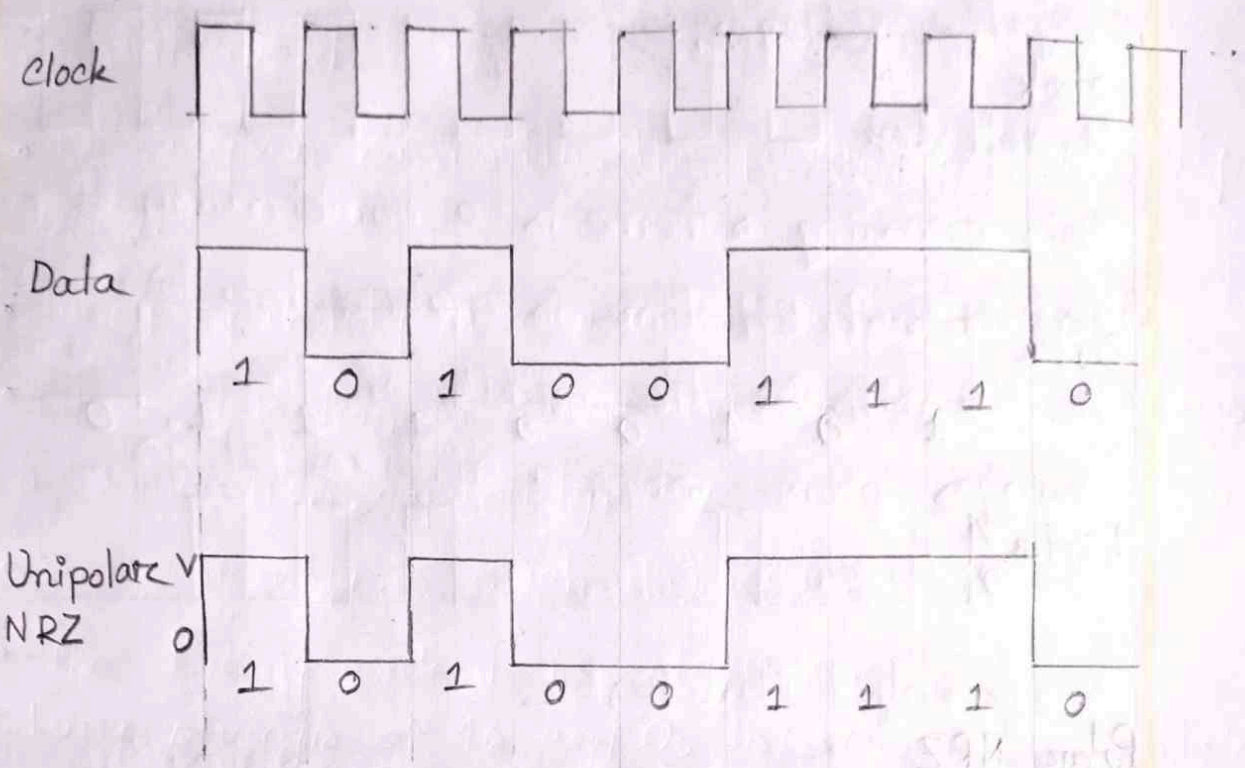
(b) Classify line coding with example.

Answer: There are 3 types of Line Coding

- Unipolar
- Polar
- Bi- Polar

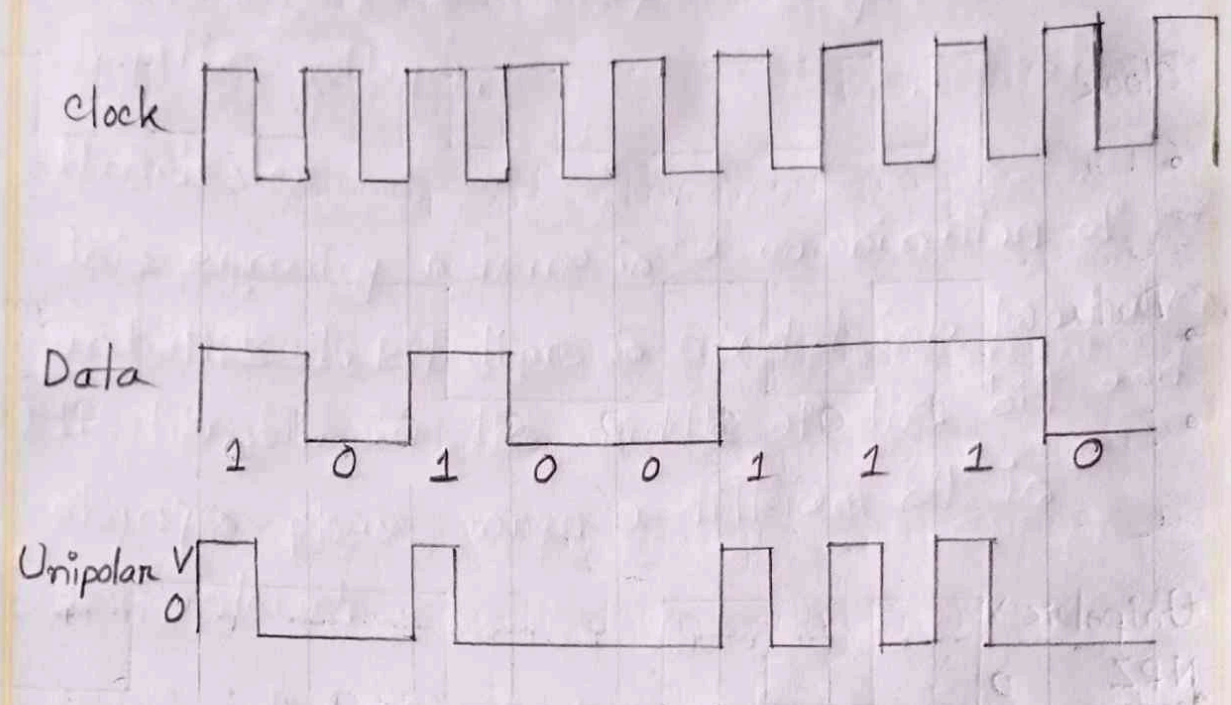
Unipolar Non-Return to Zero NRZ

In this type of unipolar signaling, a high in data is represented by a positive pulse called as Mark, which has a duration To equal to the symbol bit duration. A Low in data input has no pulse.



