Unit III

3 Multi-Access Mechanism and Ethernet Standards

3.1 : Random Access Techniques : CSMA, CSMA/CD, CSMA/CA

Q.1 Explain in brief ALOHA, slotted ALOHA mentioning efficiency advantages in each case. ☞ [SPPU : Dec.-18, Marks 6]

Ans. : • The ALOHA protocol was developed at the university of Hawaii in the early 1970s. ALOHA was developed for packet radio networks. However, it is applicable to any shared transmission medium.

- In a system when multiple users try to send messages to other stations through a common broadcast channel random access or contention techniques are used.
- Random access means there is no definite or scheduled time for any station to transmit. This scheme is simplest possible and it is asynchronous. It is asynchronous because there is no co-ordination among users.
- The basic idea of ALOHA system is applicable to any system in which unco-ordinated users are competing for the use of a single shared channel.
- When a station send data, another station may attempt to do so at the same time. The data from the two station collide and become garbled. If two signals collided, so be it. Each station would simply wait a random time and try again.

Slotted ALOHA

- In slotted ALOHA, the channel time is divided into time slots and the stations are allowed to transmit at specific instance of time. These time slots are exactly equal to the packet transmission time. All users are

then synchronized to these time slots, so that whenever a user generates a packet it must synchronize exactly with the next possible channel slot. Consequently the wasted time due to collisions can be reduced to one packet time or vulnerable period is reduced to half.

- Transmission attempts for four network user and random retransmission delays for colliding packets in slotted ALOHA is shown in Fig. Q.1.1.

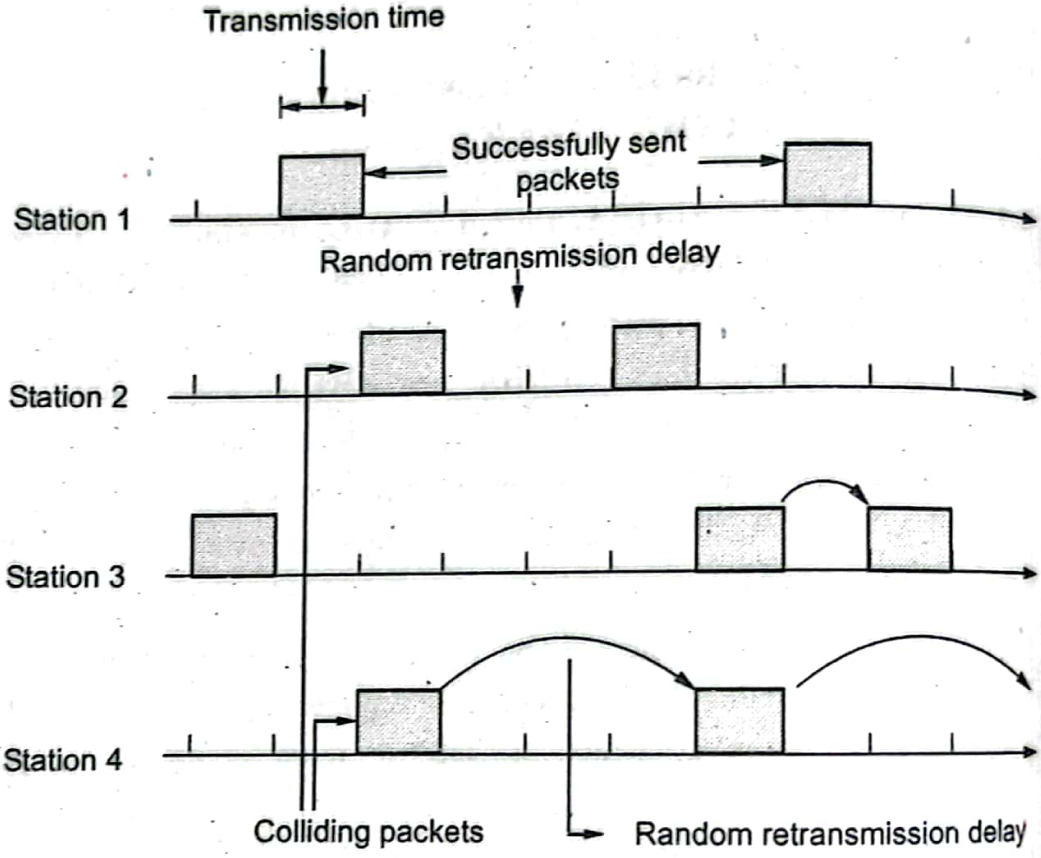


Fig. Q.1.1 Transmission attempts and random retransmission delays for colliding packets in slotted ALOHA

Assumptions :

1. All frames are of same size.
2. Time is divided into equal sized slots, a slot equals the time to transmit one frame.
3. Nodes start to transmit frames only at beginning of slots.
4. Nodes are synchronized.
5. If two or more nodes transmit in a slot, all nodes detects collision before the slot ends.

Throughput of slotted ALOHA channel

- In slotted ALOHA, the packets arrive in a synchronized fashion. The probability of single transmission during a slot time is,

$$p_o = e^{-G} \quad \ldots (Q.1.1)$$

Also

$$S = G \cdot e^{-G} \quad \ldots (Q.1.2)$$

The maximum throughput occurs at G = 1,

i.e. $$S = \frac{1}{e} = 0.368$$

which is twice that of pure ALOHA. This means that the best channel utilization that can be achieved is around 37 %.

- The relation between the offered traffic and the throughput is shown in Fig. Q.1.2.

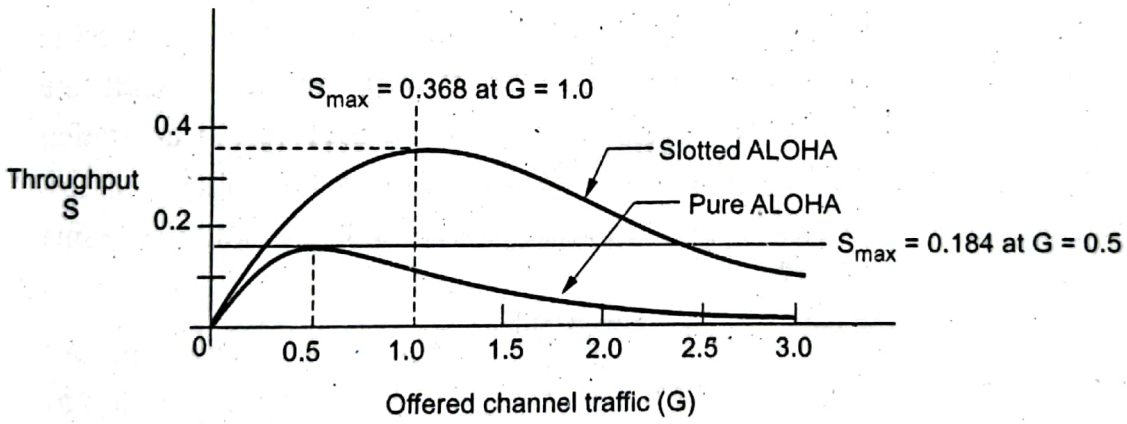


Fig. Q.1.2 Comparison of the throughput as a function of offered load for pure and slotted ALOHA

Pros and Cons of slotted ALOHA

Pros

1. Single active node can continuously transmit at full rate of channel.
2. Highly decentralized, each node independently decides when to retransmit.
3. Simple to implement.

Cons

1. Collisions waste slots.
2. Idle slots.

Q.2 Discuss CSMA/CD random access technique. How collision avoidance achieved in the same ?☞ [SPPU : Dec.-17, May-18, 19, Marks 6]

Ans. : • In both CSMA and ALOHA schemes, collisions involve entire frame transmissions. If a station can determine whether a collision is taking place, then the amount of wasted bandwidth can be reduced by aborting the transmission when a collision is detected. The Carrier Sense Multiple Access with Collision Detection (CSMA/CD) use this approach.

- CSMA/CD is the most commonly used protocol for LANs. CSMA/CD specifications were developed jointly by Digital Equipment Corporation (DEC), Intel and Xerox. This network is called as Ethernet. The IEEE 802.3 CSMA/CD standard for LAN is based on Ethernet specification.
- The basic protocol is that, a station with a message to send must monitor the channel to see if any other station is sending. If another station is sending, the second station must wait or defer, until the sending station has finished. Then it may send its message. If no station was sending at the time that it first listened, the station may send its message immediately. The term "carrier sense" indicates this "listening before transmitting" behaviour.
- If two or more stations have messages to send at the same time and they are separated by significant distances on the bus/channel, each may begin transmitting at roughly the same time without being aware of the other station. The signals from each station will superimpose on the channel and is garbled beyond the decoding ability of the receiving station. This is termed as "collision".
- A protocol is required for transmitting station to monitor the channel while sending each of its messages and to detect such "collisions".
- When a collision has been detected, each of sending stations must cease transmitting, wait for a random length of time, and then try again. Because of quick termination of transmission time and bandwidth is

saved. Therefore CSMA/CD is more efficient than ALOHA, slotted ALOHA and CSMA.

- CSMA/CD networks work best on a bus, multipoint topology with bursty asynchronous transmission. All stations are attached to one path and monitor the signal on the channel through transreceiver attached to the cable.
- CSMA/CD has totally decentralized control and is based on contention access.
- Fig. Q.2.1 illustrates this technique. Station A and station D are the extreme ends of a bus structure.

