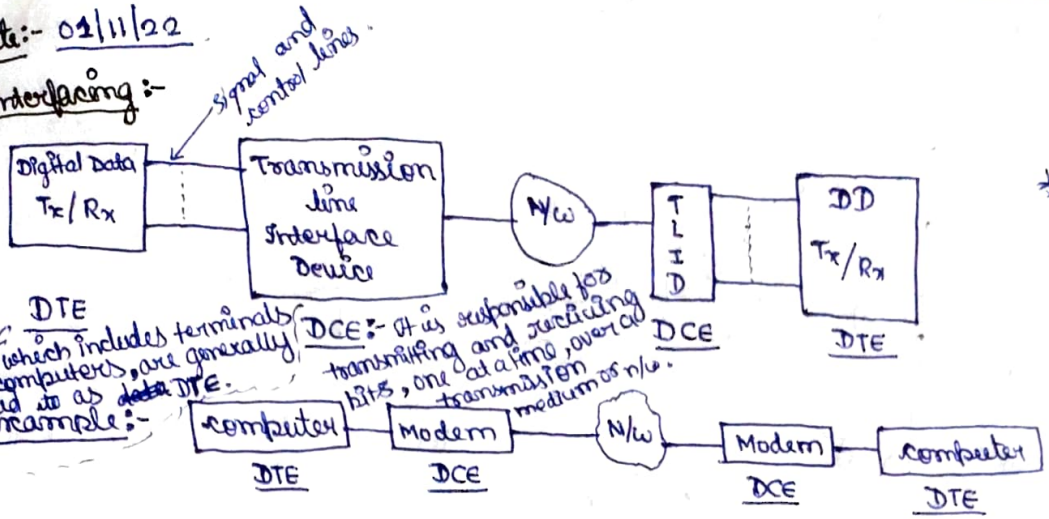
Date:- 01/11/22

* Interfacing:-



* data-terminal equipment.
* data circuit-terminating equipment

DTE:- devices which includes terminals and computers, are generally referred to as DTE.

DCE:- It is responsible for transmitting and receiving bits, one at a time, over a transmission medium or n/w.

Example:-

Standards has been developed that specifies the exact nature of DTEs and DCEs such an interface has four important characteristics:-

① Mechanical. ② Electrical. ③ Functional. ④ Procedural.

* **Mechanical:-** It defines the actual (physical) connection between DTEs and DCEs through a number of wires. Thus, in theory, a 25-wire cable could be used to connect the DTE to the DCE. In practice, far fewer interchange circuits are used in most applications.

* **Electrical:-** They have to do with the voltage level and timing of voltage changes. Both DCE and DTE must use the same code, must use the same voltage levels and must use the same duration of signal elements.

* **Functional:-** It specifies the functions that are performed by assigning meaning to each of interchanged circuits. Functions can be classified to broad characteristics of data, control, timing and electrical signal.

* **Procedural:-** It specifies the sequence of events for transmitting data based on functional characteristics.

→ The procedural specification defines the sequence in which the various circuits are used for a particular application.