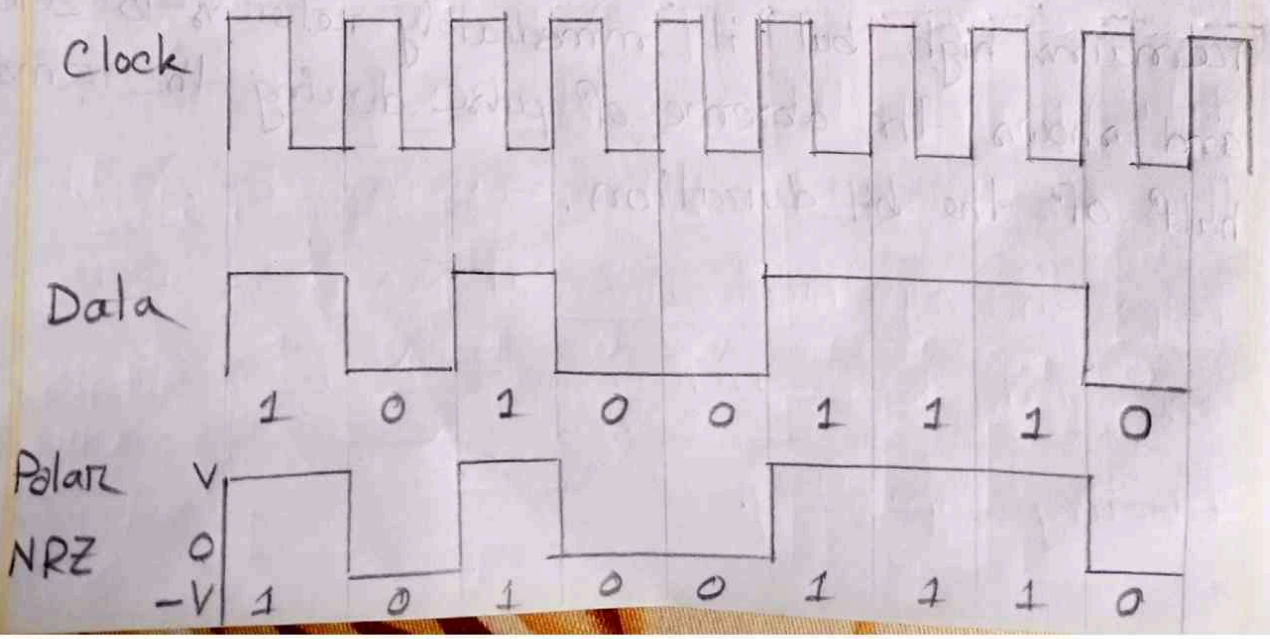
Unipolar Return to Zero RZ

In this type of unipolar signaling, a High in data, though represented by a Mark pulse, its duration is less than the symbol bit duration. Half of the bit duration remains high but it immediately returns to zero and shows the absence of pulse during the remaining half of the bit duration.



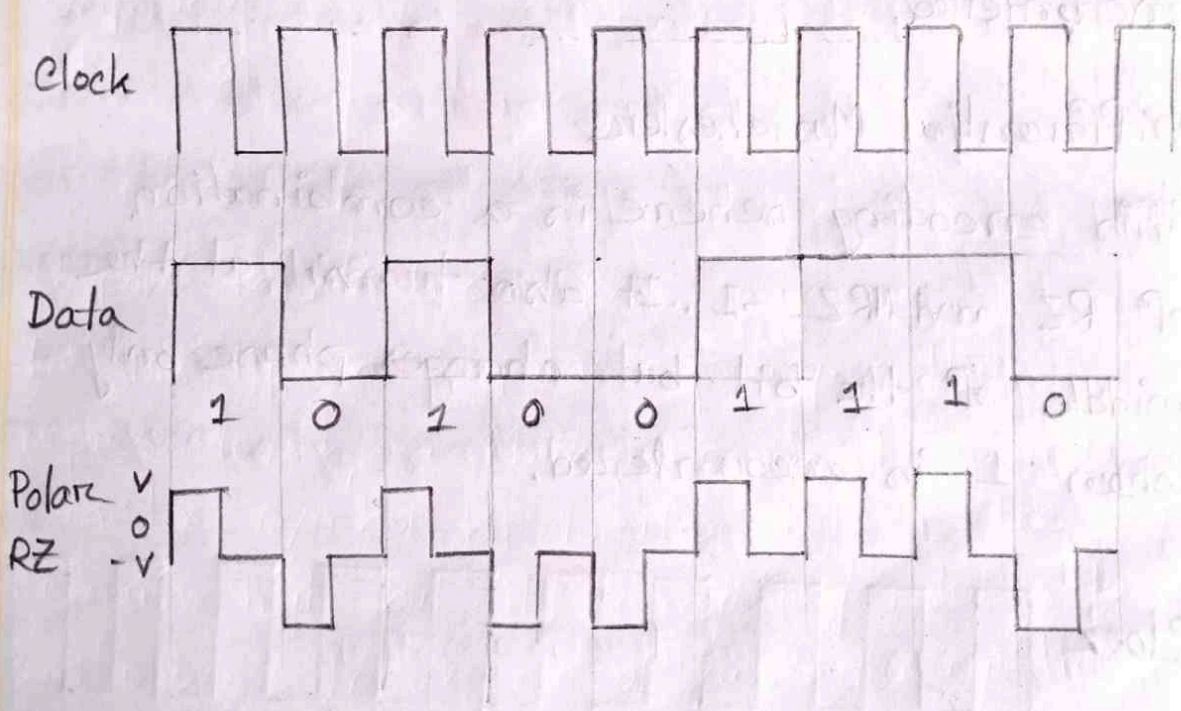
Polar NRZ

In this type of Polar signaling, a High in data is represented by a positive pulse, while a Low in data is represented by a negative pulse.



Polar RZ

In this type of Polar signaling, a high in data, though represented by a mark pulse, its duration T_0 is less than the symbol bit duration. Half of the bit duration remains high but it immediately returns to zero and shows the absence of pulse during the remaining half of the bit duration.



