Q.2 a. Explain the seven layers of OSI model.

Answer:

It has seven layers. They are separate but related. Each layer has well defined tasks and provides services to the corresponding lower layer while in transmission. In receiving mode the lower layer provides the necessary services to the upper layer. Any changes in one layer should not require changes in other layers. This kind of standardization allows communication across all types of computers.

The Seven Layers of OSI and their conceptual services -

• **Application - (layer 7)** Allows applications to use the network. The user may want to access the network for various purposes. Like for sending e-mail, transferring a file, surfing the web, accessing remote computer's resources etc.. For every task mentioned above there is a dedicated service. ***Services* –** e-mail, news groups, web applications, file transfer.

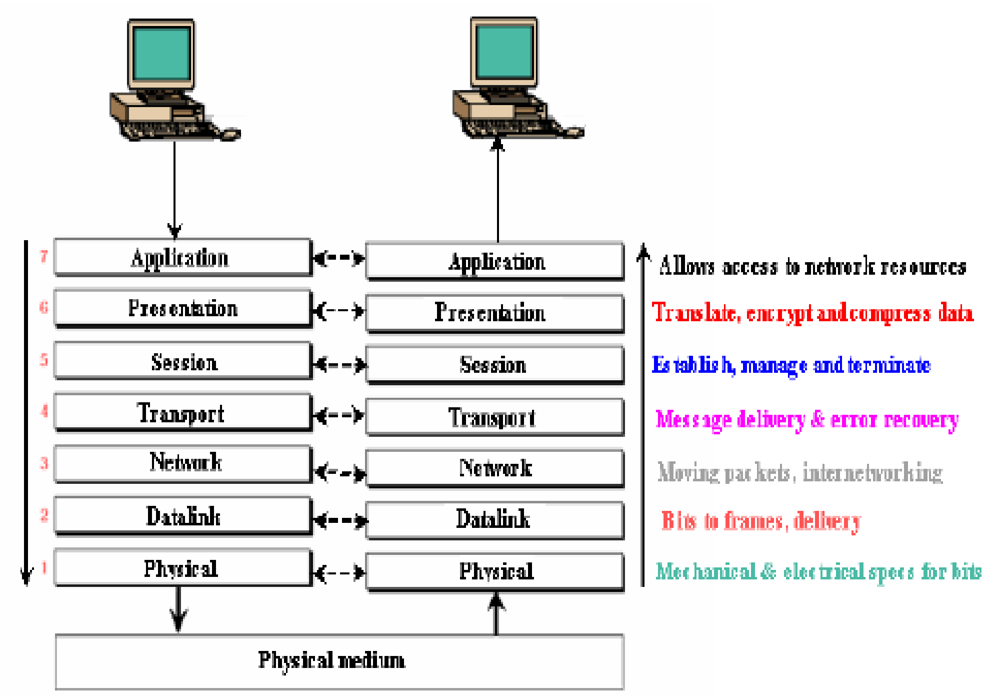


Fig 1.11.1 The OSI Layers and their functions

Presentation - (layer 6)- Translates data into a form usable by the application layer. The redirector operates here. Responsible for protocol conversion, translating and encrypting data, and managing data compression. messages are sent between layers. ***Services*** – POP, SMTP (e-mail, Post office protocol, Simple Mail Transfer Protocol), Usenet (for news groups), HTTP (hyper text transfer protocol for web applications), FTP, TFTP (File transfer protocol, trivial FTP for file transfer), Telnet (Terminal Network, A general purpose program enabling remote login into some other computer and function as if it is directly connected to that remote computer), Domain name server (finding ip addresses for domain names), SNMP (Simple Network Management Protocol).

• Session - (layer 5) Allows applications on connecting systems to standard ports to establish a session. Provides synchronization between communicating computers. Messages are sent between layers. ***Services –*** Various port numbers are POP(25), USENET(532), HTTP(80), FTP(20/21), Telnet(23), DNS(53), SNMP(161/162) etc.

