Computer Network and Data Communication

Data communication

- Data communication is the way of transfering the data / Exchanging the data between two devices through a particular transmission media.
- To implement the process of communication network should be established which allows the interconnection of more than one devices.

Characteristics of data communication

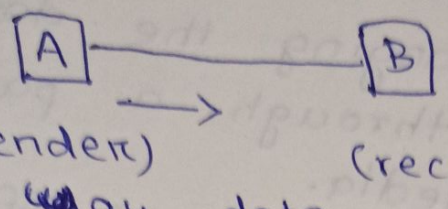
1. Delivery - Transfer of data between sender and receiver
2. Accuracy - Accurate data found in both at sender side & receiver side
3. Timelines - The transformation of data is delivered within certain fixed time.
4. Jitter - Delay in the data communication

Five components

1. message
2. sender (name & address)
3. Receiver
4. Transmission medium
5. Protocol - set of rule is regulation predefined in a network to simplify the process of data communication.

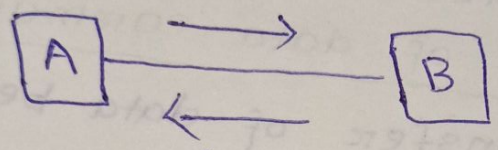
Types of Data Communication

1. Simplex (unidirectional)



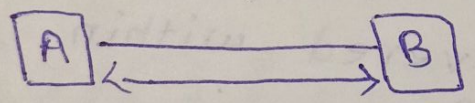
(one way data communication)
That means the sender only sending the data to the receiver.

2. Half-duplex



At a time only one operation will perform after its completion next operation will be operated.

3. Full-duplex



At a time the sender will send the data & also receive the data from ether.

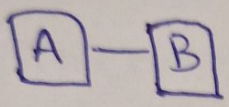
COMPUTER NETWORK

1. Performance - (measure in 2 ways)
   1. dataloss
   2. timeline
2. Reliability - To maintain the sender address and receiver address. It is also related to performance
3. Security - maintain the security level so that the data will not missed and no other sender & receiver will hamper of this.

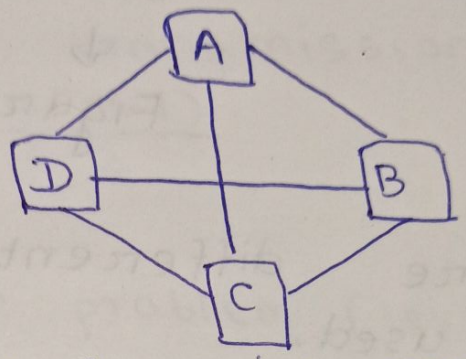
Network connection

1. Point to point

one transmission path is shared by one sender and one receiver.

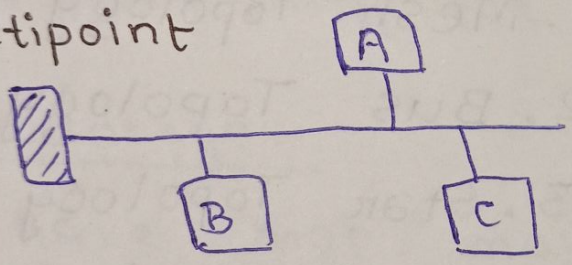


:



(point to point connection)

2. Multipoint



(multipoint)

One path is shared by number of systems.

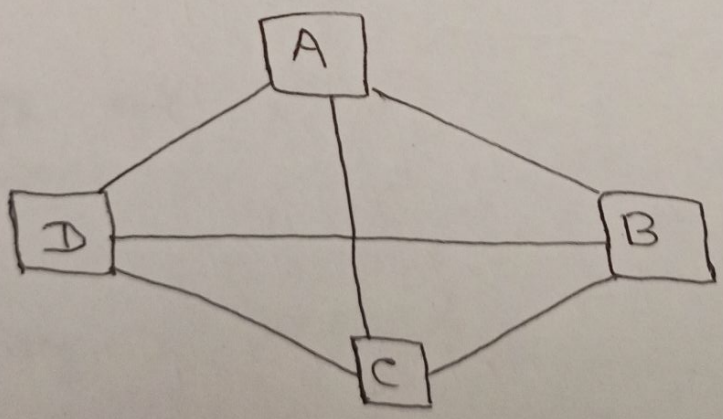
TOPOLOGY

Geometrical representation of any network.
(Outer look) ↓
structure
↓
Figure

There are different types of topology used.

These are
1. Mesh Topology
2. Bus Topology
3. Star Topology
4. Ring Topology

1. Mesh topology



→ Mesh topology is the structure of a network where every system is interconnected to the remaining system.

→ This topology maintains point to point connection throughout the network.

→ In this structure, data transmission mode will be half-duplex.

→ If 'n' no. of nodes (systems) are there then the transmission path will be $\frac{n(n-1)}{2}$

Advantages

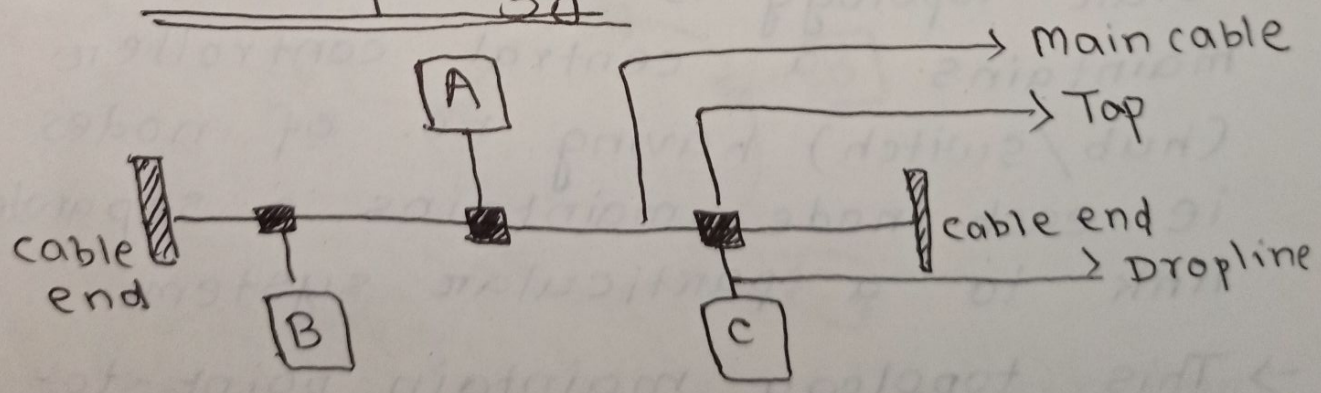
→ Less traffic problem (less congestion problem)

→ less possibility for data loss

Disadvantages

→ It have high maintainance cost due to large no. of cable connection in no. of system.

2. Bus Topology



→ Bus topology is the structure of a n/w when one transmission path is shared by no. of system

→ This topology maintain multipoint connection throughout the n/w.

→ In this structure, the transmission mode will be half-duplex.

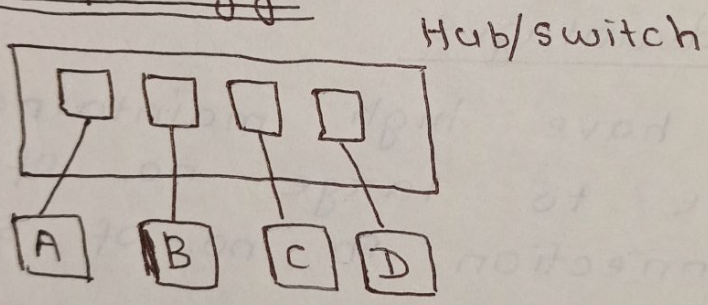
Advantages

→ less maintaince cost than mesh topology (ie cabling cost)

Disadvantage

→ More traffic problem due to single transmission path.