Bipolar Encoding

Bipolar encoding uses three voltage levels, positive, negative and zero. Zero voltage represents binary 0 and

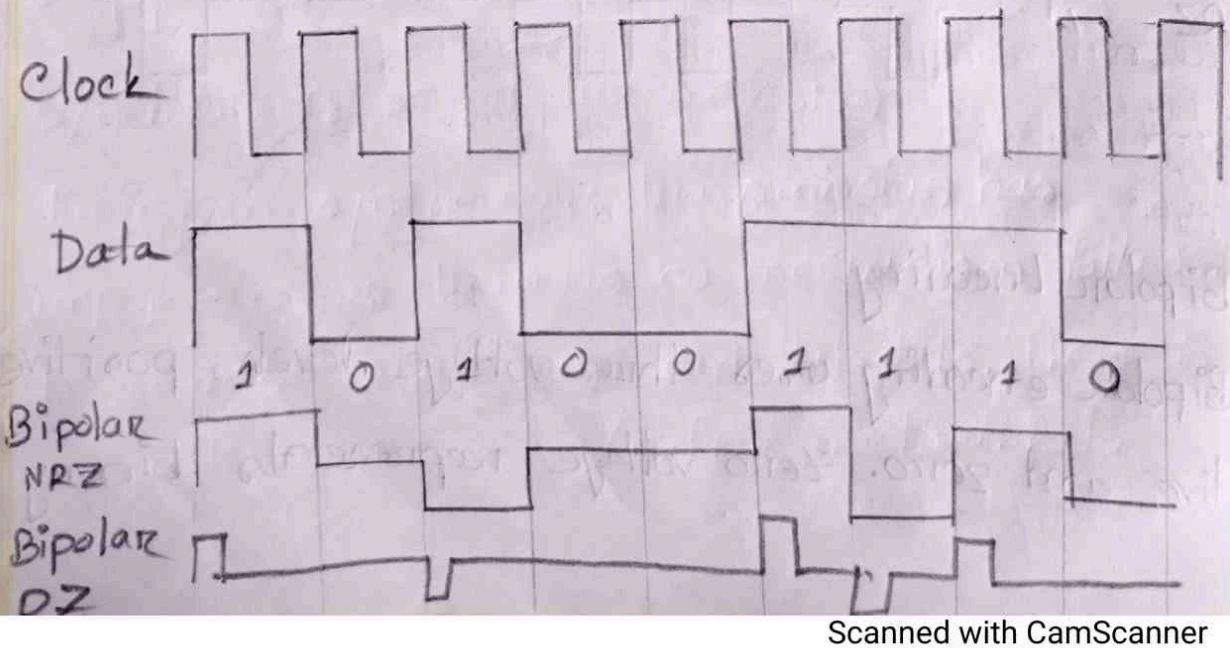
bit 1 is represented by altering positive and negative voltages.

Manchester

This encoding scheme is a combination of RZ and NRZ-L. Bit time is divided into two halves. It transits in the middle of the bit and changes phase when a different bit is encountered.

Differential Manchester

This encoding scheme is a combination of RZ and NRZ-I. It also transit at the middle of the bit but changes phase only when 1 is encountered.



4

@ Explain different transmission modes.

Answer: Transmission Modes

The transmission mode decides how data is transmitted between two computers. The binary data in the form of 1s and 0s can be sent in two different modes:

1. **Parallel:** The binary bits are organized in-to groups of fixed length. Both sender and receiver are connected in parallel with the equal number of data lines. Both computers distinguish between high order and low order data lines. The sender sends all the bits at once on all lines. Because the data lines are equal to the number of bits in a group or data frame, a complete group of bits (data frame) is sent in one go. Advantage of parallel transmission is high speed and disadvantage is the cost of wires, as it is equal to the number of bits sent in parallel.

2. Serial: In serial transmission, bits are sent one after another in a queue manner. Serial transmission requires only one communication channel.
Serial transmission can be either asynchronous or synchronous.

Asynchronous Serial Transmission

It is named so because there is no importance of timing. Data-bits have specific pattern and they help receiver recognize the start and end data bits. For example, a 0 is prefixed on every data byte and one or more 1s are added at the end. Two continuous data-frames (bytes) may have a gap between them.

Synchronous Serial Transmission

Timing in synchronous transmission has importance as there is no mechanism followed to recognize start and end data bits. There is no pattern or prefix/suffix method. Data

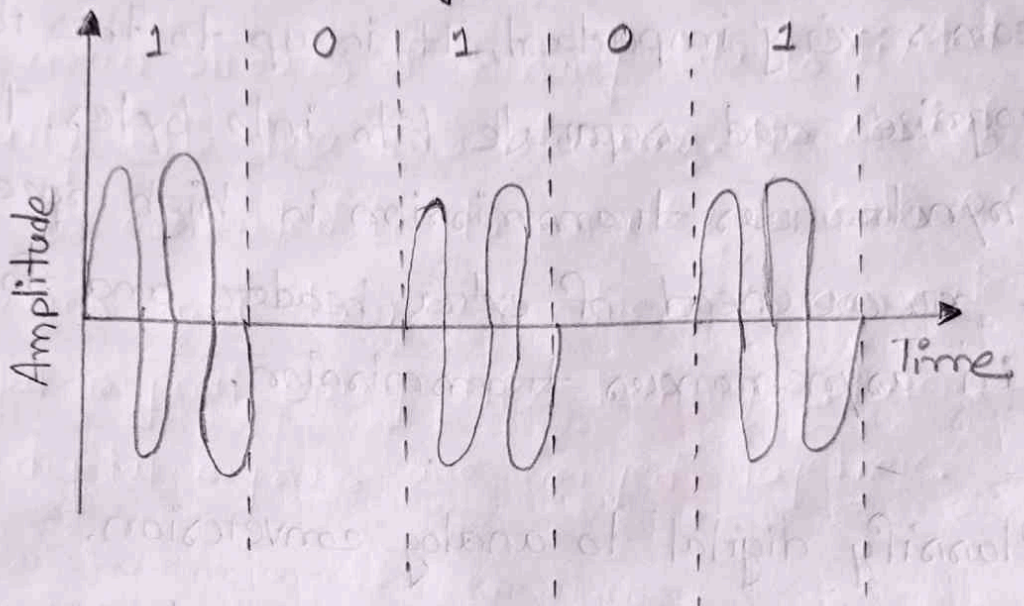
bits are sent in burst mode without maintaining gap between bytes (8-bits). Single burst of data bits may contain a number of bytes. Therefore, timing becomes very important. It is up to the receiver to recognize and separate bits into bytes. The advantage of synchronous transmission is high speed, and it has no overhead of extra header and footer bits as in asynchronous transmission.