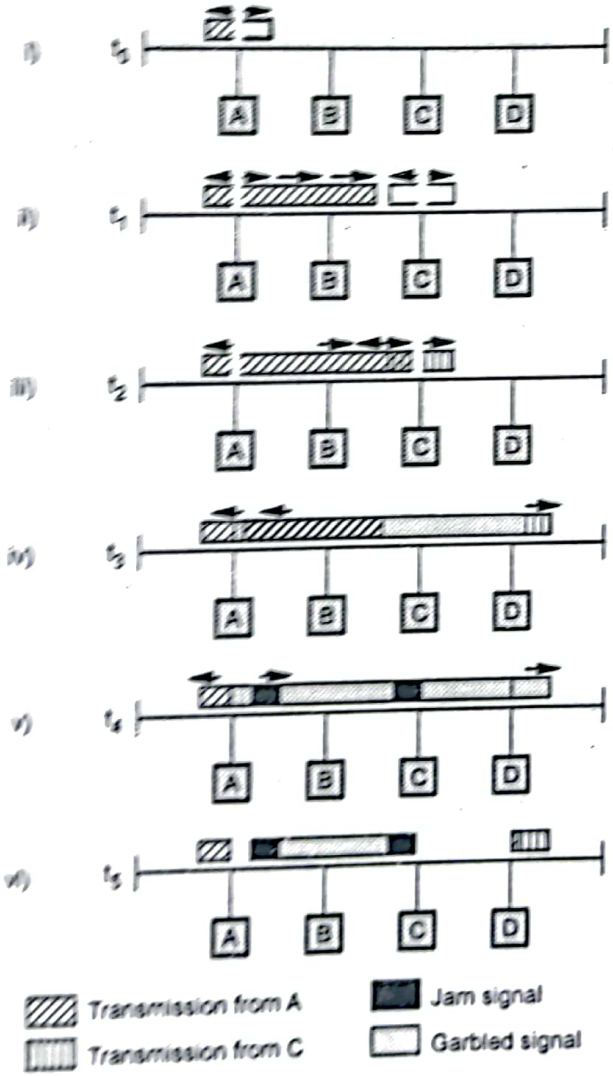


Fig. Q.2.1 CSMA/CD operation

i) Station A listens channel starts transmitting a packet addressing D.

ii) Station B and C are ready for transmission. B senses a transmission on channel so defers. C is unaware of transmission and begins its own transmission.

iii) Station A's transmission reaches C. C detects collision and ceases transmission. Sends jam signal.

iv) Effect of collision propagates back to A, A stops its transmission.

v) A sends jam signal.

vi) No station is transmitting but there are still signals on the bus.

- CSMA/CD supports both baseband and broadband system. CSMA/CD offers four options in terms of bit rate, signaling method and maximum electrical cable segment length. These are,

  1) 10BASE5 2) 10BASE2 3) 10BROAD36 4) 1BASE5

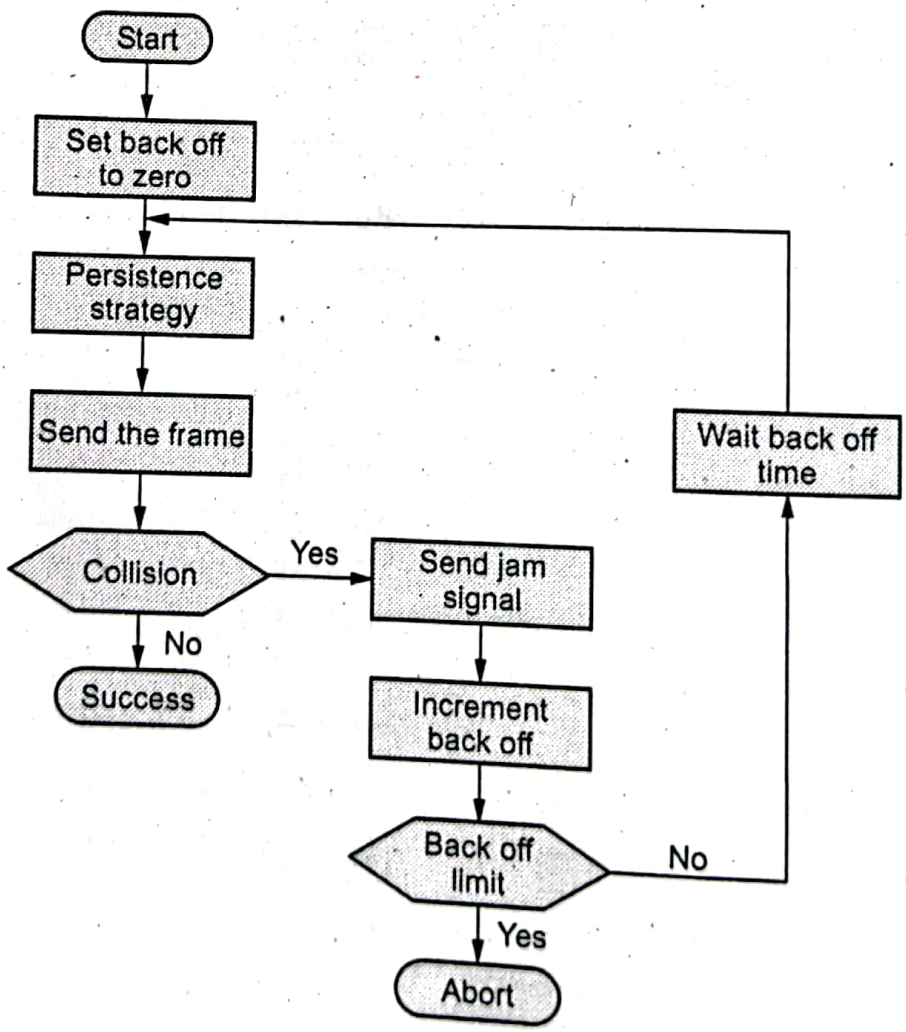


Fig. Q.2.2 Flowchart for CSMA/CD

- The numeric field in the beginning indicates the bit rate in Mbps, the middle term indicates type of signaling system i.e. baseband or broadband, the numeric field in the end indicates the electrical cable segment length in X 100 metres.
- Manchester signal code is used at the baseband level of transmission. In broadband transmission, Differential Phase Shift Keying (DPSK) is used to convert the Manchester encoded signal into analogue form.
- Fig. Q.2.2 shows the flowchart for CSMA/CD procedure.

CSMA/CD throughput

- The throughput of CSMA/CD is greater than that of pure or slotted ALOHA.
- For 1-persistent method, the maximum throughput is around 50 % when G = 1.
- For non-persistent method, the maximum throughput can go upto 90 % when G is between 3 and 8.

Q.3 Discuss CSMA/CA random access technique. How collision avoidance is achieved in this technique ?

☞ **[SPPU : May-17, Dec.-18, Marks 6]**

Ans. : • Wireless networks cannot use CSMA/CD in the MAC sublayer, since this requires the ability to receive and transmit at the same time - hence the use of CSMA/CA.

- In a wireless network, much of the sent energy is lost in transmission. The received signal has very little energy. Therefore, a collision may add only 5 to 10 percent additional energy. This is not useful for effective collision detection. We need to avoid collision on wireless networks because they cannot be detected. So CSMA/CA was invented for this network.
- Collisions are avoided by using three methods.
  a. Inter-frame space b. Contention window c. Acknowledgments
- Fig. Q.3.1 shows the all three method of CSMA/CA.

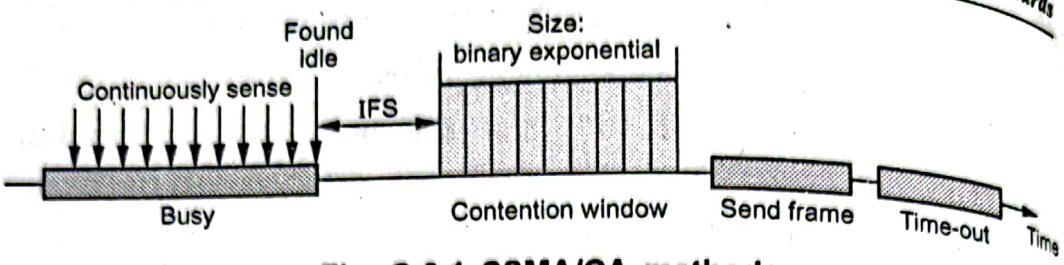


Fig. Q.3.1 CSMA/CA methods

Inter-frame space

- Collisions are avoided by deferring transmission even if the channel is found idle.
- When an idle channel is found, the station does not send immediately. It waits for a period of time called the Inter-Frame Space (IFS).
- In CSMA/CA, the IFS can also be used to define the priority of a station of a frame. A station that is assigned shorter IFS has a higher priority.

Contention window

- Contention windows are an amount of time divided into slots. A station that is ready to send chooses a random number of slots as its wait time.
- Station set one slot for the first time and then double each time the station cannot detect an idle channel after the IFS time.
- In this method, the station needs to sense the channel after each time slot.
- If the station finds the channel busy, it does not restart the process; it just stops the timer and restarts it when the channel is sensed as idle.
- This method gives the priority to the station with the longest waiting time.

Acknowledgments

- The data may be corrupted during the transmission. The positive acknowledgment and the time out can help guarantee that the receiver has received the frame.
- Fig. Q.3.2 shows the flowchart for CSMA/CA.