• Transport - (layer 4) Responsible for packet handling. Ensures error-free delivery. Repackages messages (while receiving), divides messages into smaller packets (while transmitting), and handles error handling. segments of message fragments are sent between layers. ***Services*** - TCP - connection-oriented communication for applications to ensure error free delivery; UDP - connectionless communications and does not guarantee packet delivery between transfer points

• Network - (layer 3) Translates system names into addresses. Responsible for addressing, determining routes for sending, managing network traffic problems, packet switching, routing, data congestion, and reassembling data. Datagrams are sent between layers. ***Services*** - Software & hardware addresses and packet routing between hosts and networks (IP). Two versions IP4(32 bits) & IP6(128 bits)

• Data link - (layer 2) Sends data from network layer to physical layer. Manages physical layer communications between connecting systems. Data frames are sent between layers. ***Services –*** SLIP/PPP, 802.2 SNAP, Ethernet

• Physical - (layer 1) Transmits data over a physical medium. Defines cables, cards, and physical aspects. Data bits are sent. ***Services*** - ISDN, ADSL, ATM, FDDI, CAT 1-5, Coaxial cable.

b. Why standard protocol architecture is needed for data communication.

Answer:

When computers, terminals, and/or other data processing devices exchange data, the procedures involved can be quite complex. Consider, for example, the transfer of a file between two computers. There must be a data path between the two computers, either directly or via a communication network. But more is needed. Typical tasks to be performed are as follow:

1. The source system must either activate the direct data communication path or inform the communication network of the identity of the desired destination system.

2. The source system must ascertain that the destination system is prepared to receive data.

3. The file transfer application on the source system must ascertain that the file management program on the destination system is prepared to accept and store the file for this particular user.

4. If the file formats used on the two systems are different, one or the other system must perform a format translation function.

It is clear that there must be a high degree of cooperation between the two computer systems. Instead of implementing the logic for this as a single module, the task is broken up into subtasks, each of which is implemented separately. In protocol architecture, the modules are arranged in a vertical stack. Each layer in the stack performs a related subset of the functions required to communicate with another system. It relies on the next lower layer to perform more primitive functions and to conceal the details of those functions. It provides services to the next higher layer. Ideally, layers should be defined so that changes in one layer do not require changes in other layers.

Q.3 a. Enlist the advantages of Digital transmission of data over Analog transmission.

Answer:

- **Digital technology:** The advent of large-scale integration (LSI) and very-large scale integration (VLSI) technology has caused a continuing drop in the cost and size of digital circuitry. Analog equipment has not shown a similar drop.
- **Data integrity:** With the use of repeaters rather than amplifiers, the effects of noise and other signal impairments are not cumulative. Thus it is possible to transmit data longer distances and over lower quality lines by digital means while maintaining the integrity of the data.
- **Capacity utilization:** It has become economical to build transmission links of very high bandwidth, including satellite channels and optical fiber. A high degree of multiplexing is needed to utilize such capacity effectively, and this is more easily and cheaply achieved with digital (time division) rather than analog (frequency division) technique.
- **Security and privacy:** Encryption techniques can be readily applied to digital data and to analog data that have been digitized.
- **Integration:** By treating both analog and digital data digitally, all signals have the same form and can be treated similarly.Thus economies of scale and convenience can be achieved by integrating voice, video, and digital data.

b. An AWGN channel of bandwidth 4 KHz and S/N of 1.25×10^4. Calculate channel capacity.

Answer:

$$C = B \log_2(1+S/N),\ B = 4KHz$$

$$S/N = 1.25 \times 10^4$$

Putting these values we get

$$C = 54.44 \text{ Kb/s}$$

c. Why optical fibre guided media is preferred over coaxial media.

Answer:

The following characteristics distinguish optical fiber from twisted pair or coaxial cable:

- **Greater capacity:** The potential bandwidth, and hence data rate, of optical fiber is immense; data rates of hundreds of Gbps over tens of kilometers have been demonstrated. Compare this to the practical maximum of hundreds of Mbps over about 1 km for coaxial cable and just a few Mbps over 1 km or up to 100 Mbps to 10 Gbps over a few tens of meters for twisted pair.
- **Smaller size and lighter weight:** Optical fibers are considerably thinner than coaxial cable or bundled twisted-pair cable—at least an order of magnitude thinner for comparable information transmission capacity. For cramped conduits in buildings and

underground along public rights-of-way, the advantage of small size is considerable. The corresponding reduction in weight reduces structural support requirements.