(b) Classify digital to analog conversion.

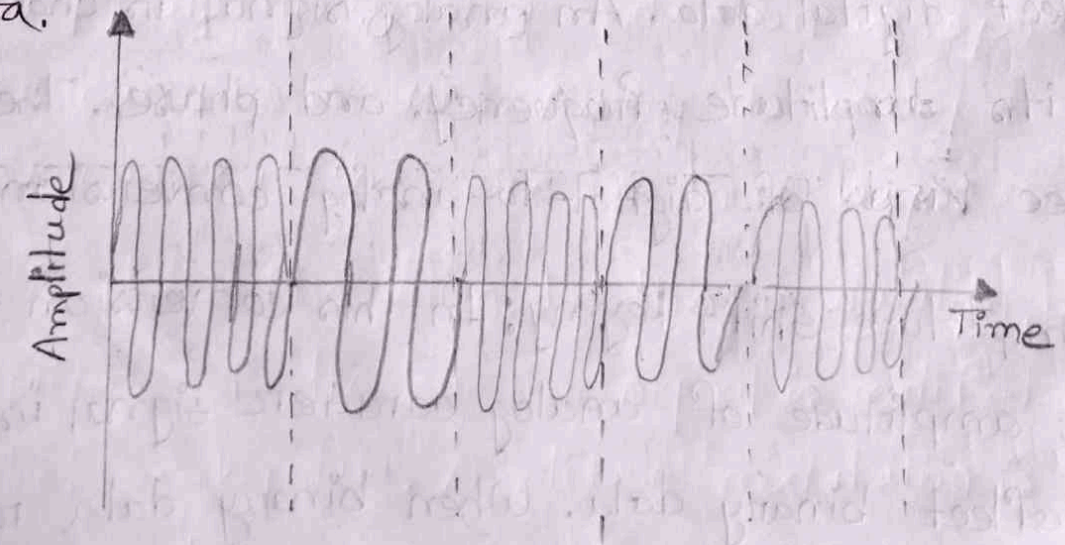
Answer: When data from one computer is sent to another via some analog carrier, it is first converted into analog signals. Analog signals are modified to reflect digital data. An analog signal is characterized by its amplitude, frequency, and phase. There are three kinds of digital-to-analog conversions:

Amplitude Shift keying: In this conversion technique, the amplitude of analog carrier signal is modified to reflect binary data. When binary data represents

digit 1, the amplitude is held; otherwise it is set to 0. Both frequency and phase remain same as in the original carrier signal.

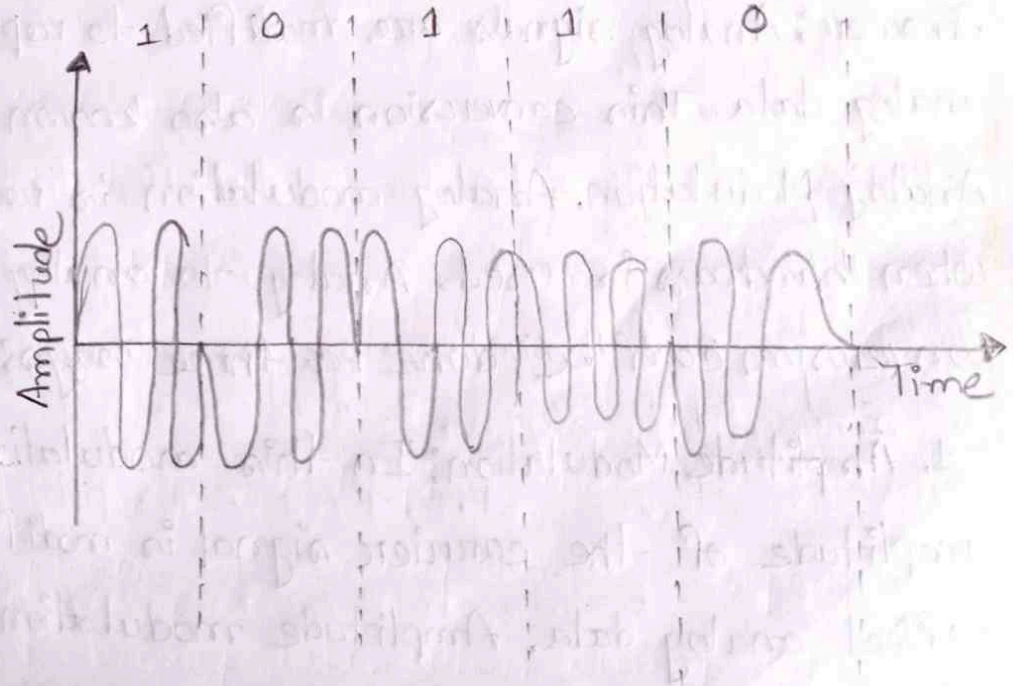


Frequency Shift keying: In this conversion technique, the frequency of the analog carrier signal is modified to reflect binary data.



This technique uses two frequencies, f1 and f2. One of them, for example f1, is chosen to represent binary digit 1 and the other one is used to represent binary digit 0. Both amplitude and phase of the carrier wave are kept intact.

Phase shift keying: In this conversation scheme, the phase of the original carrier signal is altered to reflect the binary data. When a new binary symbol is encountered, the phase of the signal is altered. Amplitude and frequency of the original carrier is kept intact.