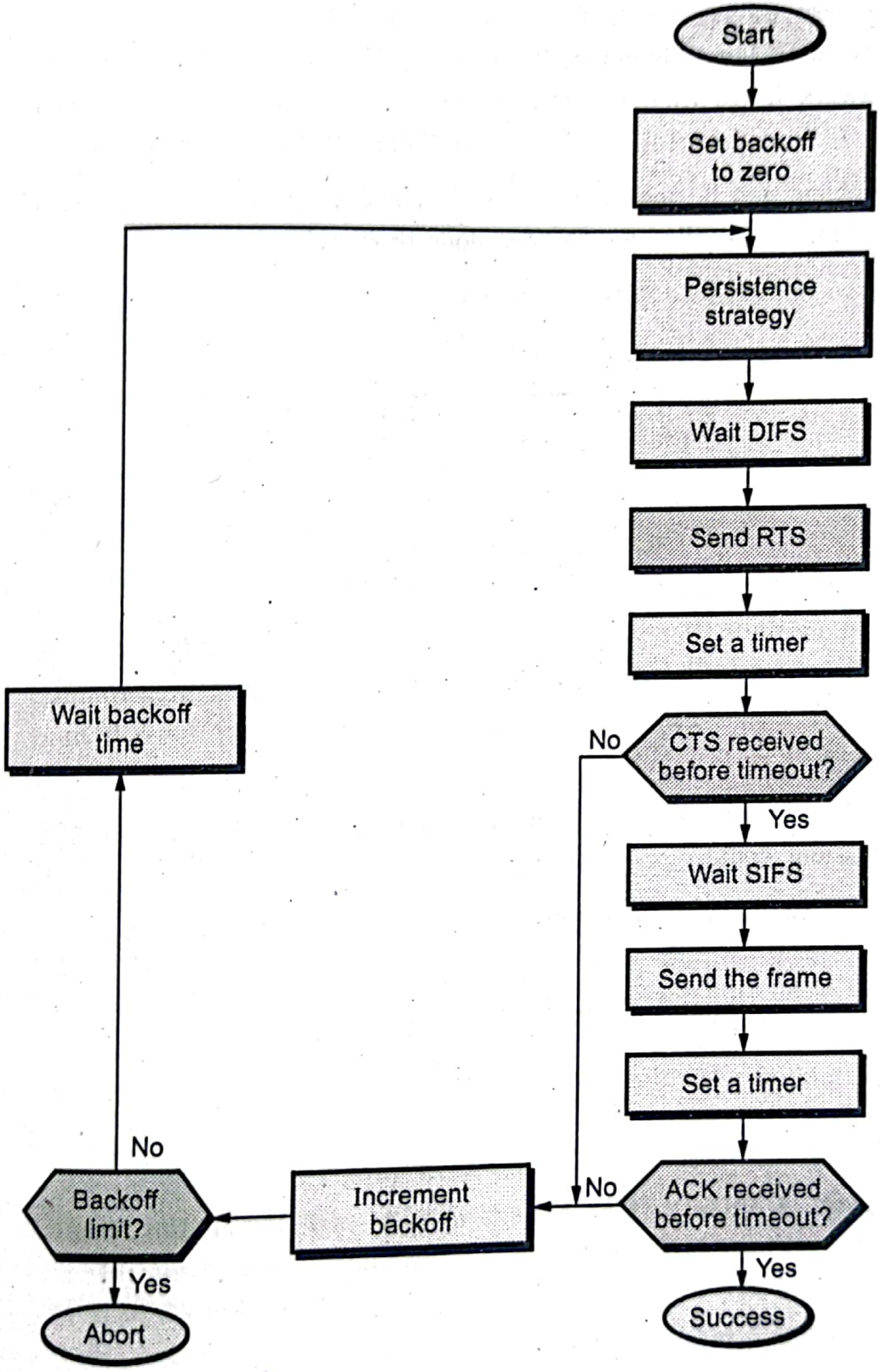


Fig. Q.3.2 Flowchart for CSMA/CA

Hidden Node Problem

- In the case of wireless network it is possible that A is sending a message to B, but C is out of its range and hence while "listening" on the network it will find the network to be free and might try to send packets to B at the same time as A. So, there will be a collision at B.
- The problem can be looked upon as if A and C are hidden from each other. Hence it is called the "hidden node problem".
- Fig. Q.3.3 shows node A is transmitting.

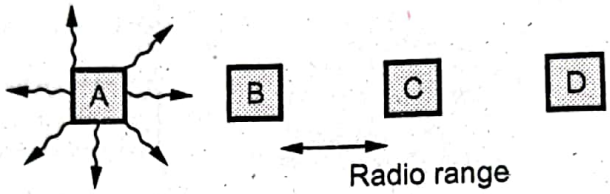


Fig. Q.3.3 A transmitting

Exposed Node Problem

- If C is transmitting a message to D and B wants to transmit a message to A, B will find the network to be busy as B hears C transmitting. Even if B would have transmitted to A, it would not have been a problem at A or D.
- CSMA/CD would not allow it to transmit message to A, while the two transmissions could have gone in parallel.
- Fig. Q.3.4 shows node B is transmitting.

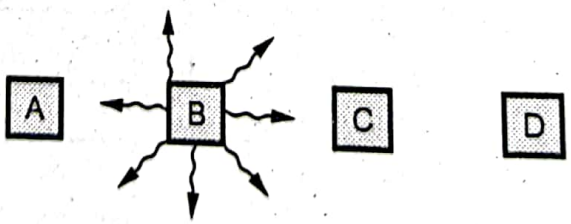


Fig. Q.3.4 B transmitting

Q.4 Explain CSMA / CA / and CSMA / CD random access technique with suitable diagram / flowchart. Also comment on efficiency of each.

☞ **[SPPU : June-22, Marks 8]**

Ans. : Refer Q.2 and Q.3.

3.2 : Controlled Access Techniques : Reservation, Polling, Token Passing

Q.5 Explain the various controlled access methods.

☞ [SPPU : Dec.-17, Marks 6]

Ans. :

1. In this, the stations consult one another to find which station has the right to send.
2. A station cannot send unless it has been authorized by other stations.
3. Controlled access methods are :
   i. Reservation ii. Polling iii. Token passing.

i. Reservation

1. Before sending data, station needs to make a reservation.
   Fig. Q.5.1 shows the reservation access method.

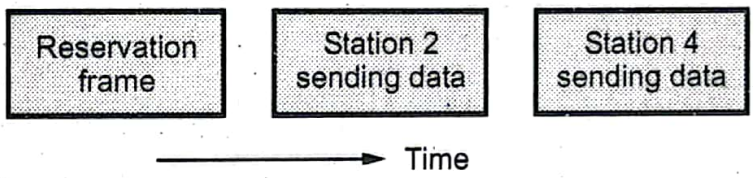


Fig. Q.5.1 Reservation access method

2. Number of reservation are equal to number of stations.
3. Each station have their own minislot in the reservation frame.
4. When station needs to send a data frame, it makes a reservation in its own minislot.
5. The stations that have made reservations can send their data frames after the reservation frame.
6. In the first slot, only station 1, 3 and 4 have made reservation.

ii. Polling

1. Polling works with topology.
2. One device is designed as primary station and other devices are secondary station.
3. Link control is done by primary device.
4. All data exchange take place through primary device.
5. Primary device decides, which device is allowed to use the channel at a given time.

6. If primary device wants to receive data, it asks the secondaries if they have anything to send, this function is called **polling.**
7. Select mode and poll mode are the two functions of polling.
8. In polling, primary device receive the data.
9. In select mode, primary device sends data to secondary device.

Fig. Q.5.2 shows the select mode.

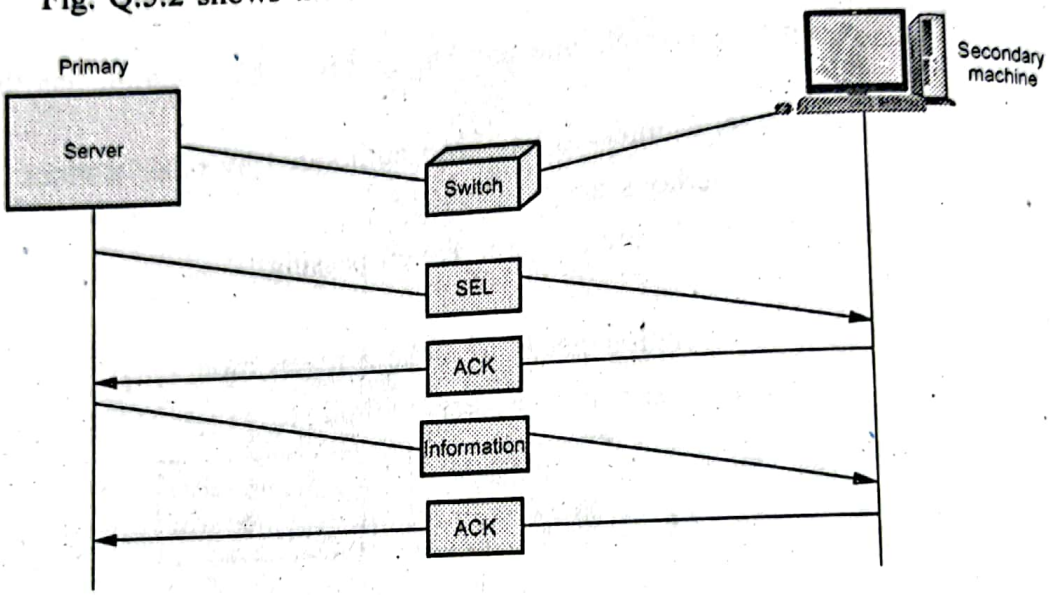


Fig. Q.5.2 Select mode

10. Link is available if primary device is not sending or receiving any data.
11. Before sending data, the primary creates and transmits a select (SEL) frame.
12. SEL frame includes address of the intended secondary device.

Fig. Q.5.3 shows the poll method. (Refer Fig. Q.5.3 on next page)

III. Token Passing

1. A station is allowed to send data when it receives a token (special frame).
2. Ring topology is used for connecting devices.
3. Each station has a predecessor and a successor.
4. Frames are coming from predecessor and going to the successor.
5. Token is circulates around the ring.