Module - IV

Date:- 03/11/22

* **Multiplexing:-**

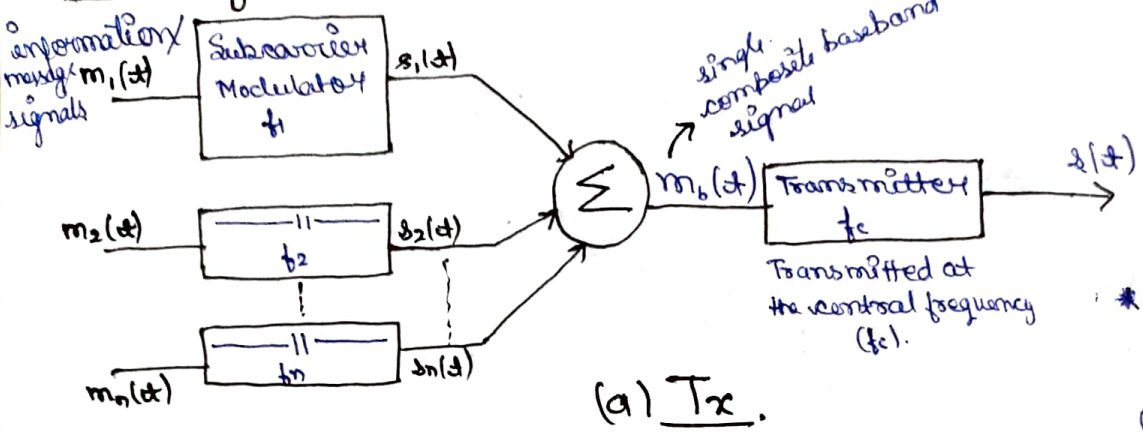
→ Multiplexing is a technique used to combine and send the multiple data streams over a single medium. The process of combining the data stream is known as multiplexing and the hardware used for multiplexing is known as multiplexer.

→ If there are multiple signals to share one medium, then the medium must be divided in such a way that each signal is given some portion of the available bandwidth.

* **Electrical Specification:-**

→ Depending on the function of the interchange circuit, the electrical values are interpreted either as binary or as control signals. A voltage more -ve than -3 volts is interpreted as binary '1' and a voltage more positive than +3 volts is interpreted as binary '0'.

* Frequency Division Multiplexing (FDM) :- (used for analog signal).

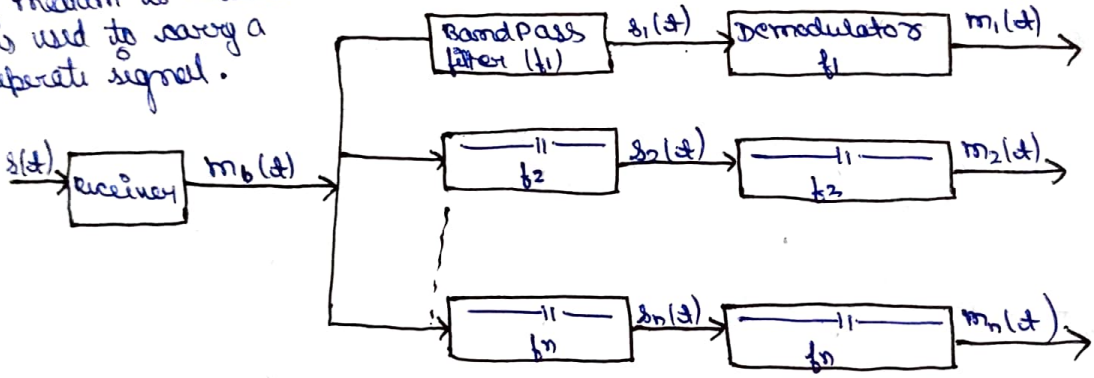


* $(m_1,)$ is modulated at central frequency (f_1).

(a) Tx.

* Signals are generated by different stations $(m_1, m_2, \dots, m_n)$.

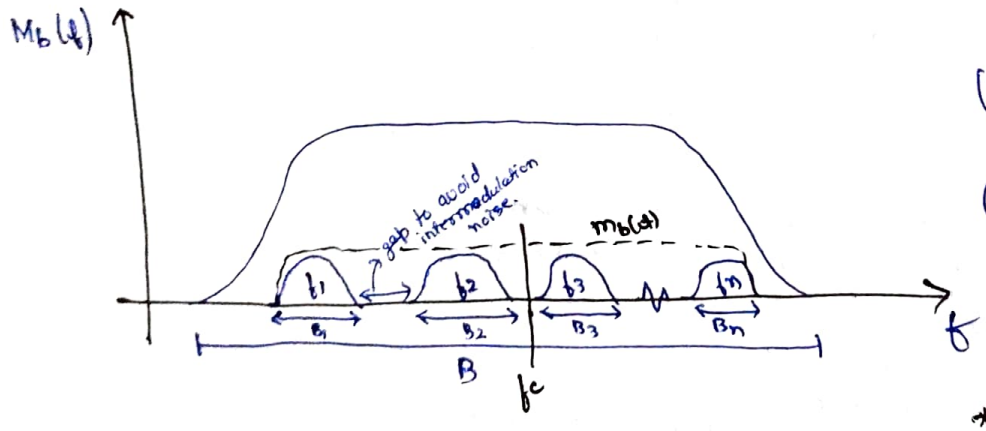
* FDM is a technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency bands, each of which is used to carry a seperate signal.