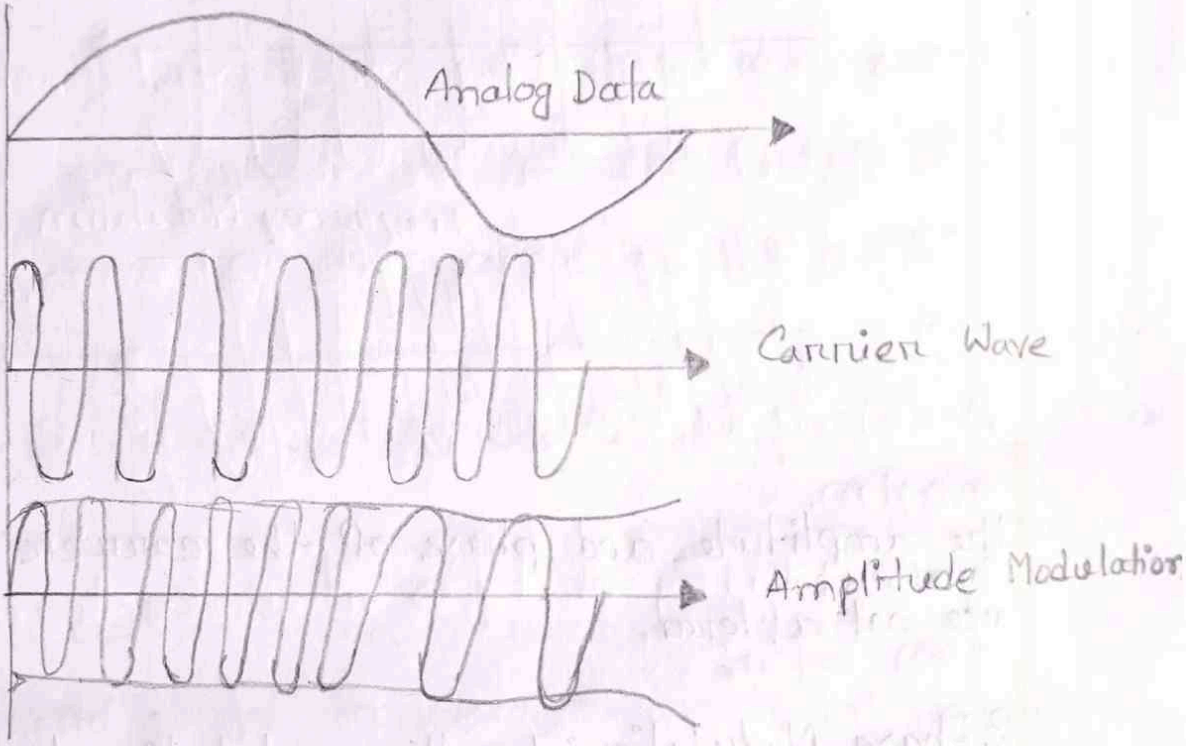
Quadrature Phase Shift keying: QPSK alters the phase to reflect two binary digits at once. This is done in two different phases. The main stream of binary data is divided equally into two sub-streams. The serial data is converted in to parallel in both sub-streams and then each stream is converted to digital signal using NRZ technique. Later, both the digital signals are merged together.

Q Classify analog to analog conversion.

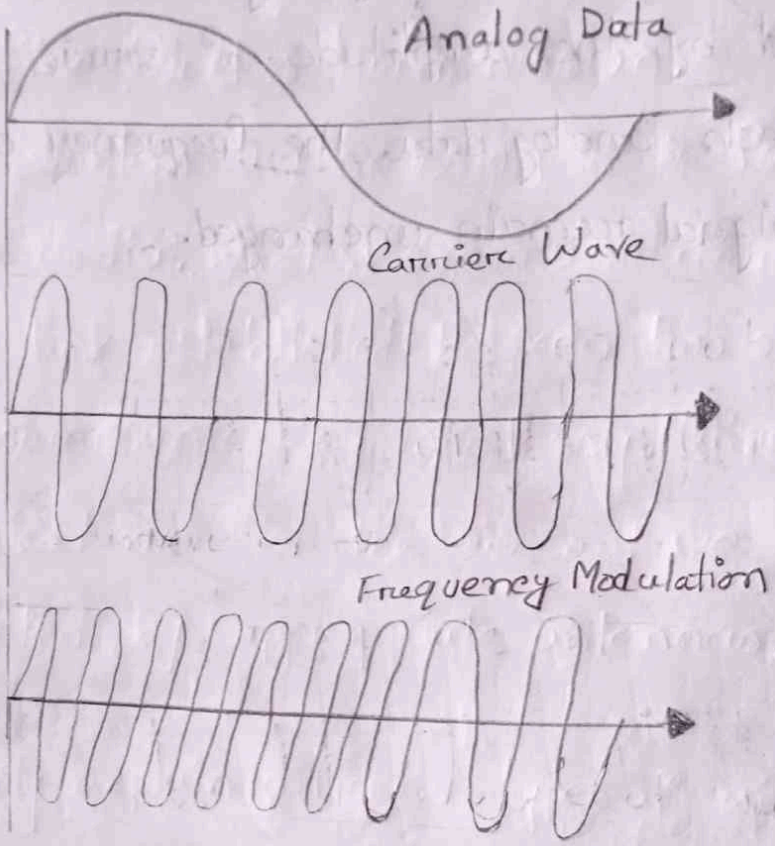
Answer: Analog signals are modified to represent analog data. This conversion is also known as Analog Modulation. Analog modulation is required when bandpass is used. Analog to analog conversion can be done in three ways:

1. Amplitude Modulation: In this modulation, the amplitude of the carrier signal is modified to reflect analog data. Amplitude modulation is implemented by means of a multiplier, the

amplitude of modulating signal (analog data) is multiplied by the amplitude of carrier frequency, which then reflects analog data. The frequency and phase of carrier signal remain unchanged.