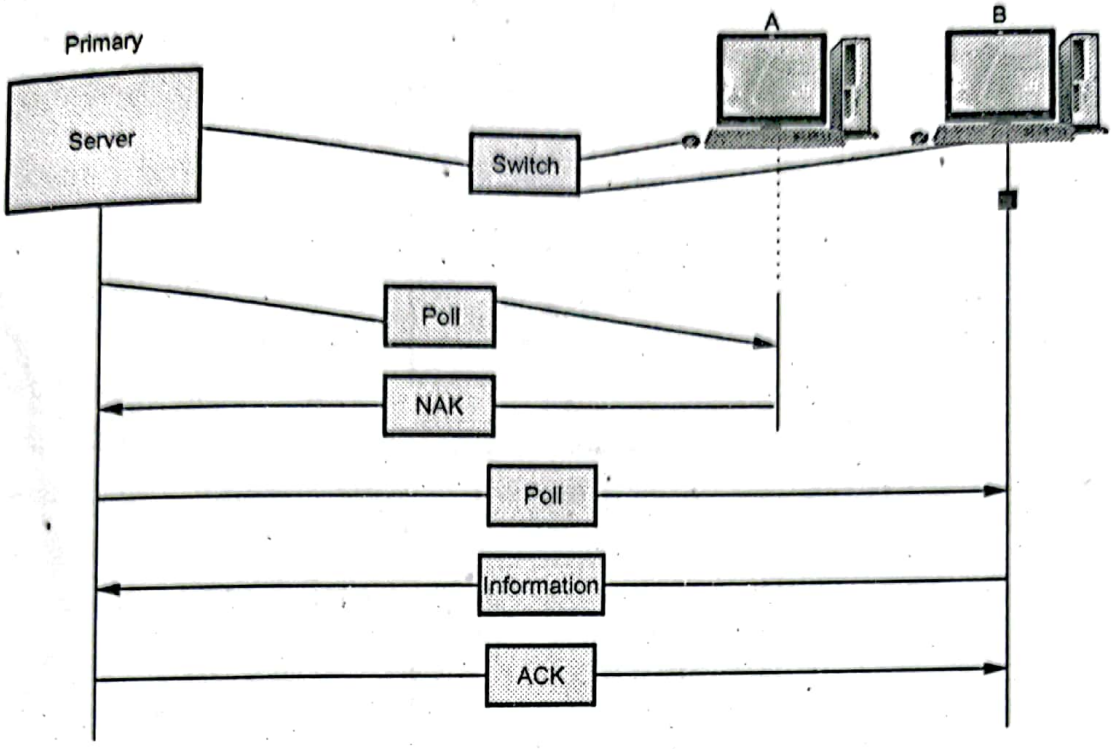


Fig. Q.5.3 Polling method

6. The station captures the token if they want to send data.
   Fig. Q.5.4 shows token passing network.

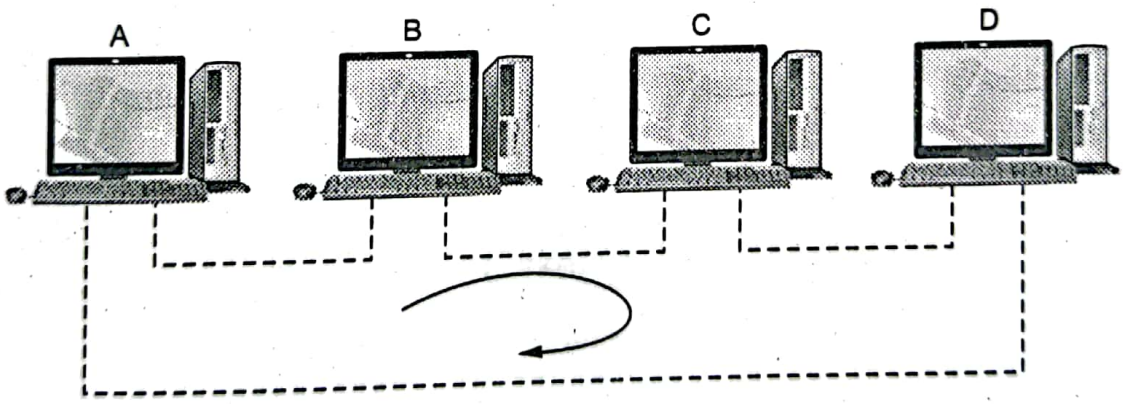


Fig. Q.5.4 Token passing network

7. Flowchart for token passing procedure is shown in Fig. Q.5.5. (See Fig. Q.5.5 on next page)

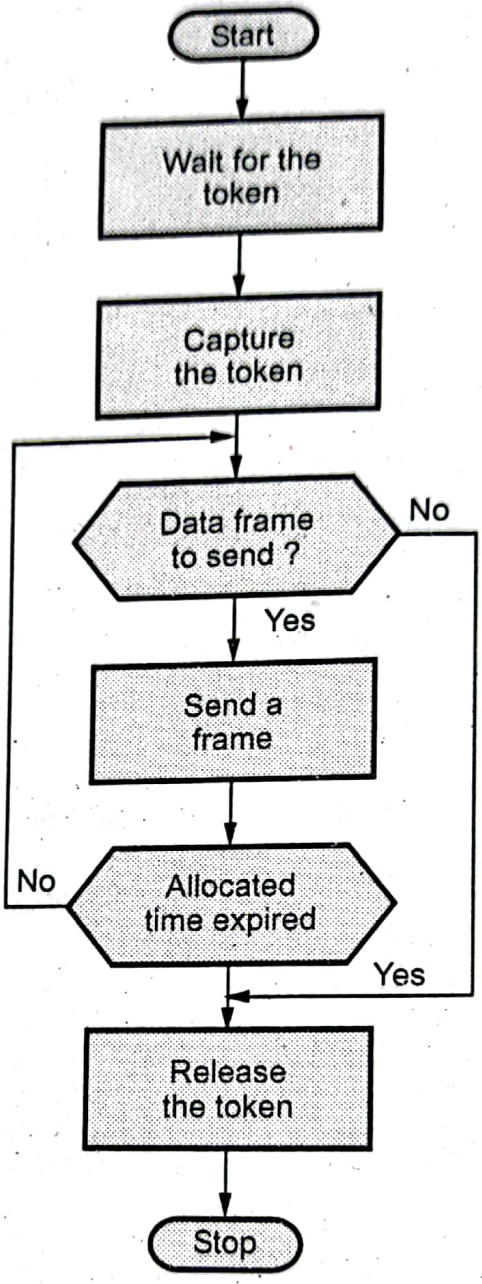


Fig. Q.5.5 Flowchart for token passing

3.3 : Channelization : FDMA, TDMA, CDMA

Q.6 Explain FDMA, TDMA and CDMA in detail.

☞ [SPPU : May-17, Marks 6]

Or Compare FDMA, CDMA, TDMA. ☞ [SPPU : Dec.-17, Marks 6]

Or Explain TDMA and CDMA with neat diagram.

☞ [SPPU : May-18, Dec.-19, Marks 6]

Or Write a note on channelization techniques (Any Two)
i) FDMA ii) TDMA iii) CDMA ☞ [SPPU : June-22, Marks 8]

Ans. : • Channelization is the multiple access method. Multiple access is the technique of sharing or dividing channel (transmission medium) for number of stations sharing it.

• Three most commonly used multiple access methods are -

1. Frequency Division Multiple Access (FDMA)
2. Time Division Multiple Access (TDMA)
3. Code Division Multiple Access (CDMA)

i) FDMA

• In FDMA the available bandwidth is divided into M number of smaller frequency bands called **sub bands**. Each station transmits its information continuously on an assigned sub band. To reduce the co-channel interference, guard band between two sub bands is provided.

If W = Available BW of channel

R = Data rate of channel

M = Number of stations

Then the transmit rate of each station is $\frac{R}{M}$ bits/sec.

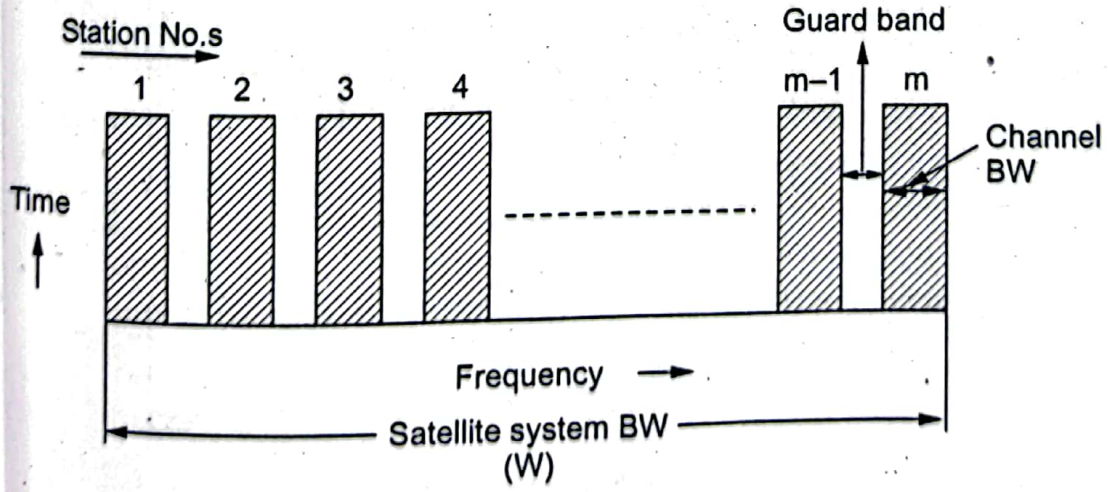


Fig. Q.6.1 FDMA

- FDMA transmissions are separated in frequency domain i.e. total available transponder bandwidth is shared by stations. Fig. Q.6.1 shows how FDMA stations use a fixed portion of frequency band all the time.
- FDMA is not suited for bursty traffic conditions because of inefficient use of transmission resources.

ii) TDMA

- TDMA is a method of time-division multiplexing of digitally modulated carriers. In TDMA, each station transmits digitally modulated carriers during a preassigned time slots, making use of the entire transmission channel during its transmission. The stations are synchronized such that only one carrier is present on the channel at any given time. Thus avoiding collisions of stations. Sufficient guard bands are also provided to ensure collision avoidance.
- Each station spends most of the time accumulating packets and preparing them for transmission in a burst during the assigned time slot. The average bit rate of each channel is same because time slot available is same for each station.
- Fig. Q.6.2 shows how TDMA stations use a fixed portion of time slot in the frequency band.