3. Star topology



→ Star topology is a structure which maintains a central controller (hub/switch) having no. of nodes ie each node maintains a separate link to a particular system

→ This topology maintain point-to-point connection throughout the network

→ Transmission mode is half-duplex.

Advantages

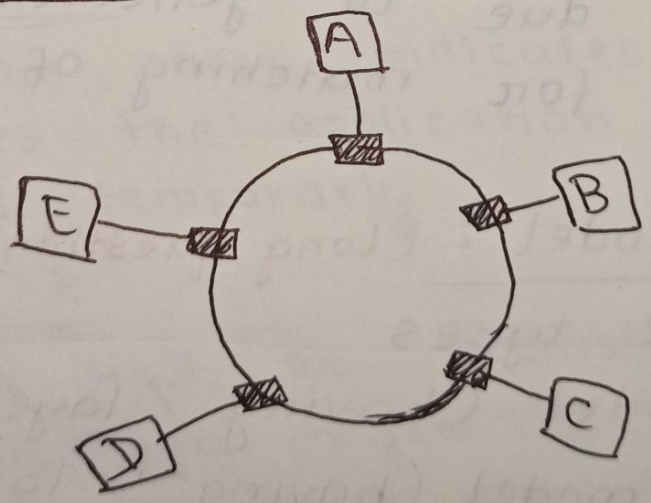
→ Less traffic problem (If n wants to send a data to D, then A send it to the corresponding node to the hub, then hub search it within which hub is attached with D, then it send the data)

→ Robustness - If one link is going to be failure it doesn't have any impact on another system.

Disadvantages

→ If hub will be fail then the transmission will be stopped. But the transmitted data will be recovered.

4. Ring topology



→ In ring topology a circular transmission path is maintain throughout the network.

→ A token is used which hold the piece of the data sender address and receiver address which circulate throughout the ring. It is a data format.

→ If a data will be sent then it will be divided and sent to the receiver.

→ An alarm will be generated when the token pass by the no. of node for making the receiver address.

Advantage

→ There is no loss of data transmission

→ Less maintainance cost

Disadvantage

→ A delay of data transformation is occur due to generation of Alarm for matching of receiver address.

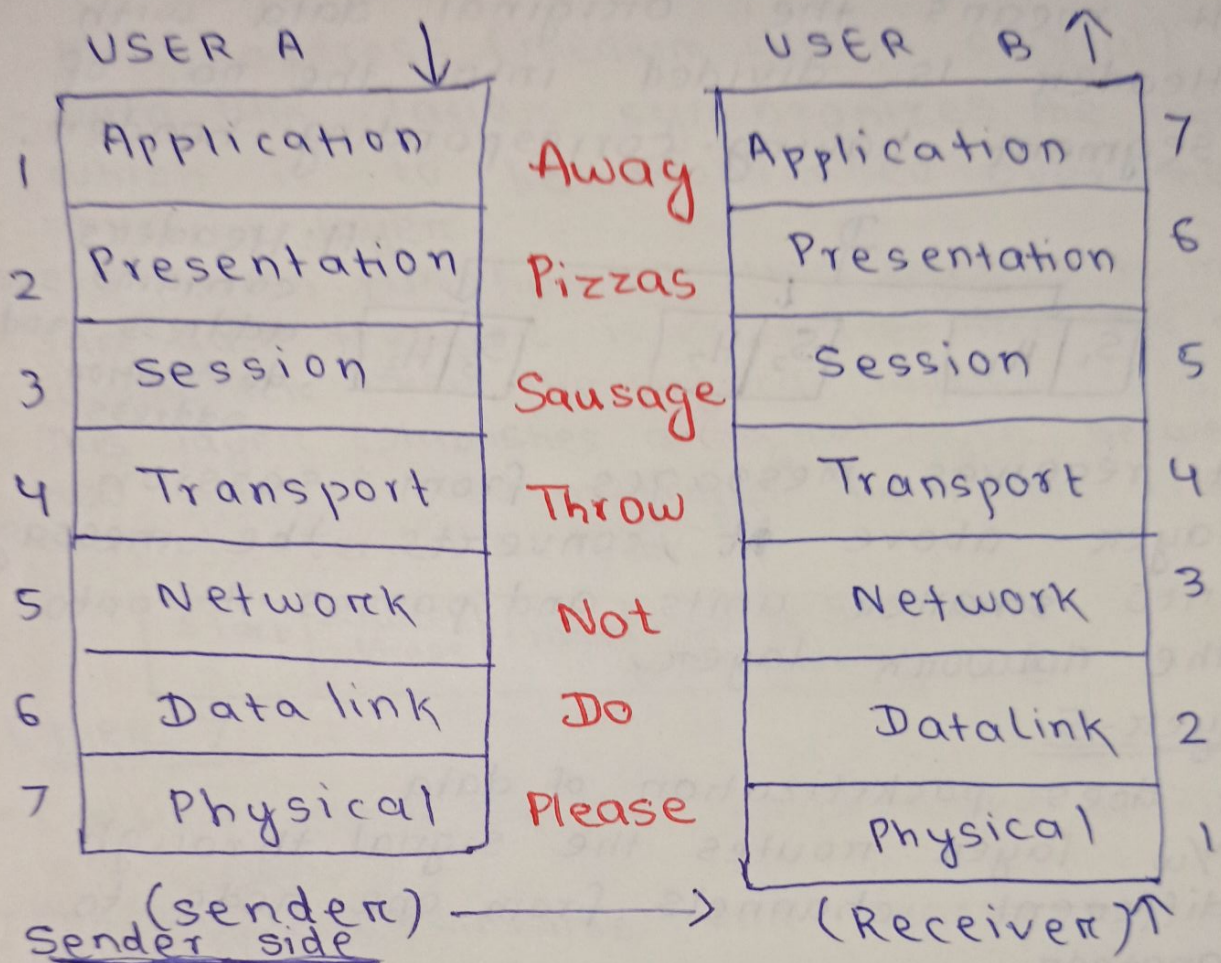
Imp

Network Model : (long question)

- It is of 2 types
  - OSI model (having 7 layers)
  - TCP/IP model (having 5 layers)
- It is the abstraction of any data between the sender and receiver.

01. OSI Model (open system Interconnect)

- It consists of 7 layers.



Sender side

Layer 1

- As the name indicates the sender stores the application program in this layer temporarly.

Layer 2

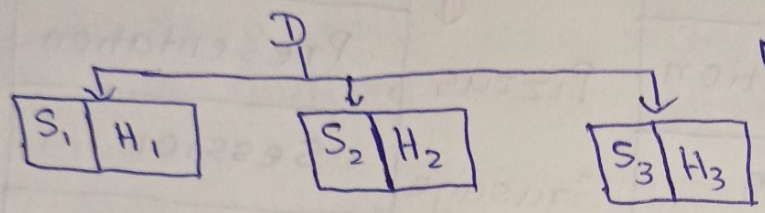
- Data will be transformed from application layer to the presentation layer to check the syntax and symantic of the data.

Layer 3

- As the name indicate this layer maintain the synchronization between the upper and lower layer.

Layer 4

- It deals with the process of segmentation
- It means the original data with Header is divided into the no. of segment having corresponding header.



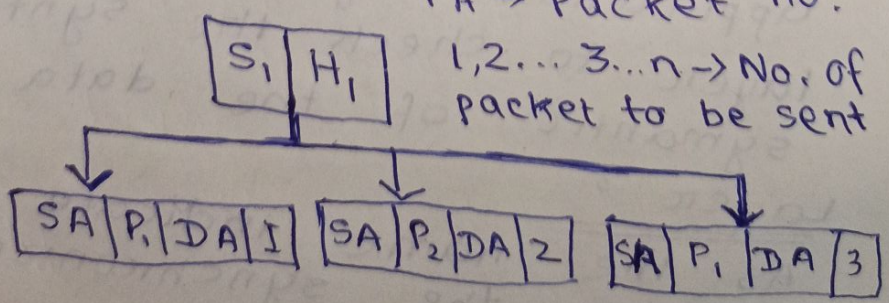
H: Headers contains source address and destination address

- It receives messages from session layer above it, converts the message into smaller units and passes it onto the network layer.