* most common example is:-
↳ radio, cable television, etc.

(b) Rx.

ⓒ Spectrum of composite baseband modulating signal :-



(Bandwidth of the signals → $B_1, B_2, \dots, B_n$)

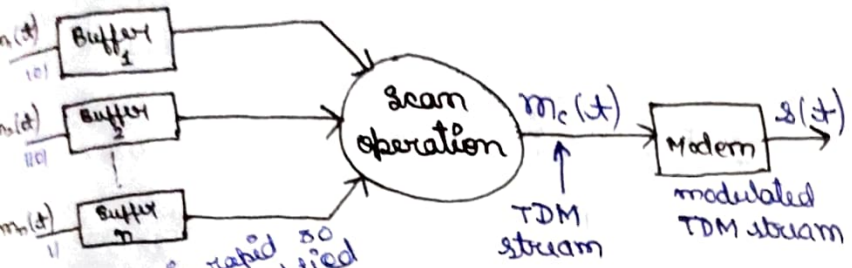
(Bandwidth of the channel → B).

* Best example:- (TV cable).

The modulated signals are combined together using a multiplexer and then the combined signal is transmitted over the communication channel, thus allowing multiple independent data streams to be transmitted simultaneously. At the receiving end, the individual signals are extracted from the combined signal by the process of demultiplexing (DEMUX).

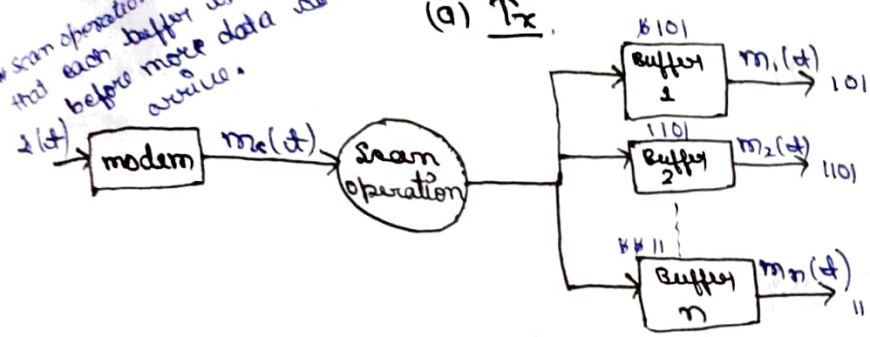
* Time Division Multiplexing (TDM) :- (done for digital signals)

(i) Synchronous TDM :- (called Synchronous because time slots are pre-assigned & constant source.) time slots are sent irrespective of whether the sources have a few records to share or not.



* Scan operation is rapid so that each buffer is emptied before more data can arrive.

(a) Tx.



(b) Rx.

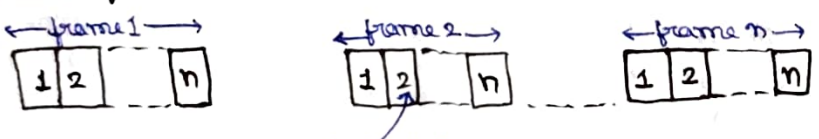
#Note :-
* size of the buffer is fixed for all. (1 bit or 2 bits)
(If Buffer 1 = 1 bit then all buffer has 1 bit).