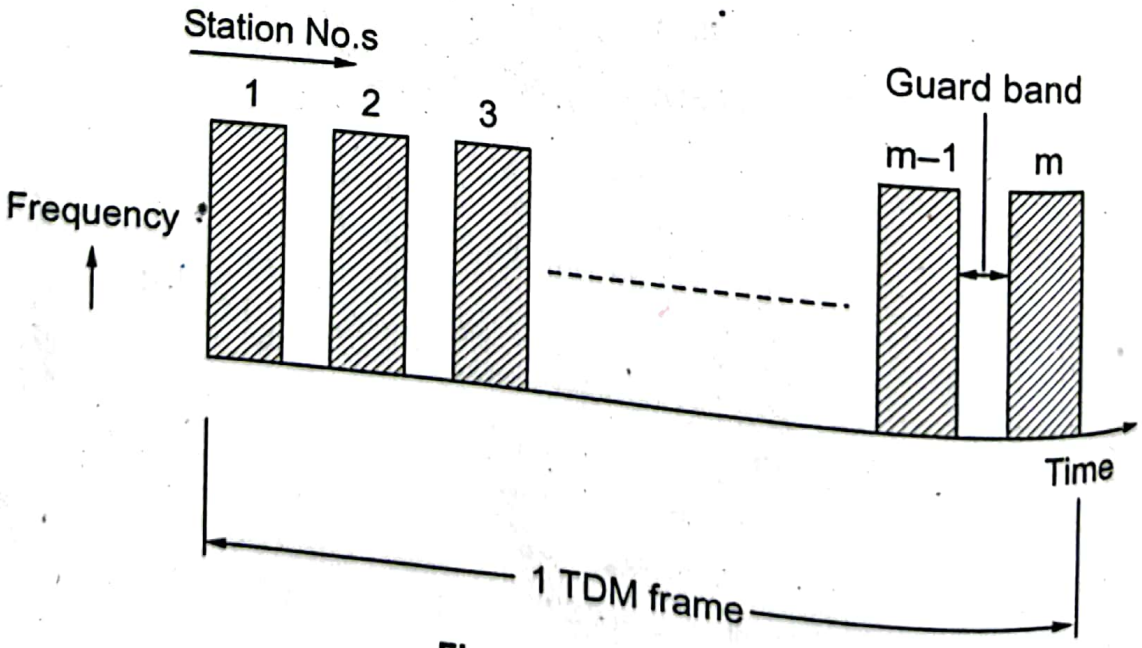


Fig. Q.6.2 TDMA

Advantages of TDMA :

1. At a given time only one carrier is present on the channel hence intermodulation distortion is eliminated.
2. TDMA transmission is separated in time domain. Processing of signal in time domain is easier.
3. TDMA is most efficient method of transmission because of efficient use of transmission resources.
4. TDMA can accomodate a wider range of bit rates by allowing a station to be allocated several slots. Thus TDMA is more flexible than FDMA.

Disadvantages of TDMA :

1. Precise synchronization between stations is required. Transmission of every station must occur during exact time slot.
2. Bit and frame timings must be maintained by TDMA.

III. CDMA

- In CDMA each station transmitter may transmit whenever it requires and can use entire bandwidth i.e. there are no restrictions on time and bandwidth. CDMA is also called as **spread spectrum multiple access** because transmission can spread throughout the bandwidth. Each station is assigned a unique binary code, this code is called as **chip code**. Each station and transmission is identified by its chip code. The receiver uses

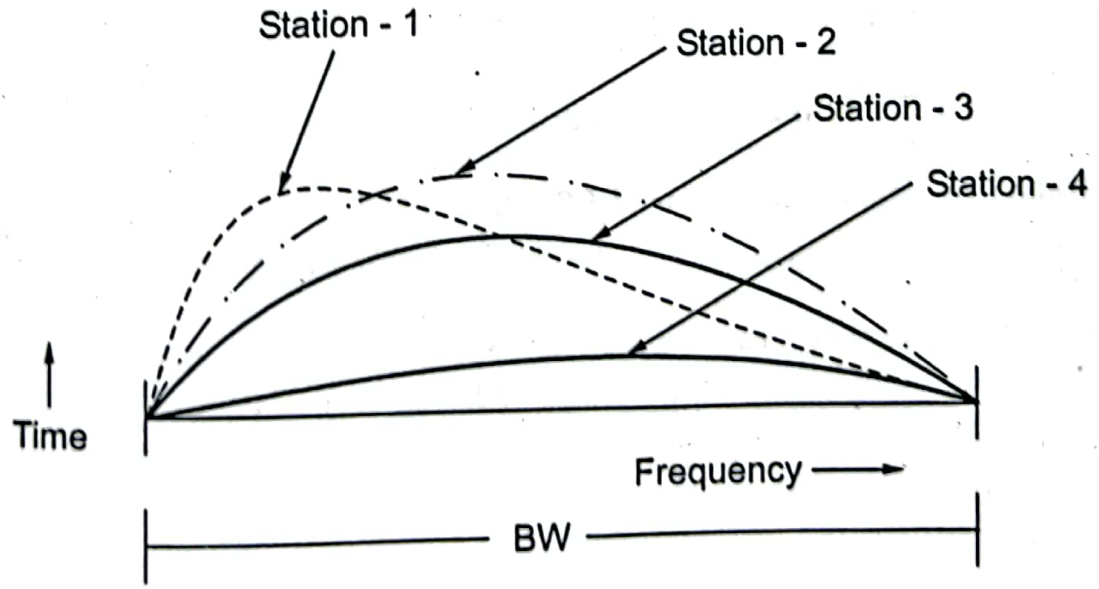


Fig. Q.6.3 CDMA technique

chip code to recover the signal from desired station. Fig. Q.6.3 shows conceptual view of CDMA technique.

Applications of CDMA :

1. CDMA is used for wireless systems with fixed base station and many mobile station at varying distance from it.
2. CDMA is used in satellite systems so that many signals can use a transponder; making it more efficient.
3. CDMA is used in digital cellular telephone services because it permits more users to occupy a given band.
4. Wideband CDMA (W-CDMA) is used for digital cell phone systems to accommodate voice transmission alongwith high speed data, FAX and internet communication.
5. CDMA is ideally suited for military application because of immunity to noise.

Advantages of CDMA :

1. Each station can use the entire bandwidth at any time.
2. High immunity for interference or jamming.

Disadvantages of CDMA :

1. The overall performance degrades with increase in number of users.
2. Time synchronization of stations is required.

3.4 : Ethernet : IEEE Standards - IEEE 802.3

Q.7 Explain the frame format for IEEE 802.3.

☞ [SPPU : May-17, Dec.-17, Marks 7]

Or Draw and explain each field of MAC frame format of IEEE 802.3.

☞ [SPPU : May-19, Dec.-19, Marks 6]

Ans. : • Ethernet does not provide any mechanism for acknowledging received frames, making it what is known as an unreliable medium.

• The frame format of the MAC is shown in Fig. Q.7.1.

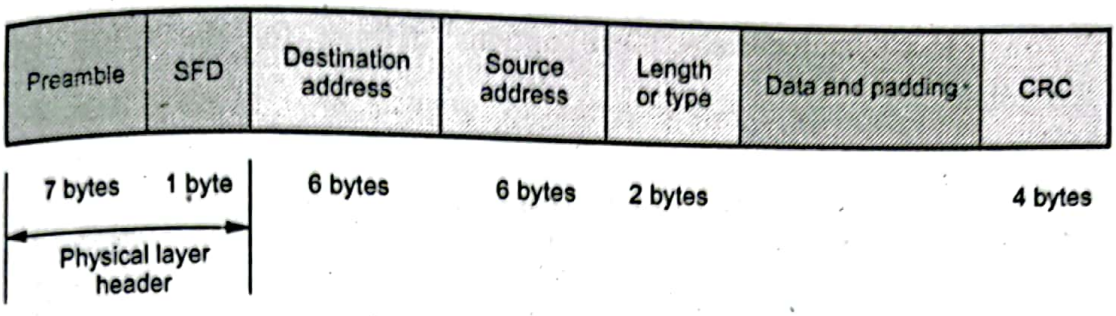


Fig. Q.7.1 802.3 Frame format

1. **Preamble :** A 7-byte pattern of alternating 0s and 1s used by the receiver to establish bit synchronization. Each frame contains the bit pattern 10101010. The pattern provides only an alert and a timing pulse. The preamble is actually added at the physical layer and is not part of the frame.
2. **Start Frame Delimiter (SFD) :** The sequence 10101011, which indicates the actual start of the frame and enables the receiver to locate the first bit of the rest of the frame.
3. **Destination Address (DA) :** The DA field is 6 bytes and specifies the station for which the frame is intended. It may be a unique physical address, a group address or a global address.
4. **Source Address (SA) :** The SA field is also 6 bytes and contains the physical address of the sender of the packet.
5. **Length or Type :** Length of LLC data field in octets, or Ethernet Type field, depending on whether the frame conforms to the IEEE 802.3 standard or earlier Ethernet specification. In either case, the maximum frame size, excluding preamble and SFD, is 1518 bytes.
6. **Data :** Data unit supplied by LLC. It is a minimum of 46 bytes and a maximum of 1500 bytes.
7. **CRC :** This field contains error detection information.

Q.8 Explain the following physical layer implementation in standard Ethernet :
i) 10Base5 ii) 10BaseT iii) 10BaseF
with respect to media, maximum length and line encoding.

☞ **[SPPU : Dec.-18, Marks 6]**

Ans. : • CSMA/CD offers various options in terms of transmission medium, signalling technique, data rate and maximum electrical cable segment length.

- Table Q.8.1 summarizes these options defined for the IEEE 802.3 medium.