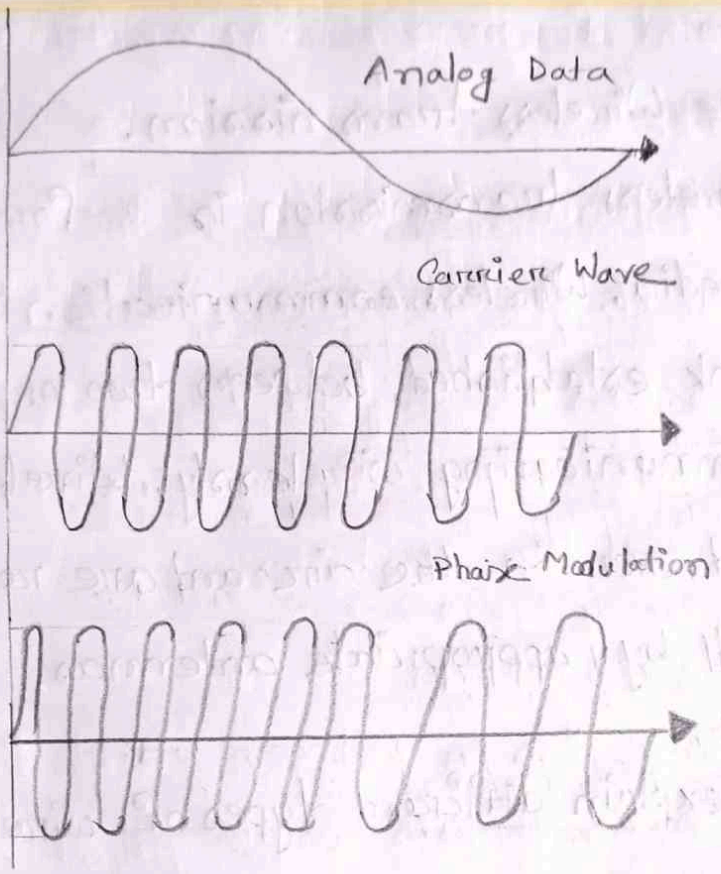


2. Frequency Modulation: In this modulation technique, the frequency of the carrier signal is modified to reflect the change in the voltage levels of the modulating signal (analog data).



The amplitude and phase of the carrier signal are not altered.

2. Phase Modulation: In the modulation technique, the phase of carrier signal is modulated in order to reflect the change in voltage (amplitude) of analog data signal.



Phase modulation is practically similar to Frequency Modulation, but in Phase modulation frequency of the carrier signal is not increased. Frequency of carrier is signal is changed (made dense and sparse) to reflect voltage change in the amplitude of modulating signal.

5

@ Define Wireless transmission.

Answer: Wireless transmission is a form of unguided media. Wireless communication involves no physical link established between two or more devices, communicating wirelessly. Wireless signals are spread over in the air and are received and interpreted by appropriate antennas.

(b) Briefly explain different types of wireless transmission.

Answer: Different types of wireless transmission is given below:

Radio Transmission

Radio frequency is easier to generate and because of its large wavelength it can penetrate through walls and structures alike. Radio waves can have wavelength from 1 mm - 100,000 km and have frequency ranging from 3 Hz (Extremely Low Frequency) to

300 GHz (Extremely High Frequency). Radio frequencies are sub-divided into six bands.

Radio waves at lower frequencies can travel through walls whereas higher RF can travel in straight line and bounce back. The power of low frequency waves decreases sharply as they cover long distance. High frequency radio waves have more power.

Lower frequencies such as VLF, LF, MF bands can travel on the ground up to 1000 kilometers, over the earth's surface.

Microwave Transmission

Electromagnetic waves above 100MHz tend to travel in a straight line and signals over them can be sent by beaming those waves towards one particular station. Because Microwaves travels in straight lines, both send and receiver must be aligned to be strictly in line-of-sight.

Microwaves can have wavelength ranging from 1mm

1 meter and frequency ranging from 300 MHz to 300 GHz.

Microwave antennas concentrate the waves making a beam of it. As shown in picture above, multiple antennas can be aligned to reach farther. Microwaves have higher frequencies and do not penetrate wall like obstacles.

Infrared Transmission

Infrared wave lies in between visible light spectrum and microwaves. It has wavelength of 700-nm to 1-mm and frequency ranges from 300-GHz to 430-THz.

Infrared wave is used for every short range communication purpose such as television and it's remote. Infrared travels in a straight line hence it is directional by nature.

Because of high frequency range, Infrared cannot cross wall-like obstacles.

Light Transmission

Highest most electromagnetic spectrum which can be used for data transmission is light or optical signaling. This is acheived by means of LASER.

Because of frequency light uses, it tends to travel strictly in straight line. Hence the sender and receiver must be in the line-of-sight. Because laser transmission in undirectional, at both ends of communication the laser and the photo-director needs to be installed. Laser beam is generally 1mm wide hence it is a work of precision to align two far receptors each ~~pointing~~ pointing to leaser source.

Q What is Multiplexing? Classify different types of multiplexing.

Answer: Multiplexing is a technique by which different analog and digital streams of transmission can be simultaneously processed over a shared link. Multiplexing divides the high capacity medium into low capacity

logical medium wit which is then shared by different streams.

Frequency Division Multiplexing

In analog multiplexing, the most used technique is Frequency Division Multiplexing (FDM). This technique uses various frequencies to combine streams of data, for sending them on a communication medium as a single signal.

Example - A traditional television transmitter, which sends a number of channels though a single cable uses FDM.

Wavelength Division Multiplexing

Wavelength Division Multiplexing (WDM) is an analog technique, in which many data streams of different wavelengths are transmitted in the light spectrum. If the wavelength increases, the frequency of the signal decreases. A prism which can turn different wavelengths into a single line, can be

used at the output of MUX and input of DEMUX.
Example - Optical Fiber Communications use the WDM technique, to merge different wavelengths into a single light for the communication.

Time Division Multiplexing

TDM is applied primarily on digital signals but can be applied on analog signals as well. In TDM the shared channel is divided among its users by means of time slot. Each user can transmit data within the provided time slot only. Digital signals are divided in frames, equivalent to time slot. i.e frame of an optimal size which can be transmitted in given time slot.

TDM works in synchronized mode. Both ends, i.e. Multiplexer and De-Multiplexer are timely synchronized and both switch to next channel simultaneously.

Code Division Multiplexing

Multiple data signals can be transmitted over a single frequency by using Code Division Multiplexing. FDM divides the frequency in smaller channels but CDM allows its users to full bandwidth and transmit signals all the time using a unique code. CDM uses orthogonal codes to spread signals.

Each station is assigned with a unique code, called chip. Signals travel with these codes independently, inside the whole bandwidth. The receiver knows in advance the chip code signal it has to receive.

6

@ What is switching?