Layer-5

- It does packetization of data
- N/w layer routes the signal through different channels from one node to another.
- It acts as a n/w controller. It manages the subnet traffic.
- It decide by which route data should take.
- It divided the outgoing data into packets is send it into datalink layer.

SA → Source address
DA → destinat^n address
PA → Packet no.
1,2... 3...n → No. of packet to be sent



Layer 6

- Here framing is done.
- It generate the physical address or MAC address (medium access control)
- Data link layer synchronizes the info which is to be transmitted over the physical layer.
- The main function of this layer is to make sure data transfer is error free from one node to another over the physical layer.
- This layer establishes a logical layer between two nodes & also manages the frame traffic control over the n/w.

start	source address	Frame	Dest^n address	end frame

Layer 7

- Physical layer is the lowest layer of the OSI model.
- It activates, maintains and deactivates the physical connection.
- It is responsible for transmission, reception of the unstructured raw data over network.
- It converts the digital/analog bits into electrical signal or optical signals.
- Data encoding is also done in this layer.

OSI model At Receiver Side

1. Physical layer

- Here, it gather all the signal then convert it into analog/digital bit
- After transmission of signal it is responsible for deactivates the physical connect
- It act as an first layer for receiver side.

2. Datalink layer

- Receiving data frames sequentially managed by this layer
- Here data bit are together form frame.
- This layer signals the transmitting node to stop, when the frame buffers are full

3. Network layer

- It assembles the incoming packets into messages for higher levels.

4. Transport layer

- It assembles the incoming the segments into messages for higher level.

5. Session layer

- Here, the synchronisation is maintain between the upper & lower level.

6. Presentation layer

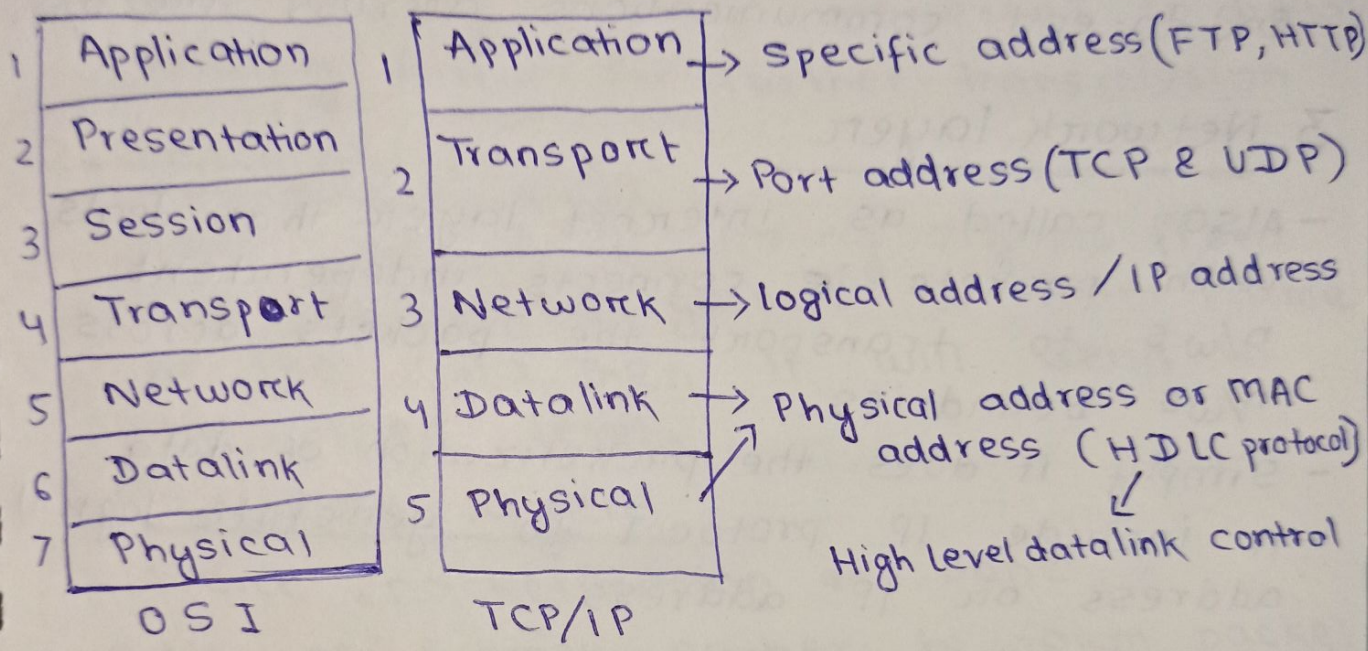
- Here, data coming from the session layer is checked by means of its syntax and semantics. Then the error free message will transfer to the application level.

7. Application layer

Here the receiver program is stored temporarily.

02. TCP/IP model / protocol

- TCP/IP model is the combination of two protocols i.e. TCP (Transmission Control Protocol) and IP (Internet protocol) which helps find out the particular address of sender and receiver in a network.



According to Sender Side

1. Application layer

- The application layer provides application with standardized data exchange.
- It's protocol include the HTTP, FTP, POP3, SMTP, SNMP to generate specific address

2. Transport layer

- It does the work of its own means it does the segmentation of data coming from application layer along with the work of presentation layer and session layer. i.e: it checks the syntax & semantic of the data and

synchronises the data in the upper & lower layer.

- It generate the unified port address using the two protocol called TCP & UDP (user datagram protocol)
- This layer is responsible for maintaining end-to-end communications accross the n/w.

3. Network layer

- Also called as internet layer that deals with packets ie connects independent n/ws to transport the packets across n/ws boundries.
- Simply it does the packetization of data
- It include IP protocol to generate logical address or IP address.

4. Datalink layer

- Here the framing is done.
- It generate the physical address or MAC address (MAC- medium access control)

5. Physical layer

- Here, frames are connected to binary bit.
  [Frame - Most smallest unit of the original data which can be directly converted to the binary bits]

[Let my address is - BBSR, NK, House No-7]

[Logical address - BBSR, NK
Physical address - House NO-7]

Receiver Side

1. Physical layer

- It act as the first layer in the receiver side as it receive the data coming from the sender side.
- Here binary bits are converted to digital/analog form for further transmission

2. Datalink layer

- Here the no. of coming signals from physical layer gather to form frame of the data. Then it will send to the upper level.

3. Network layer

- Here, packetization is done.
- No. of frames gather to form packet of the data & it pass the packet across the network.

4. Transport layer

- Here, the packet data is checked by means of its syntax, semantics.
- Synchronization of data is maintained here
- No. of packets are added to form segments that means segmentation of data is done over here

5. Application layer

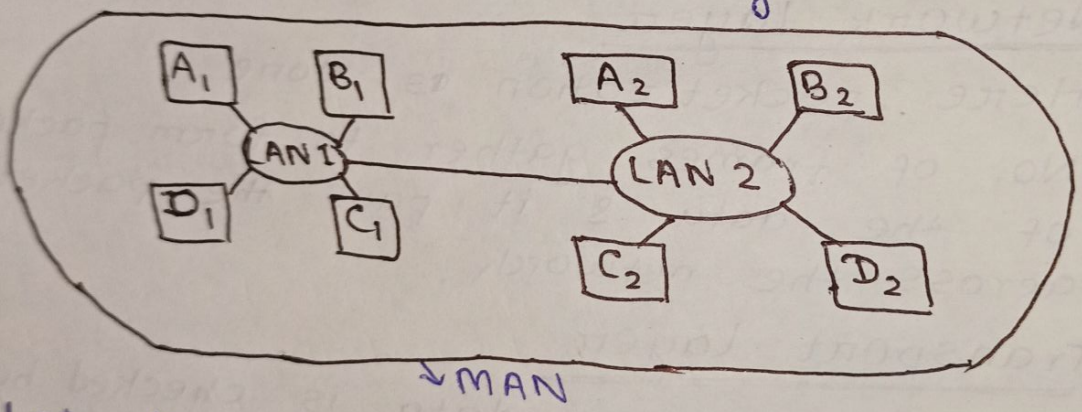
- Here the receiver program is stored.