• **Lower attenuation:** Attenuation is significantly lower for optical fiber than for coaxial cable or twisted pair and is constant over a wide range.

• **Electromagnetic isolation:** Optical fiber systems are not affected by external electromagnetic fields. Thus the system is not vulnerable to interference, impulse noise, or crosstalk. By the same token, fibers do not radiate energy, so there is little interference with other equipment and there is a high degree of security from eavesdropping. In addition, fiber is inherently difficult to tap.

• **Greater repeater spacing:** Fewer repeaters mean lower cost and fewer sources of error. The performance of optical fiber systems from this point of view has been steadily improving. Repeater spacing in the tens of kilometers for optical fiber is common, and repeater spacings of hundreds of kilometers have been demonstrated. Coaxial and twisted-pair systems generally have repeaters
every few kilometers.

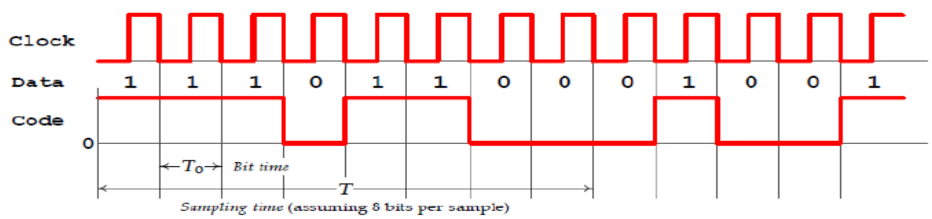
Q.4 a. Explain and Compare the advantages and disadvantages of different types of binary data formats.

Answer:

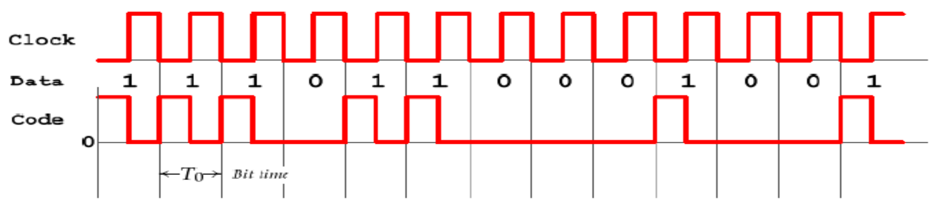
Different types of data formats.

1. Unipolar (Unipolar **NRZ** and Unipolar **RZ**):

Unipolar is the simplest line coding scheme possible. It has the advantage of being compatible with TTL logic. Unipolar coding uses a positive rectangular pulse $p(t)$ to represent binary **1**, and the absence of a pulse (i.e., zero voltage) to represent a binary **0**. Two possibilities for the pulse $p(t)$ exist3: Non-Return-to-Zero (NRZ) rectangular pulse and Return-to-Zero (RZ) rectangular pulse. The difference between Unipolar NRZ and Unipolar RZ codes is that the rectangular pulse in NRZ stays at a positive value (e.g., +5V) for the full duration of the logic **1** bit, while the pule in RZ drops from +5V to 0V in the middle of the bit time. A drawback of unipolar (RZ and NRZ) is that its average value is not zero, which means it creates a significant DC-component at the receiver.