Sr. No.	Medium options	Transmission medium	Signaling technique	Data rate (Mbps)	Maximum segment length (m)
1.	10BASE5	Coaxial cable (50 ohm)	Baseband (Manchester)	10	500
2.	10BASE2	Coaxial cable (50 ohm)	Baseband (Manchester)	10	185
3.	1BASE5	Unshielded twisted pair	Baseband (Manchester)	1	250
4.	10BASET	Unshielded twisted pair	Baseband (Manchester)	10	100
5.	10BROAD36	Co-axial cable (75 ohm)	Broad band (DPSK)	10	3600
6.	10BASEF	Fiber optics	Baseband	10	2000

Table Q.8.1 IEEE 802.3 medium options

1) **10BASE5 :** It is popularly called as **thick ethernet**. The notation 10BASE5 means that it operates at 10 Mbps, uses baseband signaling and can support segment upto 500 metres. The length of the network can be extended using repeaters. The standard allows a maximum of four repeaters in the path between any two stations, extending the effective length of the network to 2.5 km.

Application : 10BASE5 is generally used as low cost alternative for fiber optic media for use as a backbone segment with in a single building. Its extended length, higher attached device count and better noise resistance make 10BASE5 well suited for use as a network trunk for one or more floors in a building. However the high cost of connecting each device makes 10BASE5 too expensive for most LAN installations a single break or bad connection in the cable can bring the entire network down.

2) **10BASE2 :** It is popularly called as **chepearnet** or thin ethernet. It uses thin co-axial cable. The thinner cable results in significantly cheaper cost, at the penalty of fewer stations and shorter length. Therefore 10BASE2 is limited to a maximum of 30 network devices per unrepeated network segment with a minimum distance of 0.5 m. And segment length is reduced to 185 metres.

   Application : For small budget conscious installations, 10BASE2 is the most economical topology such as UNIX work stations.

   The disadvantages of 10BASE2 is that any break in the cable or poor connection will bring the entire network down and repeaters are required if more than 30 devices are connected to the network or the cable length exceeds 185 m.

3) **1BASE5 :** It is also known as **star LAN**. It specifies operation at 1 Mbps, using a passive star topology.

   Application : This options is substantially lower in cost than either of coaxial cable options. This options could be appropriate for a departmental-level LAN.

4) **10BASET :** 10BASET is 10 MHz ethernet running over UTP cable. It also uses passive star topology. The maximum cable segment allowed is 100 - 150 metres. There is no minimum distance requirements between devices, such devices cannot be connected serially but in star wired. Maximum 1024 stations can be connected to network.

   Application : 10BASET is the most flexible topology for LAN's and is generally the best choice for network installations. 10BASET hubs or multi-hub concentraters, are typically installed in a central locations to the user community. The signalling technology is very reliable even in somewhat noisy environments it automatically shutdown the offending parts without affecting the rest of the network. Cabling is cheaper and requires less skill to install. Maintenance is easy.

   The disadvantages are the hardware required is more expensive and maximum cable run from hub is 100-150 metre.

5) **10BROAD36 :** It is a 10 Mbps broadband option. It provides support to more stations over greater distances than the baseband versions. The maximum cable run is restricted to 3600 m in two segments of 1800 m from the head end. Other services such as TV or voice can also be integrated on the same cable using FDM.

6) **10BASEF :** 10BASEF is 10 Mbps running over fiber optic cabling. The maximum cable length depends on signaling technology and

medium used but can go upto 2 km unrepeated segment. It is star wired so there is no minimum distance requirement between devices.

Application : 10BASEF is the only recommended topologies for inter-building links. However they need not be limited to this role, it can also run to desktop. It has excellent noise immunity.

- The disadvantage is, it is very expensive due to the cost of connectors and terminators.

3.5 : IEEE 802.4

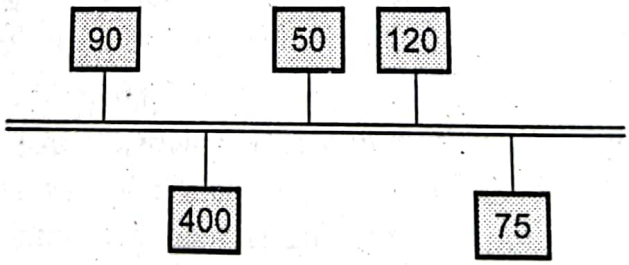
Q.9 Write short note on IEEE 802.4 (Token Bus).

☞ [SPPU : Dec.-18, Marks 4]

Ans. : • IEEE-802.4 describes a token bus LAN standards.

- In token passing method stations, connected on a bus are arranged in a logical ring. When the logical ring is initiated, the highest numbered station may send the first frame. After this it passes permission to its immediate neighbour by sending a special control frame called a **token.**

Physical topology



Logical sequence of token passing

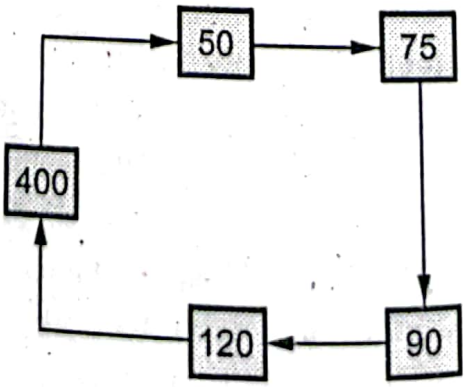
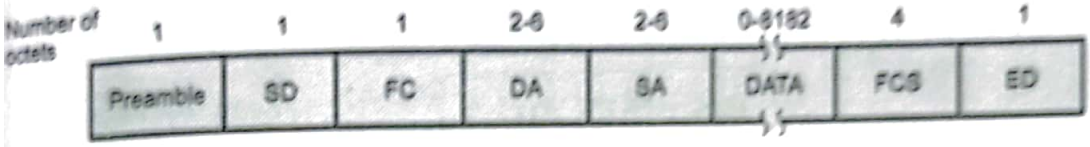


Fig. Q.9.1 Token passing sequence in a bus

The token propagates around the logical ring, with only the token holder being permitted to transmit frames. Since only one station at a time holds the token, collisions do not occur.

- There is no relation between the physical location of the station on the bus and its logical sequence number. Fig. Q.9.1 illustrates the operation of token bus.
- The token bus frame format is shown in Fig. Q.9.2. It consists of following fields.



Preamble : Bit synchronization
SD : Frame start delimiter
FC : Frame control
DA : Destination address
SA : Source address
DATA : Data field
FCS : Frame check sequence
ED : End delimiter

Fig. Q.9.2 802.4 frame format

- **Preamble :** The preamble is an at least one octet-long pattern to establish bit synchronization.
- **Start Delimiter (SD) :** It is a one octet-long unique bit pattern which marks the start of the frame.
- **Frame Control (FC) :** The frame control field is used to distinguish data frames from control frames. For data frame, it carries the frames priority. The frame control field indicates the type of the frame data frame or control frame.
- **Destination Address (DA) :** The destination address field is 2 or 6 octets long.
- **Source Address (SA) :** The source address field is also 2 or 6 octets long.

- **Frame Check Sequence (FCS) :** Frame check sequence is 4 octets long and contains CRC code. It is used to detect transmission errors on DA, SA, FC and data fields.
- **End Delimiter (ED) :** It is a unique bit pattern which marks the end of frame. It is one octet long.
- The total length of the frame is 8191 octets.

802.4 Performance :

- For token ring, the slightly higher delay compared to CSMA/CD bus occurs. For higher transmission loads the token ring performs well.

3.6 : IEEE 802.5

Q.10 Write short note on IEEE 802.5 (Token Ring).

☞ [SPPU : Dec.-18, Marks 3]

Ans. : • In a token ring a special bit pattern, called the **token**, circulates around the ring whenever all stations are idle.

- When a station transmits, it breaks the ring and inserts its own frame with destination and source addresses.