* size of the frames is equal to the no. of input sources.

eg :-
m_1 101
m_2 1101
m_3 11

x	1	x	frame 4
x	1	1	frame 3
1	0	0	frame 2
1	1	1	frame 1

(a) TDM frame :-



* slots in this convey only data and there is no need of addressing.
* uses synchronization bits at the beginning of each frame

* no. of time slots will be equal to the no. of signals being multiplexed.
* no. of input sources will depend on the channel capacity.

(ii) Statistical TDM :- (Also known as Asynchronous TDM and Intelligent TDM).

The time slots are available only on demand. Time slots are not fixed for all. (control signals are used to determine which station demanded the time slots). In general, the time slots are not wasted.

* TDM is possible when the useful bandwidth of the transmission medium exceeds the required bandwidth of signals to be transmitted.

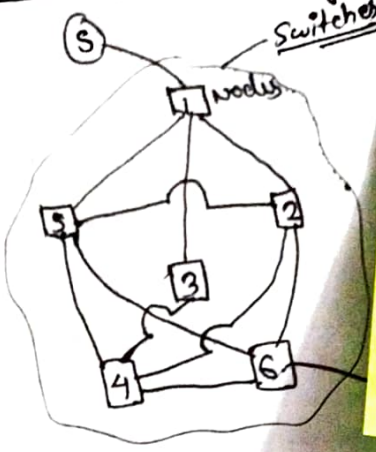
* Synchronous TDM is possible when the achievable data rate of the medium exceeds the data rate of digital signals to be transmitted.

* TDM is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern.

* no. of slots in each frame is less than the no. of inputs lines.
* slots in this contain both data and address of the destination
* it does not use synchronization bits.

Date:- 04/11/22

* Ckt / Pkt Switching:-



Advantages of switching:-
- increases the bandwidth of the n/w.
- reduced workload on individual pcs.
- increases the overall performance by reducing the traffic on the n/w.

Disadvantages:-
- switch is more expensive than network bridges.
- switch cannot determine the n/w connectivity issues easily.

* switches accept the packets, store it and then send/transfers the packets.

* Switches are hardware and/or software devices that are capable of creating temporary connection between two or more devices. (That are linked to the switch)

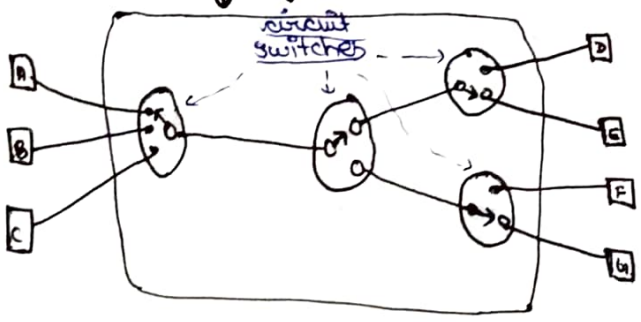
* Communication Network:-

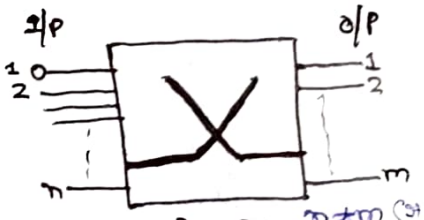
① Switched Network. (circuit switch network, Package switch network)
② Broadcast Network. (Bus N/w , ring N/w , star N/w)

* Switched Network:-

Switched N/w consist of a series of interlinked nodes also called Switches. The switching nodes are not concerned with the content of the data; rather their purpose is to provide a switching facility that will move the data from node to node until they reach their destination. The end devices that wish to communicate may be referred to as stations.

* Circuit Switching Network:-





circuit switch

(or it is not known that n=m)

* circuit switching uses following technologies:-

① Space division switches.
② Time division switches.