There are basically 3 types of n/w used.

1. **LAN** (Local Area Network)
   - Here limited number of system are connected to form LAN over a limit range of area.
   - It use the client-server architecture.

2. **MAN** (Metro plotted Area N/w)
   - Here, number of LAN together to form MAN

3. **WAN** (Wide Area N/w)
   - No of MAN together form WAN.
   - It is restricted to some geographical area like state, country etc.



Let A_1 want to send the data to D_2. Then A_1 connect to LAN 1, it connects to LAN 2, so it sends data to LAN_2 and then the data will be sent to D_2.

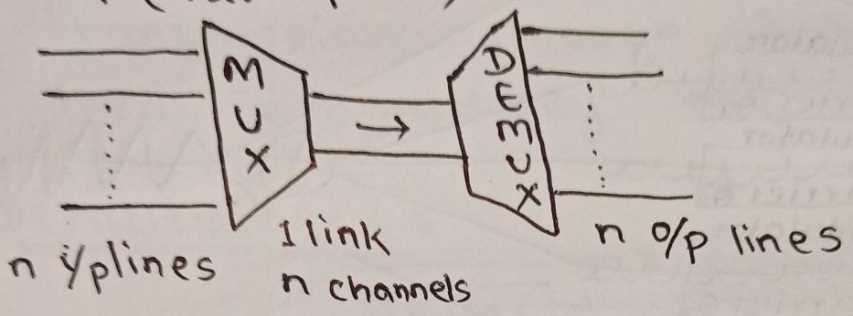
The path of transmission:

$A_1 \rightarrow$ LAN 1 $\rightarrow$ LAN 2 $\rightarrow D_2$

A concept of physical layer

MULTIPLEXING :

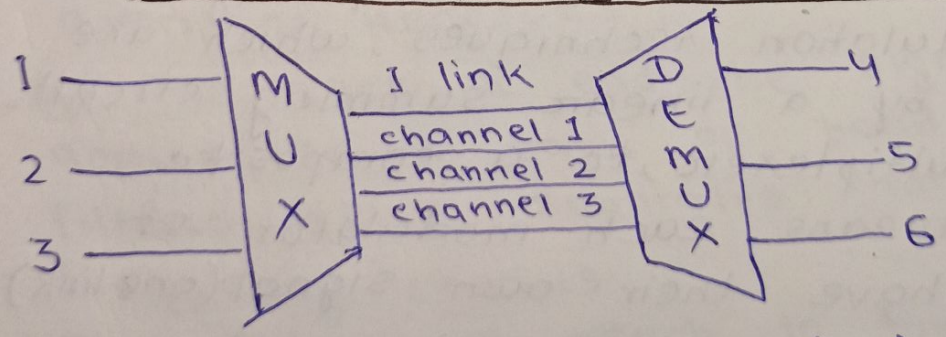
Multiplexing is the set of techniques that allows the simultaneous transmission of multiple signal across a single data link (data path)



Types of multiplexing

1. FDM (Frequency division multiplexing)
2. WDM (wave division multiplexing)
3. TDM (Time division multiplexing)

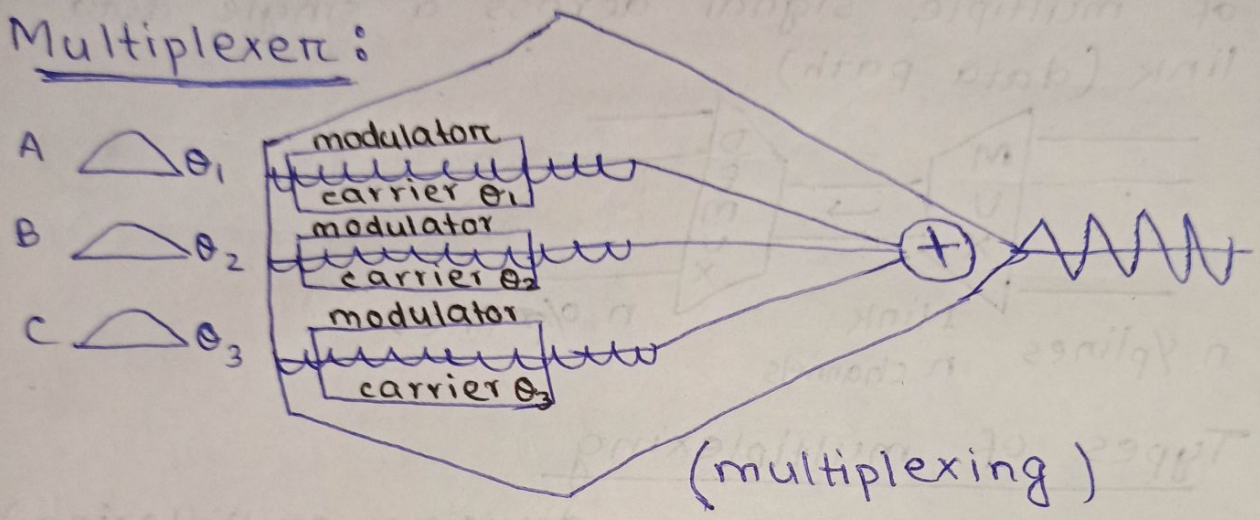
01. FDM (Frequency Division Multiplexing)



- Here, each source (sender) generates a signal of similar frequency range
- Inside the MUX, this similar signals modulate different carrier frequencies.

The resulting modulated signals are then combine into a single composite signal which will be sent over a single link that has enough band width to control or accomodate it.

Multiplexer:

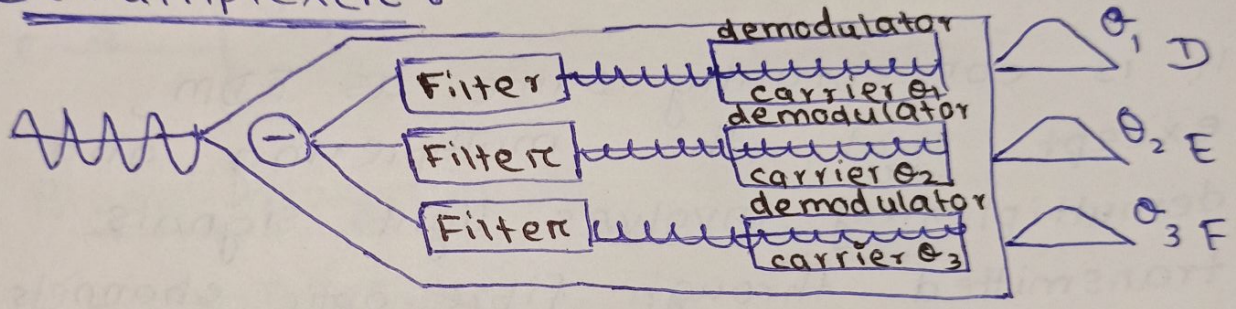


(multiplexing)

- This is done in sender side
- In FDM, the available bandwidth of a single physical medium is sub-divided into several independent frequency channels.
- Independent message signals are translated into different frequency bands using modulation techniques, which are combined by a linear summing circuit in a multiplexer, to a composite signal, means each modulator of carriers have their own signal (one link)
- Basic approach is to divide the available bandwidth of a single physical medium into a no. of smaller, independent frequency channels.

- Using modulation, independent message signals are translated into different frequency bands.
- All the modulated signals are combined in a linear summing circuit to form a composite composite signal for transmission through a single link then automatically the channels are formed.