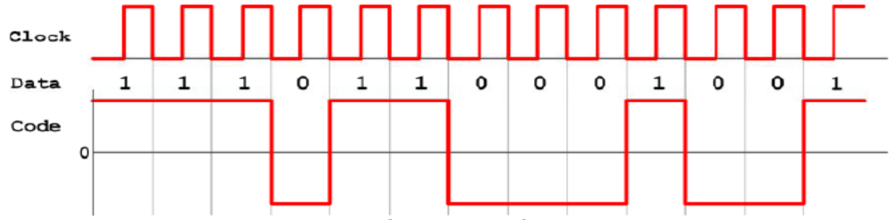
Unipolar NRZ Code



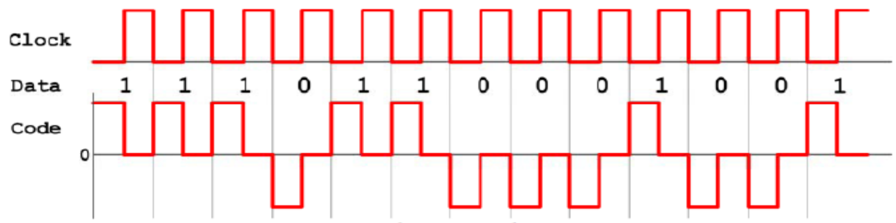
Unipolar RZ Code

The disadvantage of unipolar RZ compared to unipolar NRZ is that each rectangular pulse in RZ is only half the length of NRZ pulse. This means that unipolar RZ requires twice the bandwidth of the NRZ code.

Polar (Polar **NRZ** and Polar **RZ**): In Polar NRZ line coding binary **1**‟s are represented by a pulse *p*(*t*) and binary **0**‟s are represented by the negative of this pulse -*p*(*t*) (e.g., -5V). Polar (NRZ and RZ) signals .Using the assumption that in a regular bit stream a logic **0** is just as likely as a logic **1**,polar signals (whether RZ or NRZ) have the advantage that the resulting Dccomponent is very close to zero.



Polar NRZ Code

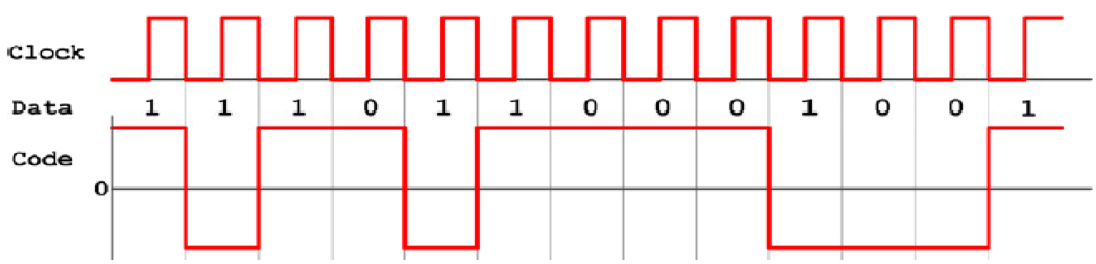


Polar RZ Code

The rms value of polar signals is bigger than unipolar signals, which means that polar signals have more power than unipolar signals, and hence have better SNR at the receiver. Actually, polar NRZ signals have more power compared to polar RZ signals. The drawback of polar NRZ, however, is that it lacks clock information especially when a long sequence of **0**‟s or **1**‟s is transmitted.

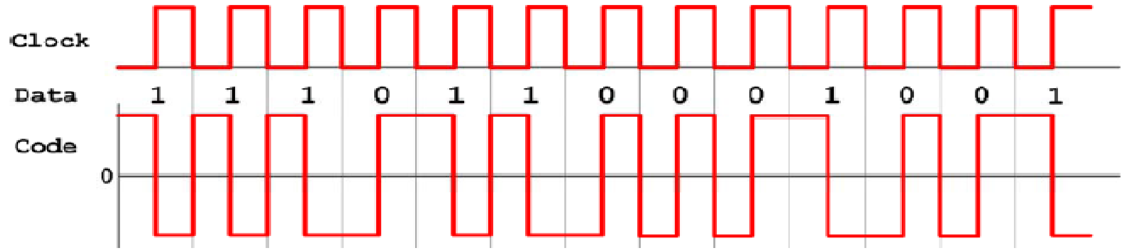
Non-Return-to-Zero, Inverted (NRZI):

NRZI is a variant of Polar NRZ. In NRZI there are two possible pulses, *p*(*t*) and –*p*(*t*). A transition from one pulse to the other happens if the bit being transmitted is a logic **1**, and no transition happens if the bit being transmitted is a logic **0**.