* Circuit switching is a switching circuit that establishes a dedicated path between sender and receiver.
* Circuit switching involves three phases:- ① circuit establishment. ② Data Transfer. ③ circuit disconnect.

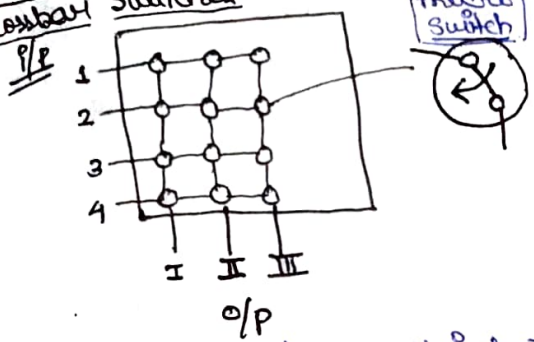
→ Before any signal to be transmitted an end-to-end circuit must be established.

After the establishment of the path the information can now be transmitted from station to station. The data may be analog or digital depending upon the nature of the network

After some period of data transfer the connection is terminated.

* Space Division Switches :-

① Crossbar Switches :-



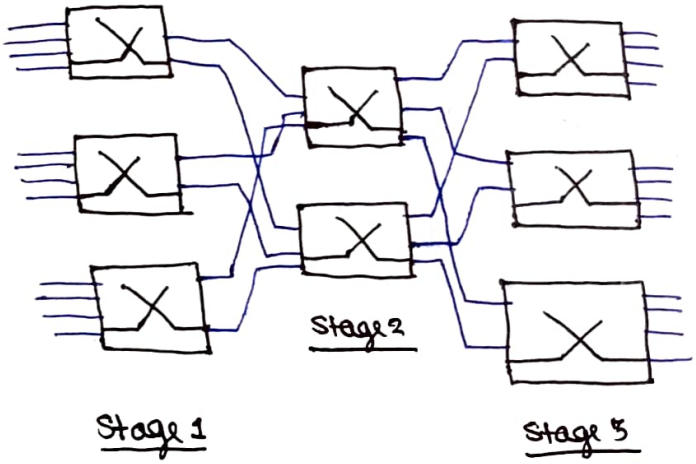
* Path of the circuit are separated from each other spatially.
* Initially designed for analog networks, now it is being used for both analog and digital switching.
* Major problem → cost {to overcome multi stage switches is preferred}.

* It is used to connect a no. of inputs and outputs.
* No. of crosspoints = (no. of inputs × no. of outputs).
(micro switches)

* No Blockage happens since sufficient no. of crosspoints are available.
* The crosspoints are inefficiently utilized; even when all of the attached devices are active, only a small fraction of the crosspoints are engaged.
No. of cross points grows with the no. of attached stations.

② Multistage Switches :- (requires more complex control scheme.)

crossbar switches :- [⧓]



* Intermediate stages have less no. of crossbar switches than initial and final stages.
* No. of stages and No. of crossbar switch used at each stage.

Stage 1	Stage 2	Stage 3
4×2×3	3×3×2	2×4×3
= 24	= 18	= 24

{Total crosspoints = 66}

By using '66' crosspoints we can have '12' inputs and '12' outputs

{If using above, then the no. of crosspoints = 12×12 = 144, more no. of crosspoints, hence Multistage switches are preferred}.

* A path is always available to connect an input to an output; that this may not be the case with a multiple-stage switch. The heavier lines indicate ones already in use.

* Space-division switches :-

A space-division switch is one in which the signal paths are physically separated from one another. each connection requires the establishment of a physical path through the switch that is dedicated solely to the transfer of signals between two end points. The basic building block of the switch is a metalic crosspoint or semiconductor gate that can be enabled and disabled by a control unit.

Date:- 09/11/22

* The main difference between the space DS and time DS is sharing of crosspoints. crosspoints are not shared in SDS whereas in TDS they can be shared in TDM.