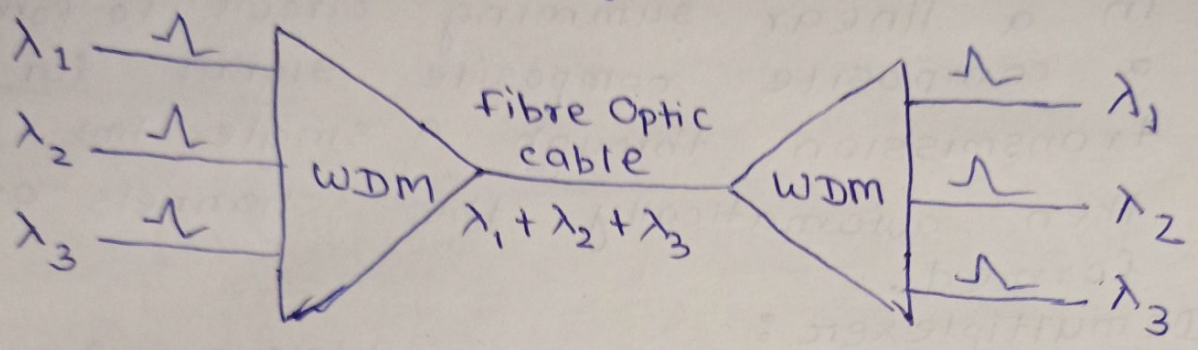
Demultiplexer :



- It is done in the receiver's side
- This composite signal will reach at the receiver side. The composite signal will be divided first to reach at the specific receives.
- At the receiver end the signals is applied to a bank of band-pass filters, which separates individual frequency chanels
- The filter will attach to the specific receiver which will filter out the carrier signal from the composite signal
- Then demodulation will occur for each carrier
- Then the original data will be received by the receiver.

2. WDM (Wave Division Multiplexing)

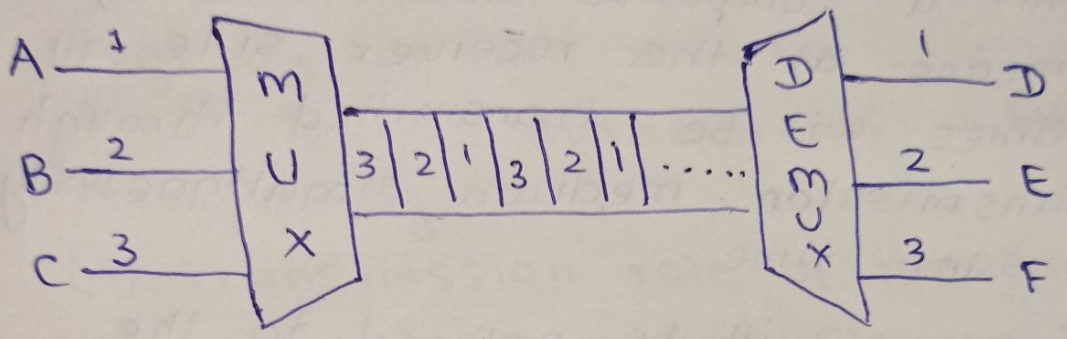
- This is a process where we given the emphasis to the wave length of the source signals.



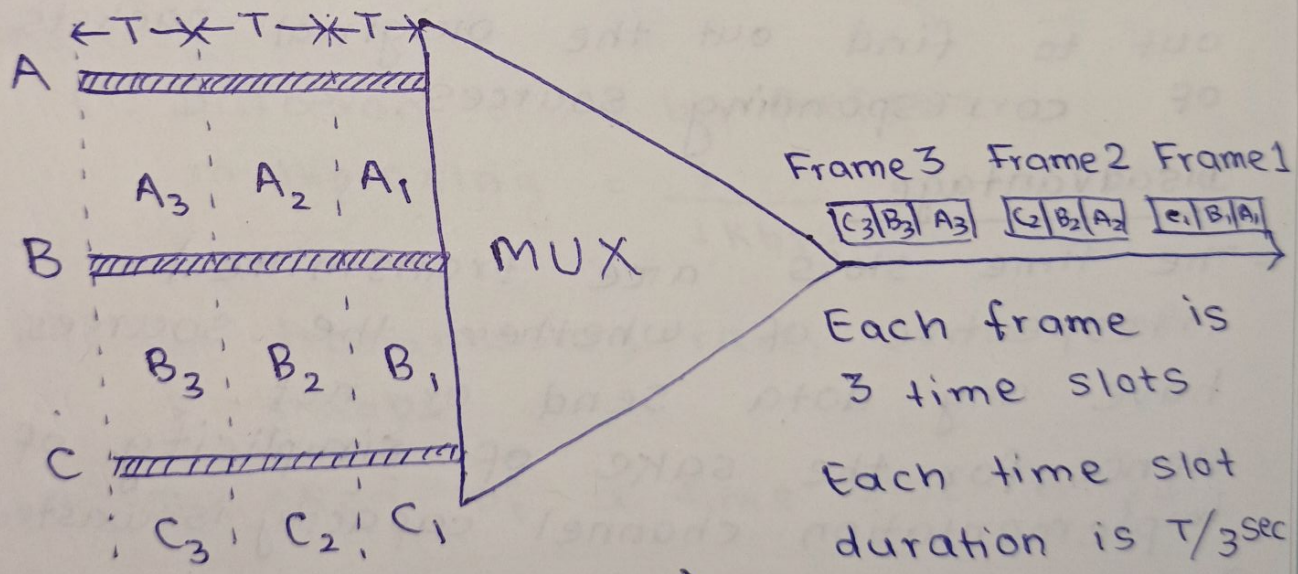
- It is conceptually same as FDM, except that the multiplexing and demultiplexing involves light signals transmitted through fibre-optic channels.
- The idea is the same: we are combining different frequency signals. However, the difference is that the frequency is very high.
- It is designed to utilize the high data rate capacity of the fibre optic cable.

3. TDM (Time Division Multiplexing)

- It is a digital process that allows several connection to share the high bandwidth of a link.
- Each connection occupies a portion of time in the link.



Block diagram of TDM



(Synchronus TDM)

- In FDM, all signals operate at the same time different frequencies, but in TDM all signals operate with same frequency at different times.

- Here data are transferred in the "frame" structure which consist of no. of slots where each slot is typically 1 bit or 1 char in length.
- The frames are scanned sequentially to form a composite data stream, that means at the receiver side all the frames will be transmitted through the transmission medium simultaneously at the same time.
- Each frame will be entered to the demux to carry out the demultiplexing, so that each frame will be filtered out to find out the original packets of corresponding sources.

Disadvantage

- The time slots are transmitted irrespective of whether the sources have any data send or not.
Hence, for the sake of simplicity of implementation channel capacity is wasted.

Ex:- If one more data is present in source no. 3 then another frame is created with 2 blank slots & one data slot.
But those blank slots need the same time to process that the data slot need to proccess.
So, there is a time delay.
The format is | ε_1 | .. | .. |

Advantage

- The total time alloted to the n/w to do a data transmission will be divided equally.
- As equally data transmission is performed, no data loss is occured

Q 'y' 1 Kbps connections are multiplexed together. A unit is 1 bit.
Find the (I) duration of 1 bit before multiplexing
(II) transmission rate of the link
(III) Duration of a time slot
(IV) Duration of the frame.