Manchester encoding:

In Manchester code each bit of data is signified by at least one transition. Manchester encoding is therefore considered to be self-clocking, which means that accurate clock recovery from a data stream is possible. In addition, the DC component of the encoded signal is zero. Although transitions allow the signal to be self-clocking, it carries significant overhead as there is a need for essentially twice the bandwidth of a simple NRZ or NRZI encoding.



b. A signal is quantized using 10 bit PCM. Find the signal to quantization noise ratio.

Answer:
(SNR)db = 6.02 n + 1.76, where n is the number of bits used for quantization. In this case, (SNR)db = 60.2 + 1.76 = 61.96 dB.

c. Why should PCM be preferable to DM for encoding analog signals that represent digital data.

Answer:
Analog signals in the voice band that represent digital data have more high frequency components than analog voice signals. These higher components cause the signal to change more rapidly over time. Hence, DM will suffer from a high level of slope overload noise. PCM, on the other hand, does not estimate changes in signals, but rather the absolute value of the signal, and is less affected than DM.

Q.5 a. What do you mean by error control? What are techniques used for error control?

Answer: Page Number 201 of Text Book

b. Calculate the required bit rate for a TDM carrier, say DS-489, to support 30 voice channels using 6-bit samples and a structure similar to DS-1.

Answer:

Voice sampling rate = 2 X4 kHz = 8 kHz; 6 bits/sample
Thus: 30 voices channels: 30 X8 X6 = 1440 kbps
1 synchronous bit/channel: 30 X8 = 240 kbps
1 synchronous bit/frame: 1 X 8 = 8 kbps
TOTAL: 1688 kbps

c. Ten 9600-bps lines are to be multiplexed using TDM. Ignoring overhead bits in the TDM frame, what is the total capacity required for synchronous TDM? Assuming that we wish to limit average TDM link utilization to 0.8, and assuming that each TDM link is busy 50% of the time, what is the capacity required for statistical TDM?

Answer:

Synchronous TDM: 9600 bps × 10 = 96 kbps
Statistical TDM: 9600 bps × 10 × 0.5/0.8 = 60 kbps

Q.6 a. Compare circuit switching, datagram packet switching and virtual circuit packet switching.

Answer:

Circuit Switching	Datagram Packet Switching	Virtual Circuit Packet Switching
Dedicated transmission path	No dedicated path	No dedicated path
Continuous transmission of data	Transmission of packets	Transmission of packets
Fast enough for interactive	Fast enough for interactive	Fast enough for interactive
Messages are not stored	Packets may be stored until delivered	Packets stored until delivered
The path is established for entire conversation	Route established for each packet	Route established for entire conversation
Call setup delay; negligible transmission delay	Packet transmission delay	Call setup delay; packet transmission delay
Busy signal if called party busy	Sender may be notified if packet not delivered	Sender notified of connection denial
Overload may block call setup; no delay for established calls	Overload increases packet delay	Overload may block call setup; increases packet delay
Electromechanical or computerized switching nodes	Small switching nodes	Small switching nodes
User responsible for message loss protection	Network may be responsible for individual packets	Network may be responsible for packet sequences
Usually no speed or code conversion	Speed and code conversion	Speed and code conversion
Fixed bandwidth	Dynamic use of bandwidth	Dynamic use of bandwidth
No overhead bits after call setup	Overhead bits in each packet	Overhead bits in each packet

b. Discuss implicit congestion signalling for congestion control.

Answer:

When network congestion occurs, two things may happen: (1) The transmission delay for an individual packet from source to destination increases, so that it is noticeably longer than the fixed propagation delay, and (2) packets are discarded. If a source is able to detect increased delays and packet discards, then it has implicit evidence of network congestion. If all sources can detect congestion and, in response, reduce flow on the basis of congestion, then the network congestion will be relieved. Thus, congestion control on the basis of implicit signaling is the responsibility of end systems and does not require action on the part of network nodes. Implicit signaling is an effective congestion control technique in connectionless, or datagram, configurations, such as datagram packet-switching networks and IPbased internets. In such cases, there are no logical connections through the internet on which flow can be regulated. However, between the two end systems, logical connections can be established at the TCP level. TCP includes mechanisms for acknowledging receipt of TCP segments and for regulating the flow of data between source and destination on a TCP connection. Implicit signalling can also be used in connection-oriented networks. For example, in frame relay networks, the LAPF control protocol, which is end to end, includes facilities similar to those of TCP for flow and error control. LAPF control is capable of detecting lost frames and adjusting the flow of data accordingly.