Answer: Switching is process to forward packets coming in from one port to a port leading towards the destination. When data comes on a port it is called ingress, and when data leaves a

port or goes out it is called egress. A communication system may include number of switches and nodes. At broad level, switching can be divided into two major categories:

- Connectionless: The data is forwarded on behalf of forwarding tables. No previous handshaking is required and acknowledgements are optional.
- Connection Oriented: Before switching data to be forwarded to destination, there is a need to pre-establish circuit analog the path between both endpoints.

(b) Briefly explain different types of switching.

Answer: Different types of switching :-

Circuit switching

When two nodes communicate with each other over a dedicated communication path, it is called circuit switching. In circuit switching, to transfer the data circuit must be established so that the data transfer

can take place.

Circuits can be permanent or temporary. Applications which use circuit switching may have to go through phases:

- Establish a circuit
- Transfer the data
- Disconnect the circuit

Circuit switching was designed for voice applications. Telephone is the best suitable example of circuit switching. Before a user can make a call, a virtual path between caller and callee is established over the network.

Message Switching

In message switching, the whole message in treated as a data unit and is switching / transferred in its entirety.

This technique was considered substitute to circuit switching. As in circuit switching the whole path is blocked for two entities only. Message switching is replaced by packet

switching. Message switching has the following drawbacks:

- Every switch in transit path needs enough storage to accommodate entire message.
- Because of store-and-forward technique and waits included until resources are available, message switching is very slow.

Packet Switching

Shortcomings of message switching gave birth to an idea of packet switching. The entire message is broken down into smaller chunks called packets. The switching information is added in the header of each packet and transmitted independently.

It is easier for intermedia networking devices to store small size packets and they do not take much resources either on carrier path or in the internal memory of switches.

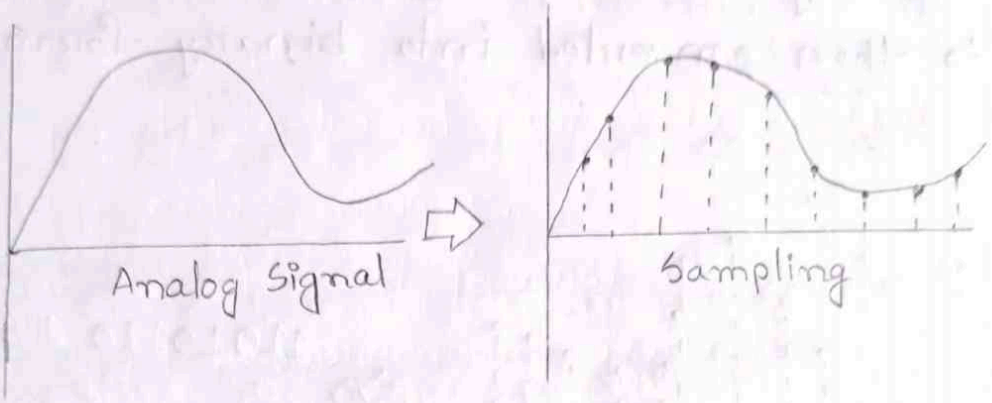
@ How to convert analog signals into digital signals? Explain with example.

Answer: Analog-to-digital Conversion Microphones

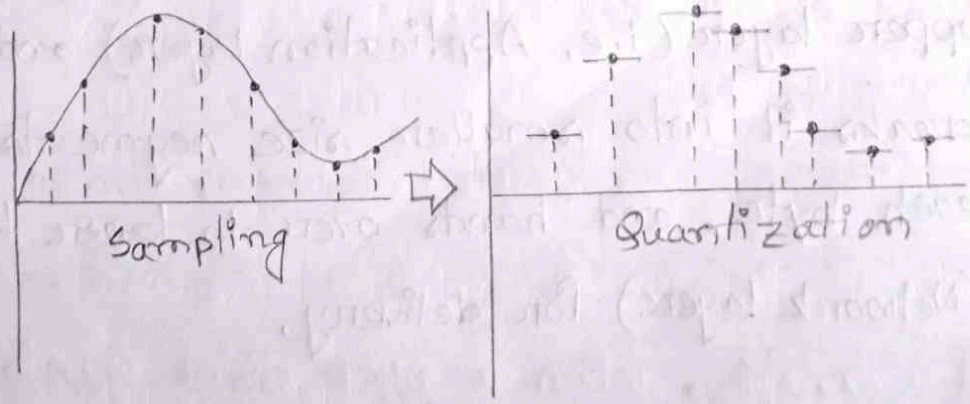
create analog voice and camera creates analog videos which are treated is analog data. To transmit this analog data over digital signals, we need analog to digital conversion. Analog data is a continuous stream of data in the wave form whereas digital data is discrete. To convert analog wave into digital data, we use Pulse Code Modulation (PCM). PCM is one of the most commonly used method to convert analog data into digital form. It involves three steps:

- Sampling
- Quantization
- Encoding.

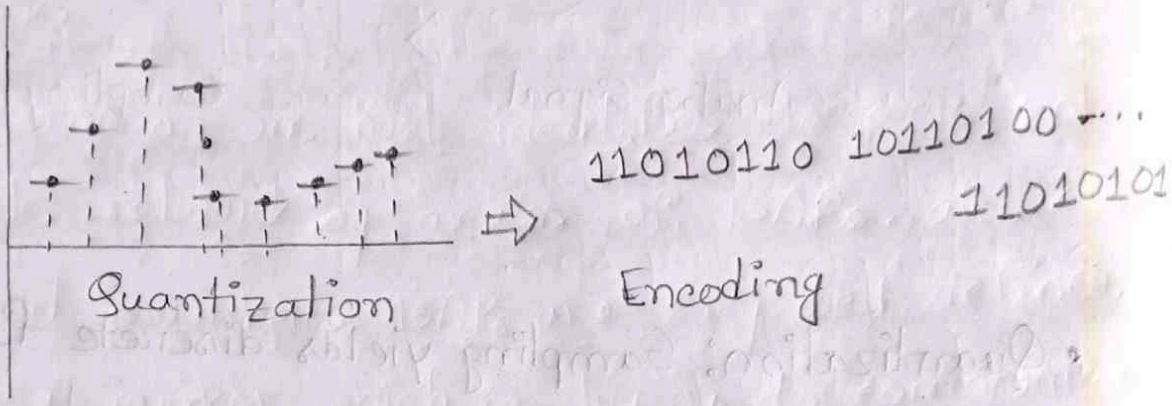
• Sampling: The analog signal is sampled every T interval. Most important factor in sampling is the rate at which analog signal is sampled. According to Nyquist Theorem, the sampling rate must be at least two times of the highest frequency of the signal.