Ans -

(I) Duration of 1 bit before multiplexing $= \frac{1}{1 \text{ Kbps}}$

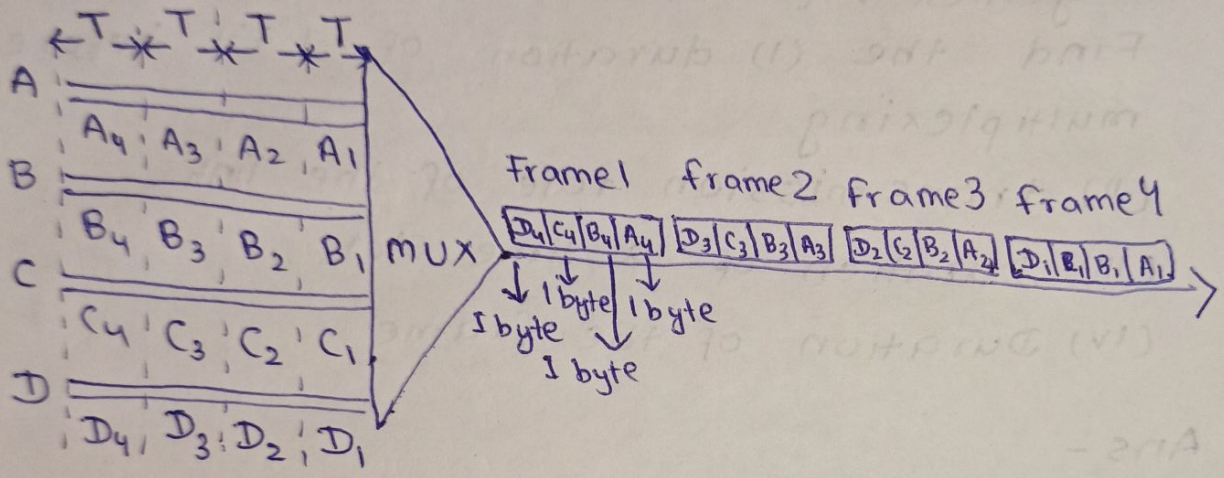
(II) The transmission rate of the line is 4 Kbps

(III) Duration of a time slot is $1/4$ s.

(IV) Duration of the frame is 1 sec.
(As one frame consist of 4 slots)

Q 4 channels are multiplexed using TDM. If each channel sends 100 bytes per sec and we multiplex 1 byte per channel show the frame travelling on the link.
(i) The size of the frame (ii) duration of frame (iii) frame rate (iv) Bit rate for the link.

Ans-



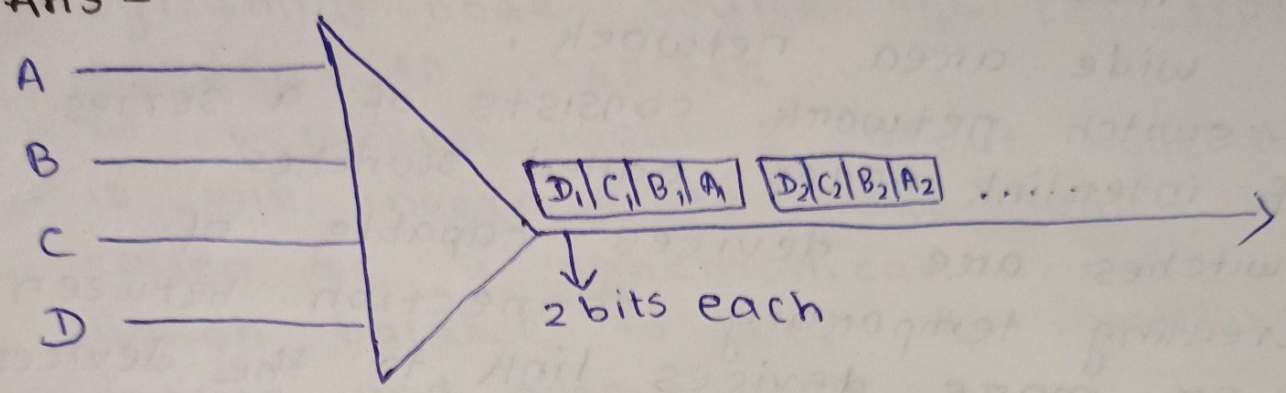
(i) The size of the frame is 4 bytes = 32 bit
(ii) Duration of frame = 1/100 s
(iii) The bit rate = 32 × 100
= 3200 bit per sec
= 3200 bps
(iv) Frame rate = 100 frames per sec
no. of frames formed = 100

Q A multiplexer combines four 100 kbps channels using a time slot of 2 bits. Show the o/p with 4 arbitary i/p.
(1) what is the frame rate
(2) what is the frame duration

(3) what is bit rate

(4) what is bit duration

Ans -



(I) frame rate $= 100 \times 10^3 \times 4$

Frame $= \dfrac{100 \times 10^3 \times 4}{8} = 50 \times 10^3$ frame/sec

(II) Frame duration $= \dfrac{1}{50{,}000}$ s $= 20$ µs

(III) Bit rate $= \dfrac{4 \times 10^3 \times 100}{8} = 50{,}000$ frames

(IV) Bit duration $= 400$ kbps

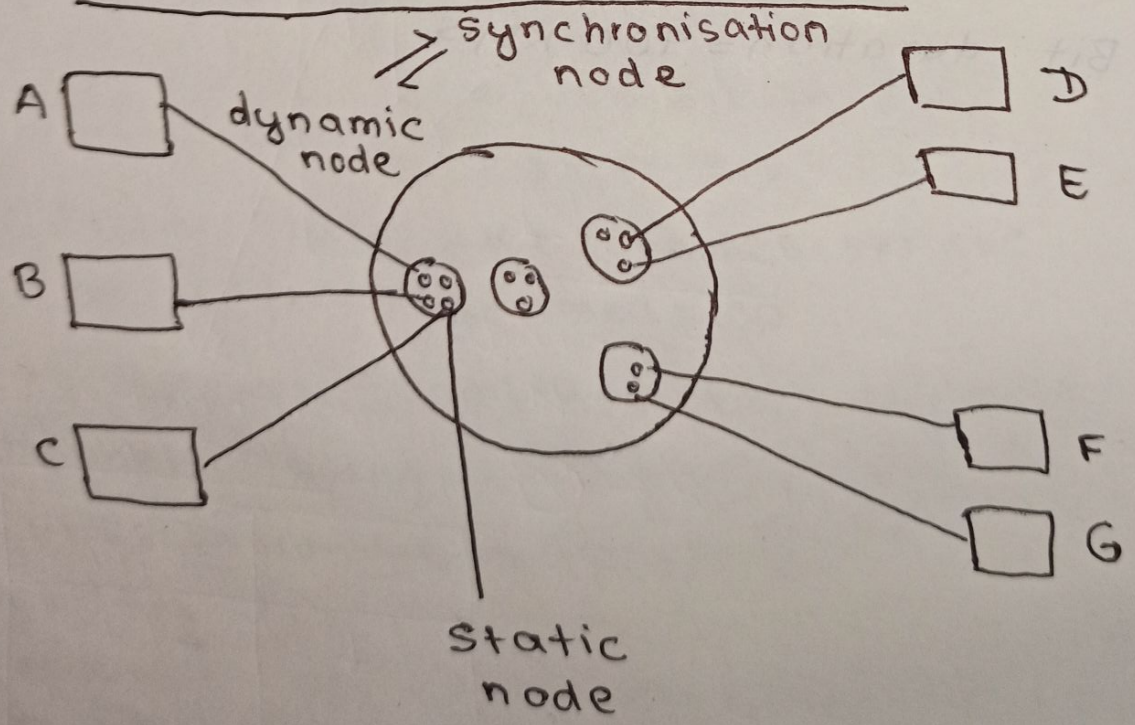
SWITCHING

It is the important technique that can determine how connection are needed and how data moment is handled in wide area network.

- A switch network consists of a series of interlink nodes called switches.
- Switches are devices capable of creating temporary connection between 2 or more devices link to the devices.
- It is of 3 types.

1. Circuit Switched network
2. Packet Switched network
   (a) Datagram network
   (b) Virtual circuit network
3. Message switched network

01. Circuit switched network



- The empty node is called static node who holds the connection
- Dynamic node is the node which is made routes or medium or interlink.
- Dynamic node source the path from sender to receiver.
- In between input & output node there is one intermediate node which is called as a synchronization node which balance to keep the route betn inputs and output nodes.
- The sending system first establish a link with the receiving link.
- After the link is establish the data is transmitted from sender to receiver.
- After the data flow stops the link is automatically released to put the next connection.
- Circuit switching is done at the physical layer.