Q.7 a. Define network topology and discuss the various types of topology with example.

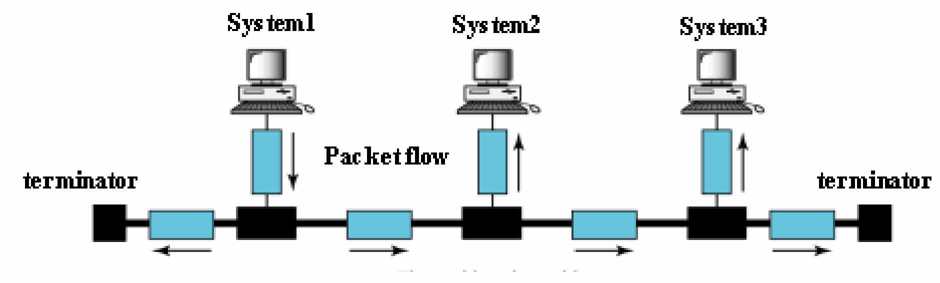
Answer:

The topology defines how the devices (computers, printers..etc) are connected and how the data flows from one device to another. There are two conventions while representing the topologies. The physical topology defines how the devices are physically wired. The logical topology defines how the data flows from one device to another.

Broadly categorized into I) Bus II) Ring III) Star IV) Mesh

Bus topology:

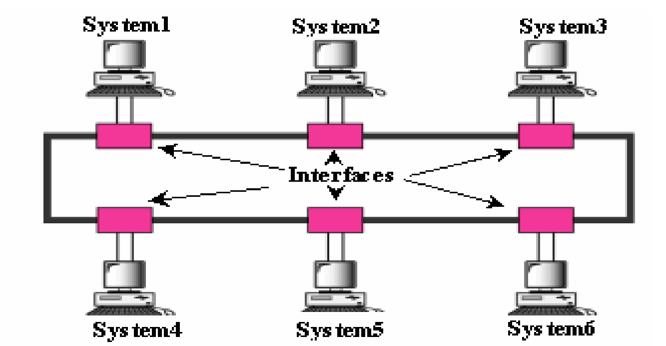
In a bus topology all devices are connected to the transmission medium as backbone. There must be a terminator at each end of the bus to avoid signal reflections, which may distort the original signal. Signal is sent in both directions, but some buses are unidirectional. Good for small networks. Can be used for 10BASE5(thick net), 10BASE2(thin net) or 10BROAD36 (broad band) co-axial bus standards.



The main problem with the bus topology is failure of the medium will seriously affect the whole network. Any small break in the media the signal will reflect back and cause errors. The whole network must be shutdown and repaired. In such situations it is difficult to troubleshoot and locate where the break in the cable is or which machine is causing the fault; when one device fails the rest of the LAN fails.

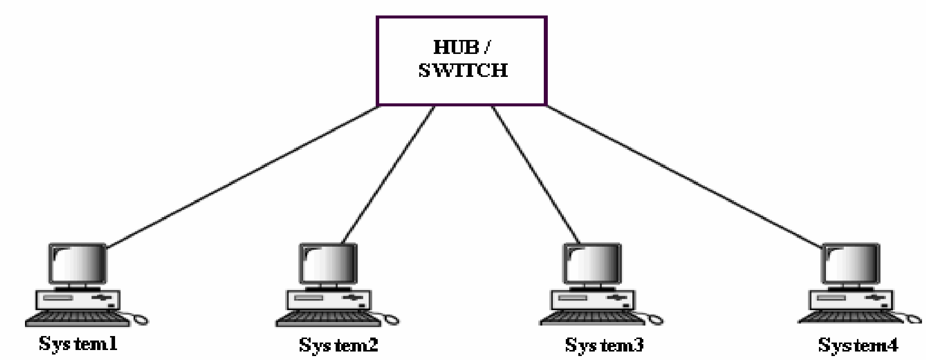
Ring Topology:

Ring topology was in the beginning of LAN area. In a ring topology, each system is connected to the next as shown in the following picture.