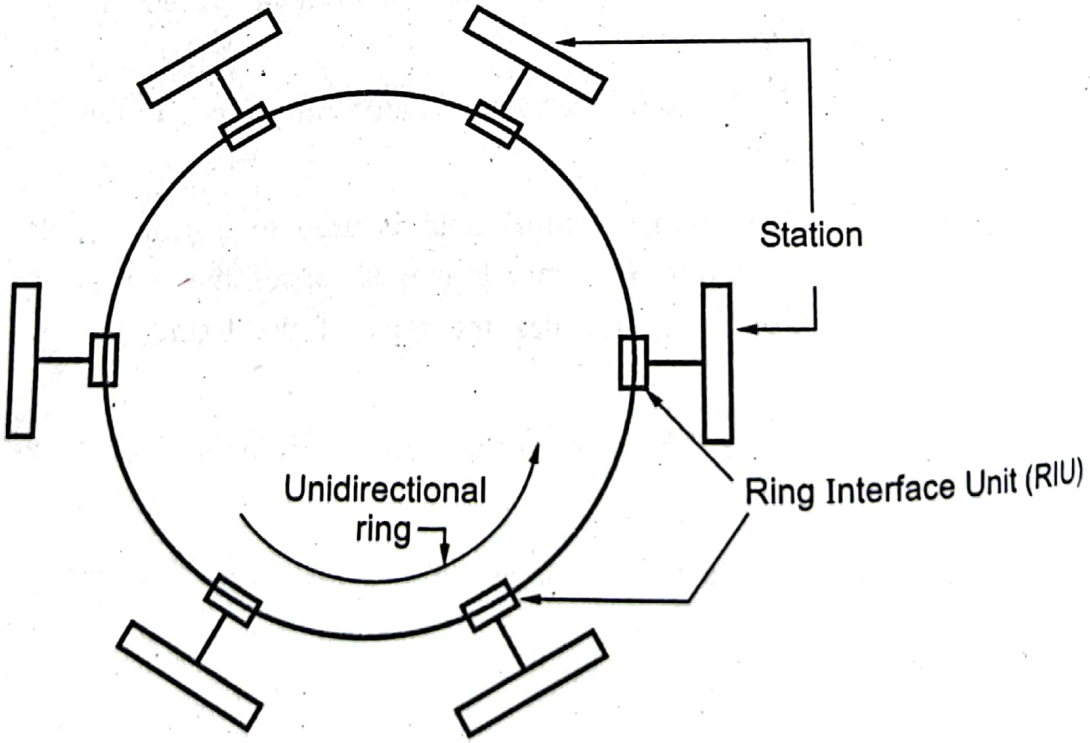


Fig. Q.10.1 A ring network

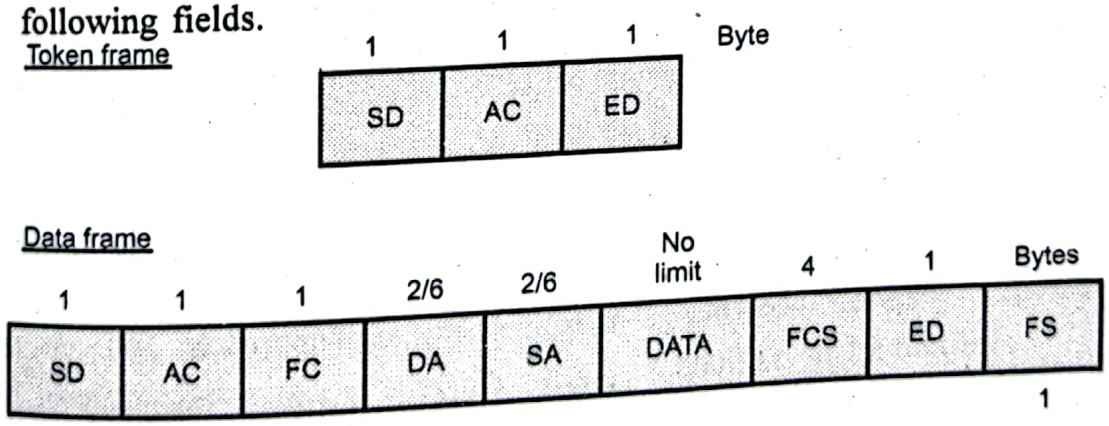
- When the frame eventually returns to the originating station after completing the round, the station removes the frame and closes the ring. Because there is only one token, only one station can transmit at a given instant, thus solving the channel access problem. .
- Fig. Q.10.1 shows token ring arrangement.
- Each station is connected to the ring through a Ring Interface Unit (RIU). The sequence of token is determined by the physical locations of the stations on the ring.

IEEE 802.5 cable standards :

- The token ring standard IEEE 802.5 specifies two types of transmission medium discussed below.
  1) **Shielded Twisted Pair (STP) :** It uses differential Manchester signaling technique. Data rate is 4 or 16 Mbps. Maximum number of repeaters allowed is 250.
  2) **Unshielded Twisted Pair (UTP) :** It uses differential Manchester signaling technique. Data rate is 4 Mbps, maximum number of repeaters allowed is 250.

IEEE 802.5 Frame Format

- The IEEE 802.5 token protocol is shown in Fig. Q.10.2. It consists of following fields.



SD : Start delimiter
AC : Access control
FC : Frame control
DA : Destination address
SA : Source address
DATA : Data field
FCS : Frame check sequence
ED : End delimiter
FS : Frame status

Fig. Q.10.2 Formats of IEEE 802.5 frames

- **Start Delimiter (SD) :** Start delimiter field marks the beginning of the frame. It is one octet long unique bit pattern.
- **Access Control (AC) :** It is a one octet long field containing priority bits (P), token bit (T), monitoring bit (M), and reservation bits (R).
- **Frame Control (FC) :** It is one octet long field and indicates the type of frame data frame or control frame. It also distinguishes the control frames.
- **Destination Address (DA) :** The destination address field is 2 or 6 octets long.
- **Source Address (SA) :** The source address field is also 2 or 6 octets long.
- **Data Field :** It can have 0 or more octets. There is no maximum size but the frame transmission time is limited by the token holder timer.
- **Frame Check Sequence (FCS) :** The frame check sequence is 4 octets long and contains the CRC code. It checks on DA, SA, FC and data fields.
- **End Delimiter (ED) :** It is one octet long and contains a unique bit pattern marking the end of a token or data frame.
- **Frame Status (FS) :** This field is one octet long and contains a unique bit pattern marking the end of a token or data frame.

Token Ring Performance :

- When traffic is light, the token will spend most of its time idly circulating around the ring. When traffic is heavy, there is a queue at each station. The network efficiency can approach 100 % under conditions of heavy load.

Q.11 Compare IEEE 802.3, IEEE 802.4, IEEE 802.5 in a tabular format.

☞ **[SPPU : June-22, Marks 9]**

Ans. :

Sr. No.	802.3	802.4	802.5
1.	Size of the frame format is 1572 bytes.	Size of the frame format is 8202 bytes.	Variable size
2.	Size of the data field is 0 to 1500 bytes.	Size of the data field is 0 to 8182 bytes.	No limit
3.	No priorities.	It supports priorities.	Priorities are possible.
4.	Non deterministic.	More deterministic than 802.3.	Deterministic
5.	Minimum frame required is 64 bytes.	It can handle short minimum frames.	It supports short frames.
6.	Efficiency decreases when speed increases and collision affects the throughput.	Throughput and efficiency at high load are excellent.	Throughput and efficiency at high load are excellent.
7.	Modems are not required.	Modems are required.	Modems are required.
8.	Protocol is simple.	Protocol is extremely complex.	Protocol is moderately complex.

3.7 : IEEE 802.6

Q.12 Explain IEEE 802.6.

Ans. : The IEEE 802.6 standard describes a MAN (Metropolitan Area Network) standard called DQDB (Distributed Queue Dual Bus).

- Fig. Q.12.1 shows architecture of the DQDB metropolitan area network.

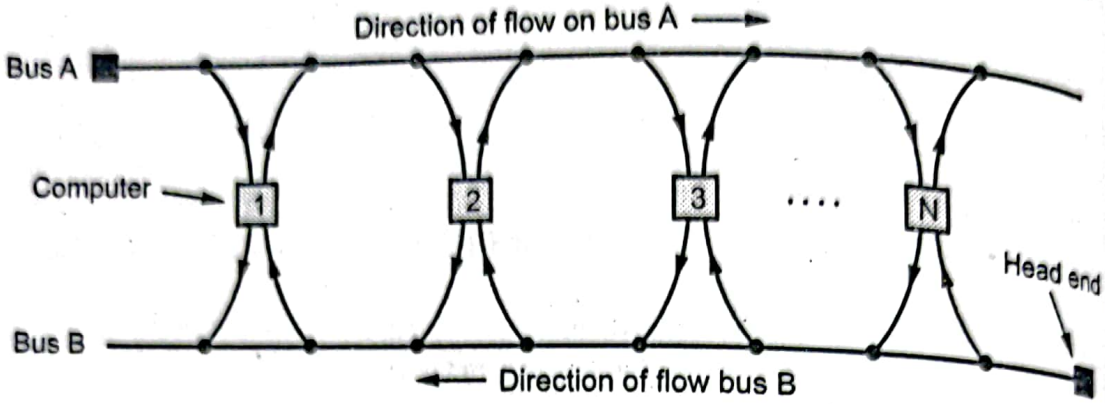


Fig. Q.12.1 Architecture of the DQDB metropolitan area network

- The network is defined as a high-speed shared medium access protocol for use over a dual, counter-flowing, unidirectional bus networks. The use of paired bus provides a failure tolerant configuration.
- DQDB is able to carry data, voice, and video transmissions, with bandwidth being allocated using time slots on the bus.
- It can cover an entire city, upto 160 km at a rate of 44.736 Mbps.
- Basic rule : If you want to send some thing to one of your right hand neighbours, use upper bus A; otherwise, lower bus B.
- Direction of flow on a bus points to down stream. Fixed-size 53-byte cells with 44-byte payload are used, similar to ATM.
- Stream of cells flows down on a bus. Each cell has a busy(B) bit and request (R) bit. If a cell is occupied, its B bit is 1. You make a request by setting a cell's R bit to 1.

3.8 : Fast Ethernet

Q.13 Discuss Fast Ethernet technology in brief. State its specification.

☞ [SPPU : May-17, Marks 6]

Or Explain following physical layer implementation in Fast Ethernet: i) 100BaseTX ii) 100BaseFX iii) 100BaseT4 with respect to media, maximum length and line encoding.

☞ [SPPU : May-19, Marks 6]

Or Compare 100BASE-TX, 100BASE-FX, 100BASE-T4.

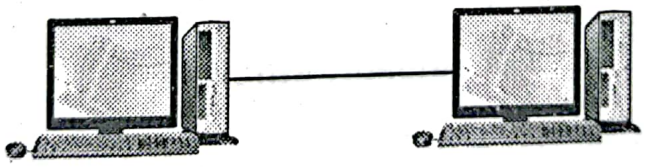
☞ [SPPU : Dec.-17, Marks 7]

Ans. : • Fast ethernet is backward compatible with standard ethernet. The goals of fast ethernet can be :

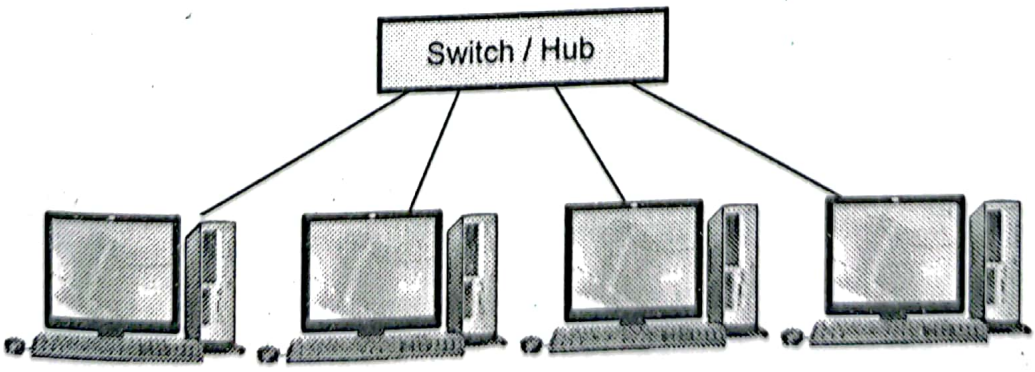
1. Upgrade the data rate to 100 Mbps.
2. Keep the same 48-bit address.
3. Keep the same frame format.
4. Make it compatible with standard ethernet.
5. Keep the same minimum and maximum frame length.