Advantage

- As there is a dedicated path from sender to receiver, so there is no chance of dataloss & also time line will be maintain.

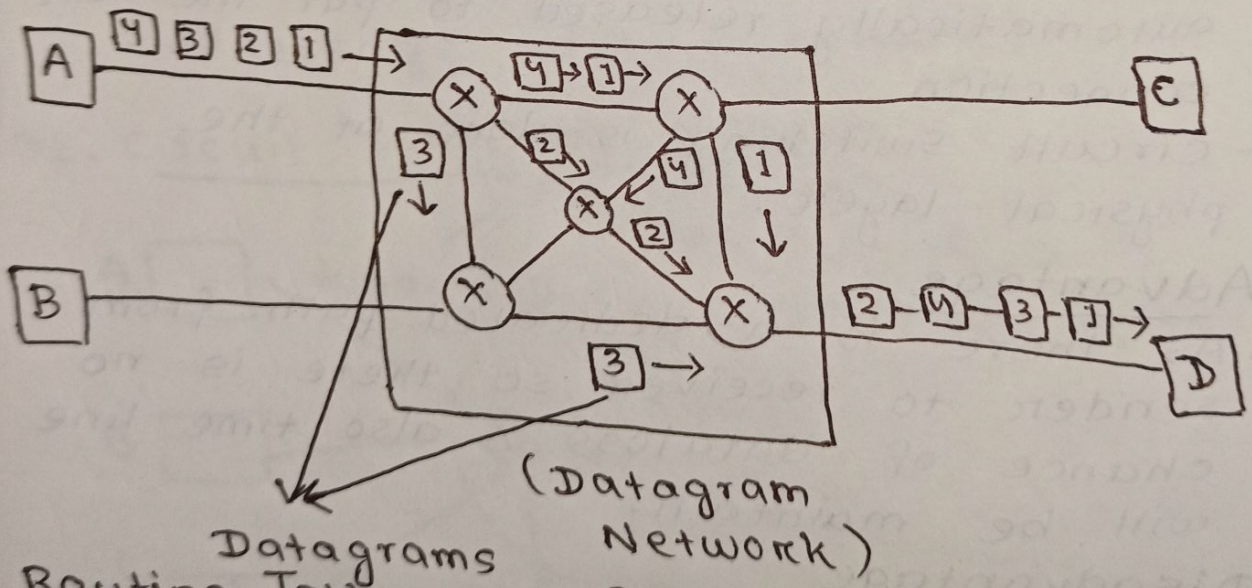
Disadvantage

- The structure of the switch is very complicated because it contains more than, 1 nodes to handle the i/o devices
- So for this maintenance cost will be very high.

02. Packet switch network

- It is a network in which the data will be transmitted from sender to receiver by divide the original data into the most smallest packet
- Packet switch network can be implemented in 2 ways 1) By creating the datagram which is known datagram circuit network otherwise it can be done by creating a virtual circuit in between the sender & receiver which is called as virtual circuit switch network.

(a) Datagram Networks :



(Datagram Network)

Routing Table

Destinat^n address	Port no
3212	1
⋮	⋮
45321	7

(X) → Router Symbol

- In a datagram network, each packet is treated independently in separate paths. Even if a packet can't be divided into smaller unit known as datagram depending upon the demand of the network.
- Datagram switching is normally done at Network layer.
- Before transmitting all the packets from the i/p router it will store for some time then it will be forwarded by checking the channel is free or not for this reason there will be time delay in receiving the corresponding packets in proper manner at the receiver side.
- Each router maintains a routing tables which contain 2 fields : Destination address & port no. of the receiver

---

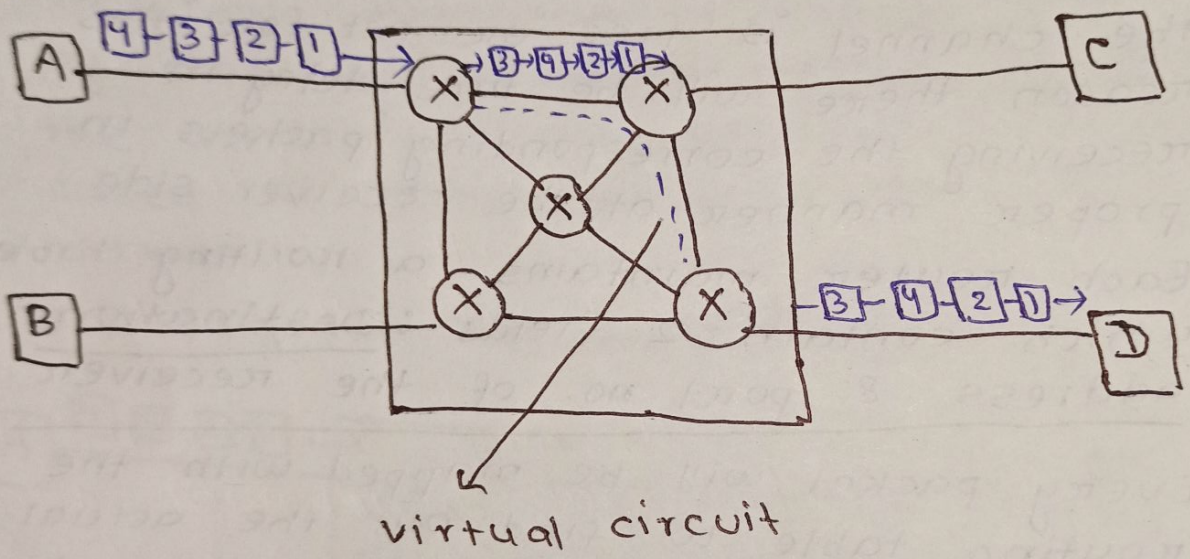
- Every packet will be mapped with the routing table to find out the actual receiver inside the network with its corresponding port no.
- After this process, the packets mayn't be arrived in the proper sequence at the receiver side. For this reason for the arrangement of all the packet to get the original data, it will be forwarded to the upper layer (transport layer which contains the UDP - user datagram protocol helps to arrange all the packets in a proper sequence.

- Now, all the packets are ready to forwarded to application layer in the combination of original data to be stored in the form of application program which can be seen by the user

(b) Virtual Circuit N/w

- It is the combination of circuit switch n/w & datagram n/w

-



- Virtual circuit is establish from the i/p router to o/p router to complete the single transmission who holds 4 packets according to the diagram.
- The temporal virtual path is disabled by the i/p router when number of packets of data.

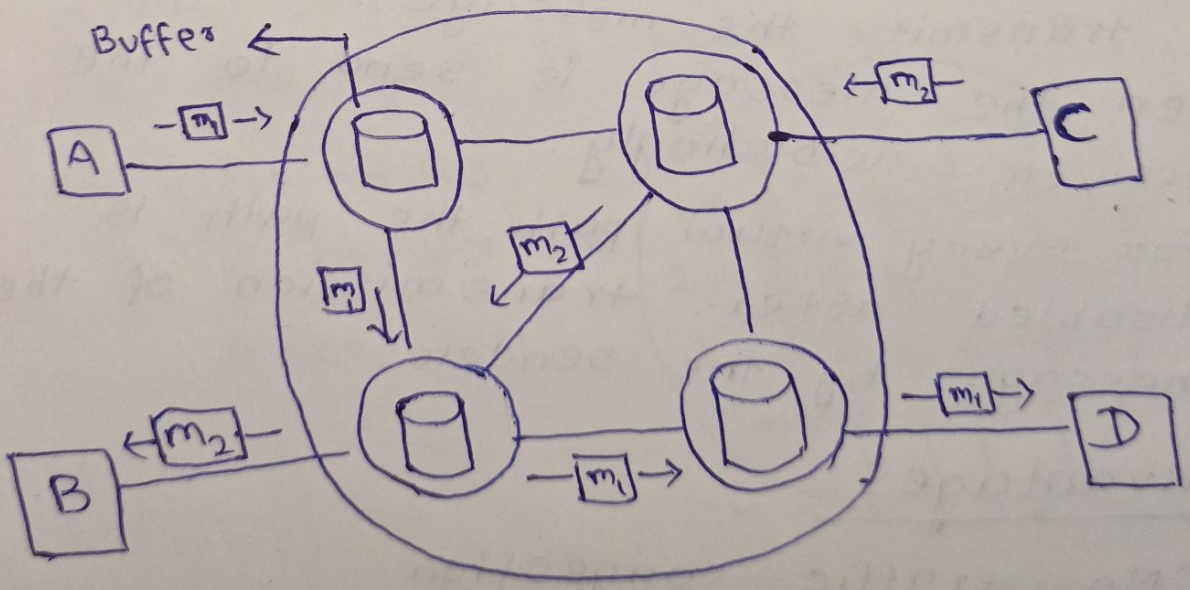
- After this process, the packet may not be arrived in the proper sequence at the receiver side.