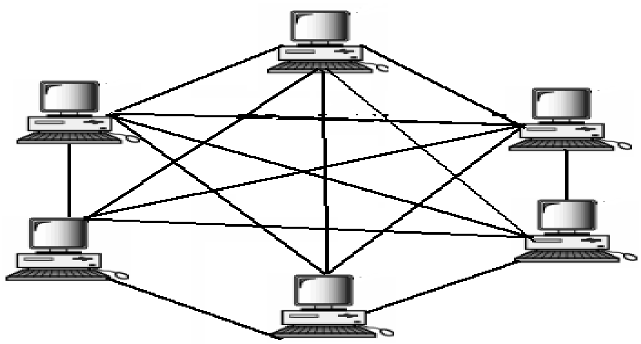
Each device has a transceiver which behaves like a repeater which moves the signal around the ring; ideal for token passing access methods. In this topology signal degeneration is low; only the device that holds the token can transmit which reduces collisions. If you see its negative aspect it is difficult to locate a problem cable segment; expensive hardware.

Star topology:
In a star topology each station is connected to a central node. The central node can be either a hub or a switch. The star topology does not have the problem as seen in bus topology. The failure of a media does not affect the entire network. Other stations can continue to operate until the damaged segment is repaired.



Commonly used for 10BASE5, 10BASE-T or 100BASE-TX types The advantages are abling is inexpensive, easy to wire, more reliable and easier to manage because of the use of hubs which allow defective cable segments to be routed around; locating and repairing bad cables is easier because of the concentrators; network growth is easier. The disadvantages are all nodes receive the same signal therefore dividing bandwidth; Maximum computers are 1,024 on a LAN. Maximum UTP (Un shielded twisted pair) length is 100 meters; distance
between computers is 2.5 meters.

Mesh topology:
A mesh physical topology is when every device on the network is connected to every device on the network; most commonly used in WAN configurations Helps find the quickest route on the network; provides redundancy. Very expensive and not easy to set up.



Hybrid topology:
A hybrid topology is a combination of any two or more network topologies in such a way that the resulting network does not have one of the standard forms. For example, a tree network connected to a tree network is still a tree network, but two star networks connected together exhibit hybrid network topologies. A hybrid topology is always produced when two different basic network topologies are connected.

b. Briefly explain why high speed LANs is required.

Answer:

The following are examples of requirements that call for higher-speed LANs:

- **Centralized server farms**: In many applications, there is a need for user, or client, systems to be able to draw huge amounts of data from multiple centralized servers, called server farms. An example is a color publishing operation, in which servers typically contain hundreds of gigabytes of image data that must be downloaded to imaging workstations. As the performance of the servers themselves has increased, the bottleneck has shifted to the network.
- **Power workgroups:** These groups typically consist of a small number of cooperating users who need to draw massive data files across the network. Examples are a software development group that runs tests on a new software version, or a computer-aided design (CAD) company that regularly runs simulations of new designs. In such cases, large amounts of data are distributed to several workstations, processed, and updated at very high speed for multiple iterations.

High-speed local backbone: As processing demand grows, LANs proliferate at a site, and high-speed interconnection is necessary.

Q.8 a. Draw IPv6 Header format and write about various field used in it.

Answer: Page Number 560 of Text Book

b. Discuss ARP (Address Resolution Protocol).

Answer: Page Number 555 of Text Book

Q.9 Write short notes on:

(i) TCP
(ii) MIME
(iii) SMTP
(iv) UDP

Answer: Page Number 643, 662, 710 of Text Book

Text Book

Data and Computer Communications, Eight Edition (2007), William Stallings, Pearson Education Low Price Edition.