- Fast ethernet refers to a set of specifications developed by the IEEE 802.3 committee to provide a low cost, ethernet compatible LAN operating at 100 Mbps. A traditional ethernet is half duplex : A station can either transmit or receive a frame, but it cannot do both simultaneously.
- Fast ethernet supports the full duplex with full duplex operation, a station can transmit and receive simultaneously. In fact, there is no collisions and the CSMA/CD algorithm is no longer needed.

Topology



(a) Point-to-point



(b) Star

Fig. Q.13.1 Fast ethernet topology

- Fast ethernet is designed to connect two or more stations together. If there are only two stations, they can be connected point-to-point. Three or more stations need to be connected in a star topology with a hub or a switch at the center. It is shown in the Fig. Q.13.1.

Summary sheet of fast ethernet

Parameters	100BASE-TX		100BASE-FX	100BASE-T4
Transmission medium	STP	Cat 5 UTP	Fiber	Cat 3, 4, 5 UTP
Number of wires	4	4	2	4
Data rate	100 Mbps	100 Mbps	100 Mbps	100 Mbps
Maximum segment length	100 m	100 m	100 m	100 m
Network span	200 m	200 m	400 m	200 m
Line coding	MLT-3	MLT-3	4B5B	8B/6T/NRZ

3.9 : Gigabit Ethernet

Q.14 Explain Gigabit ethernet.

Ans. : • Goals of gigabit ethernet

1. Upgrade the data rate to 1 Gbps.
2. Make it compatible with standard or fast ethernet.
3. Use the same 48-bit address.
4. Use the same frame format.
5. Keep the same minimum and maximum frame lengths.

- It support the two different modes of operations.

i) Full duplex ii) Half duplex.

- In full duplex mode, there is a central switch connected to all computers or other switches. Each switch has buffers for each input port

in which data are stored until they are transmitted. There is no collisions in this mode. This means that CSMA/CD is not used.

- Gigabit ethernet can also be used in half duplex mode. In this case, a switch can be replaced by a hub, which acts as the common cable in which a collision might occur. The half duplex approach uses CSMA/CD. For shared medium hub operation, there are two enhancements to the basic CSMA/CD scheme.

1. **Carrier extension :** It defines the minimum length of a frame as 512 bytes.
2. **Frame bursting :** It allows for multiple short frames to be transmitted consecutively, up to a limit, without relinquishing control for CSMA/CD between frames.

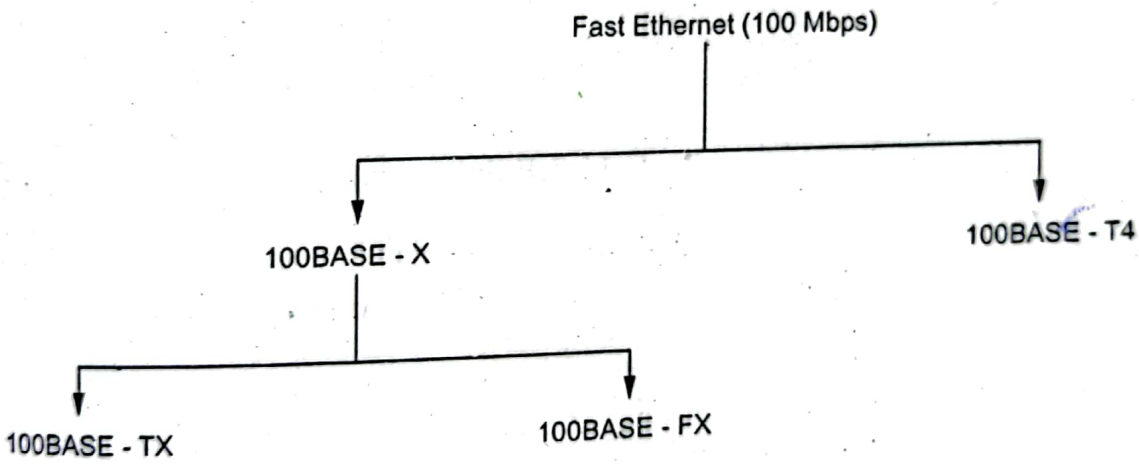


Fig. Q.14.1

Transmission Media

Summary sheet of gigabit ethernet

Parameters	1000Base-SX	100Base-LX	100Base-CX	1000Base-T
Transmission medium	Fiber short wave	Fiber long wave	STP	Cat 5 UTP
Number of wires	2	2	2	4

Maximum segment length	550 m	500 m	25 m	100 m
Line coding	NRZ	NRZ	NRZ	4D-PAM5

Topology

- Gigabit ethernet is designed to connect two or more stations. If there are only two stations, thsey can be connected point-to-point. Fig. Q.14.2 shows the point-to-point connection.

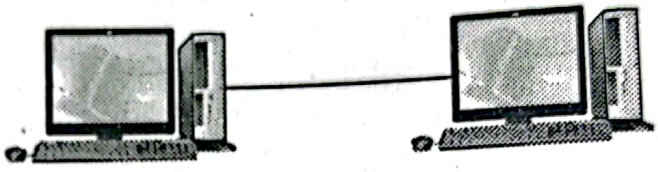


Fig. Q.14.2 Point-to-point

- Three or more stations need to be connected in a star topology with a hub or a switch at the center. This is shown in Fig. Q.14.3.

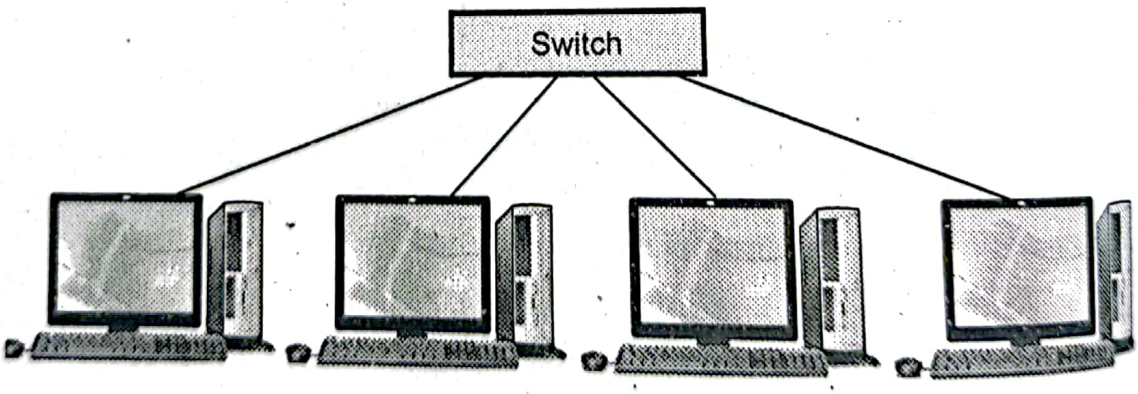


Fig. Q.14.3 Star

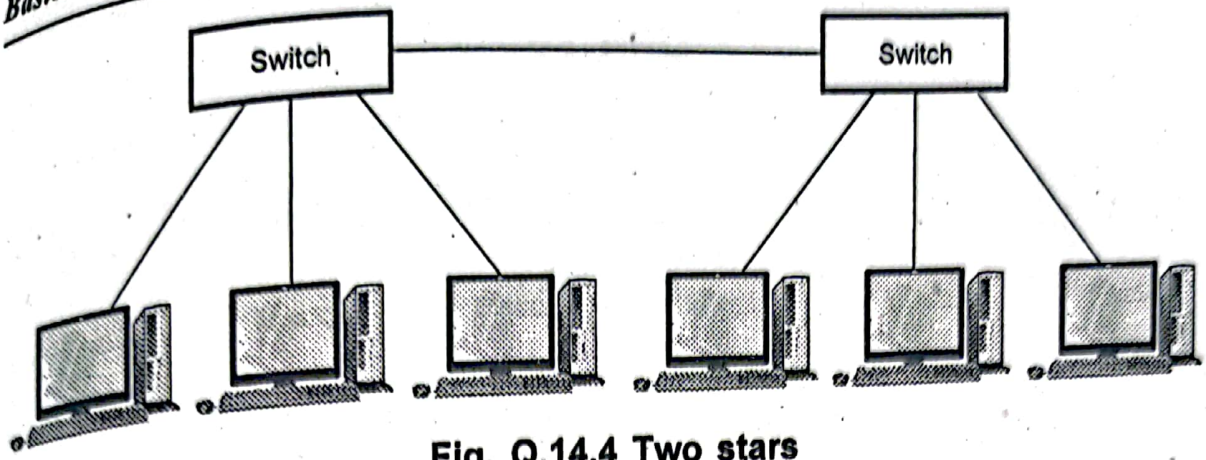


Fig. Q.14.4 Two stars

Q.15 Write a note on :

i) Standard ethernet [Refer Q.7]

ii) Fast etherenet [Refer Q.13]

iii) Gigabit ethernet [Refer Q.14]

☞ [SPPU : June-22, Marks 9]

END...