• Quantization: Sampling yields discrete form of continuous analog signal. Every discrete pattern shows the amplitude of the analog signal at that instance. The quantization is done between the maximum amplitude value and the minimum amplitude value. Quantization is approximation of the instantaneous analog value.



• **Encoding:** In encoding, each approximated value is then converted into binary format.



(17) 6

@ Define transport layer.

Answer: Transport layer offers peer-to-peer and end-to-end connection between two processes on remote hosts. Transport layer takes data from upper layer (i.e. Application Layer) and then breaks it into smaller size segments, numbers each byte, and hands over to lower layer (Network layer) for delivery.

(b) Write down the functions of transport layer.

Answer: The functions of transport layer is given below:

- The layer is the first one which breaks the information data, supplied by Application layer in to smaller units called segments. It numbers every byte in the segment and maintains their accounting.

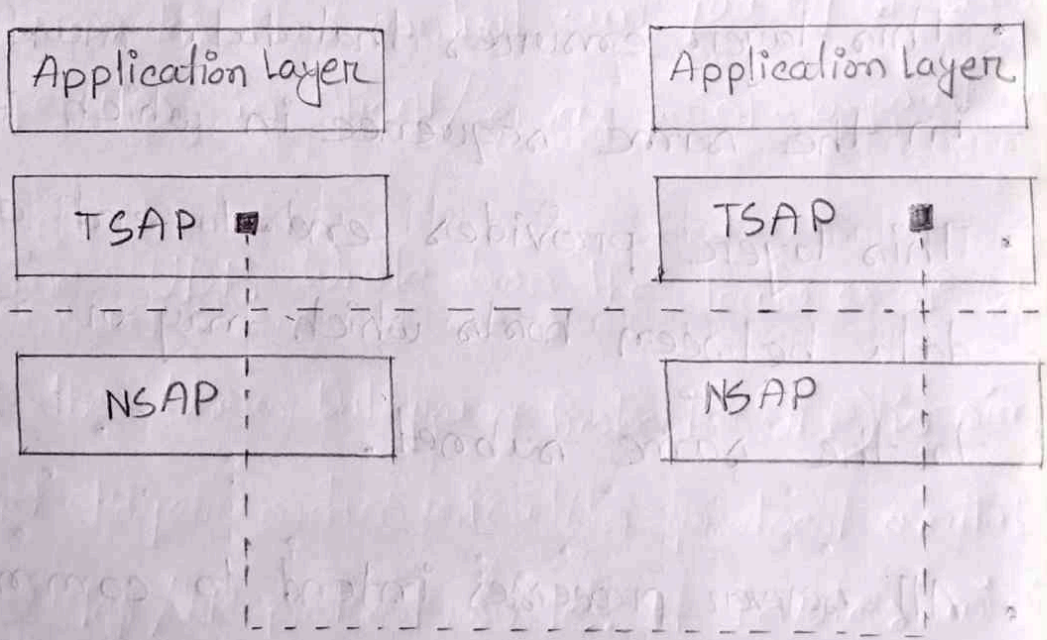
- This layer ensures that data must be received in the same sequence in which it was sent.
- This layer provides end-to-end delivery of data between hosts which may or may not belong to the same subnet.

- All server processes intend to communicate over the network are equipped with well-known Transport Service Access Points (TSAPs) also known as port numbers.

Q Explain End-to-End Communication in transport layer.

Answer:

A process on one host identifies its peer host on remote network by means of TSAPs, also known as Port numbers. TSAPs are very well defined and a process which is trying to communicate with its peer knows this in advance.



For example, when a DHCP client wants to communicate with remote DHCP server, it always

requests on port number 67. When a DNS client wants to communicate with remote DNS server, it always requests on port number 53 (UDP).

The two main Transport layer protocols are:

- Transmission Control Protocol
  It provides reliable communication between two hosts.
- User Datagram Protocol
  It provides unreliable communication between two hosts.

8

(a) Define TCP. Write down the features of TCP.

Answer: The Transmission Control Protocol (TCP) is one of the most important protocols of Internet Protocols suite. It is most widely used protocol for data transmission in communication network such as internet.

Features

- TCP is reliable protocol. That is, the receiver

always sends either positive or negative acknowledgement about the data packet to the sender, so that the sender always has bright clue about whether the data packet is reached the destination or it needs to resend it.

- TCP ensures that the data reaches intended destination in the same order it was sent.
- TCP provides error-checking and recovery mechanism
- TCP provides end-to-end communication
- TCP provides flow control and quality of service.
- TCP operates in client/server point-to-point mode.

⑥ Define UDP. Write down the features of UDP.

Answer: The User Datagram Protocol (UDP) is simplest Transport Layer communication protocol available of the TCP/IP protocol suite. It involves minimum amount of communication machine.

Features:

- UDP is used when acknowledgement of data

does not hold any significance.

- UDP is good protocol for data flowing in one direction.
- UDP is simple and suitable for query based communications,
- UDP is not connection oriented,
- UDP does not provide congestion control mechanism.
- UDP does not guarantee ordered delivery of data.
- UDP is stateless.
- UDP is suitable protocol for streaming applications such as VoIP, multimedia streaming.

Q What are the requirements and applications of UDP?

Answer: We deploy UDP where the acknowledgement packets share significant amount of bandwidth along with the actual data. For example, in case of video streaming, thousands of packets are forwarded towards its users. Acknowledging all the packets is

troublesome and may contain huge amount of bandwidth wastage. The best delivery mechanism of underlying IP protocol ensures best efforts to deliver its packets, but even if some packets in video streaming get lost, the impact is not calamitous and can be ignored easily. Loss of few packets in video and voice traffic sometimes goes unnoticed.

UDP application

Here are few applications where UDP is used to transmit data:

- Domain Name Services
- Simple Network Management Protocol
- Trivial File Transfer Protocol
- Routing Information Protocol
- Kerberos