For this reason for the arrangement of all the packet to get the original data, it will be forwarded to the upper layer (Transport layer) which contains the UDP-user datagram protocol helps to arrange all the packets in a proper sequence.

- Now, all the packets are ready to forwarded to application layer in the combination of original data to be stored in the form of application program which can be seen by the user.

03. Message Switching (Store & forward)

- In message switching each message is treated as an independent unit & it includes its own destination and source address.



A → D

C → B

Buffer: It is the temporal memory location which stores the message for some time to check the next node is free or not for handling the stored message.

Here, A is send the message to D at the same time C send the data to B.

- First, A is send the message to D at the same time C sends the data to B.

First the message is stored in the buffer then the buffer check whether the next nod is free or not.

If it's free then it create a virtual path from one node to another & transmit the message.

Then the message is send to the receiver accordingly.

- For every virtual path, the path is disabled after transmission of the message by the sender.

Advantages

- No traffic congestion

Disadvantages

- Time delay
- Require more memory space to process the buffer for maintenance

Structure of switch

01. Space-Division Switch

- It is a structure of switch to divide the total space/memory available inside the switch depending upon the number of i/p and o/p who generates no. of cross points/Grid points.

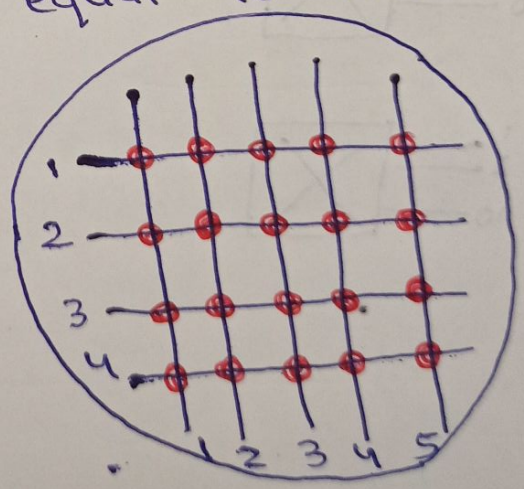
Ex: cross bar switch

If there are 'n' of i/p and 'm' no. of o/p then the total number of cross points available in a switch i.e the grid is equal to n x m.

Ex:- let n = 40

m = 60

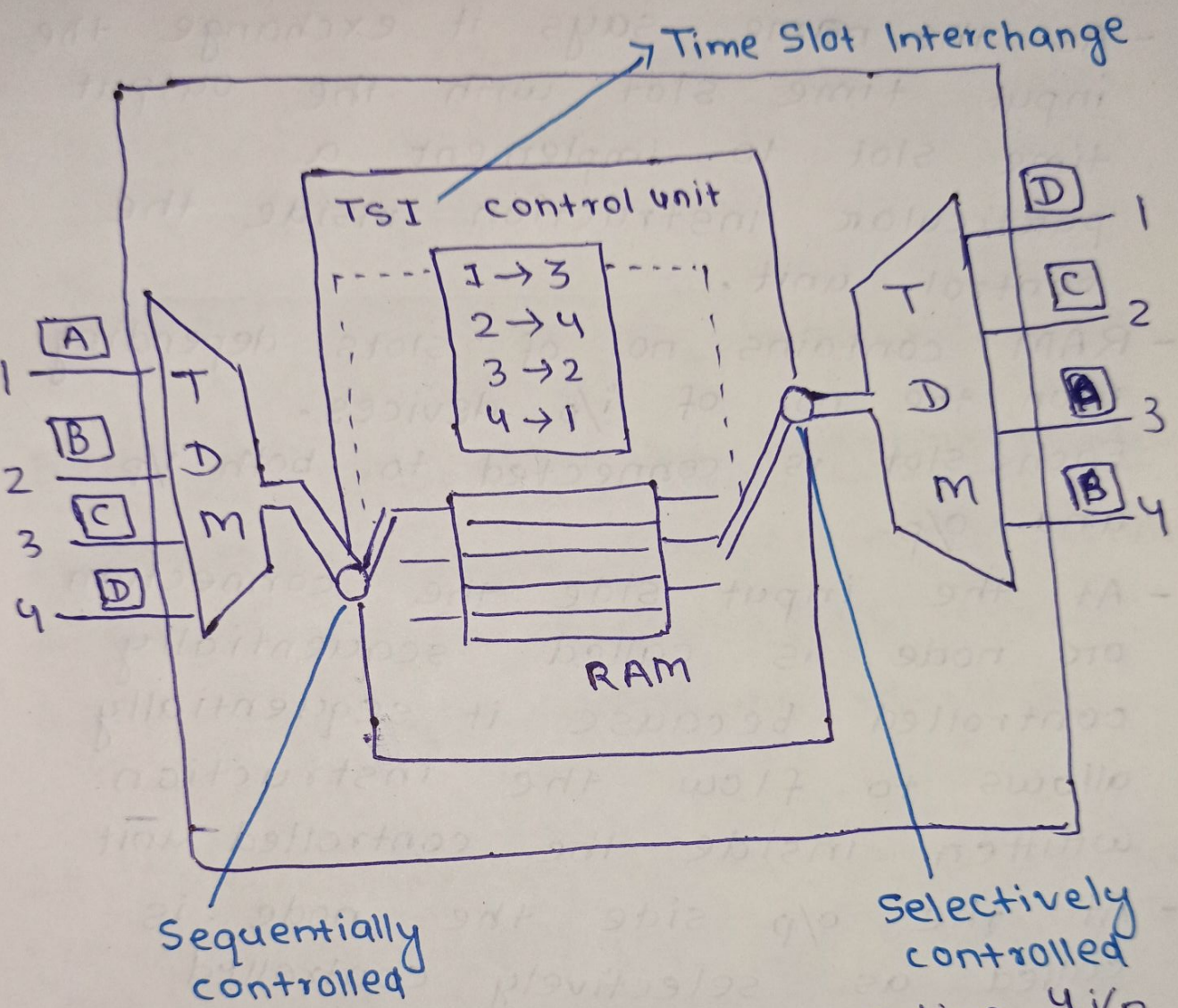
n x m = 2400



n = 4 n x m = 20

m = 5 (grid)

02. Time Division Switch



- It shows a system connecting 4 i/p lines with 4 o/p lines with the pattern
  1 → 3
  2 → 4
  3 → 2
  4 → 1

- TDS is the combination of TDM with TSI.

- TSI holds 2 components ie control unit and RAM.
- As the name says it exchange the input time slot with the output time slot to implement a particular instruction inside the control unit.
- RAM contains no. of slots depending upon the no. of i/p devices. Each slot is connected to both i/p and o/p.
- At the input side the connection or node is called sequentially controlled because it sequentially allows to flow the instruction written inside the controlled unit
- At the o/p side the node is called as selectively controlled because it select which will be the o/p slot of corresponding i/p slot.