* Time Division Switches:-

* uses Time division multiplexing (TDM) to achieve switching
* uses two methods:-

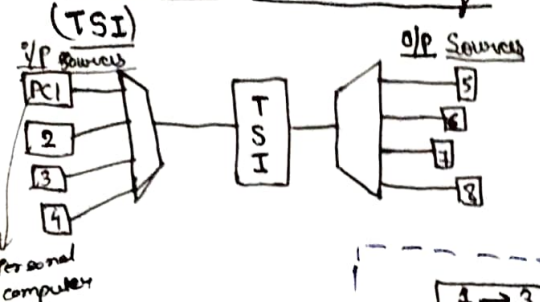
① Time slot interchange (TSL).

② Time Division Multiplexing Bus (TDM)

① * TDS involves the partioning of a lower speed bit stream into pieces that shares a higher-speed stream with other bit streams. The individual pieces, or slots are manipulated by control logic to route data from input to output

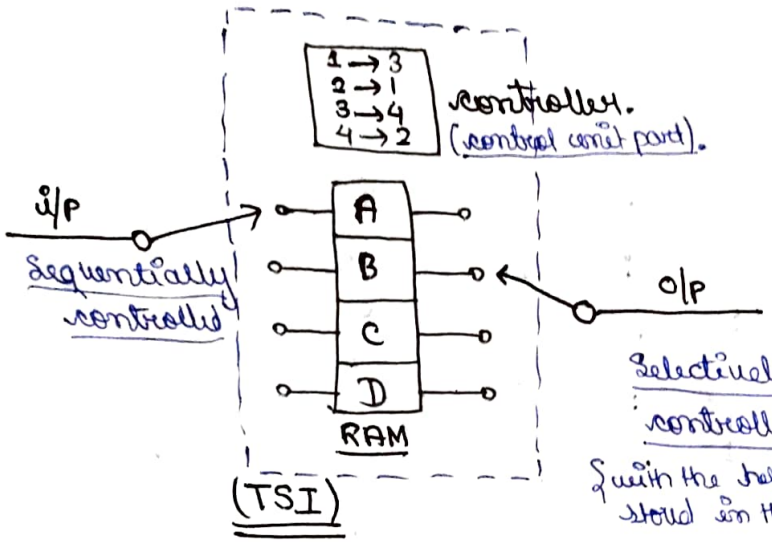
(Can be common in TDM bus)

* Time slot interchange:-



1 → 6 {can be achieved by TSI}
2 → 7
3 → 5
4 → 8

{in reversal
1 → 5
2 → 6
3 → 7
4 → 8}



{with the help of information stored in the controller}.

* Size of the RAM must be at least the capacity of the TDM frames so as to accomodate the given time slots.

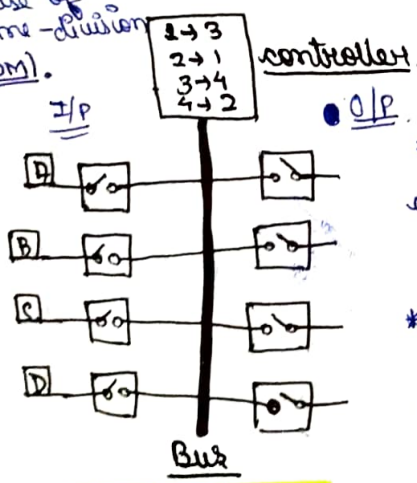
(equal or greater than)

* The RAM capacity must be equal to or at least the no. of time slots in the given TDM frames so as to accomodate the given time slots.

* a sample input during a time slot may be sent to the output during a different time slot.

② TDM Bus:-

↳ Based on the use of synchronous time-division multiplexing (TDM).



* A particular output switch is closed according to the information stored in the controller

* In a TDM Bus, data or information arriving from an input line is put onto specific timeslots on a high-speed bus.

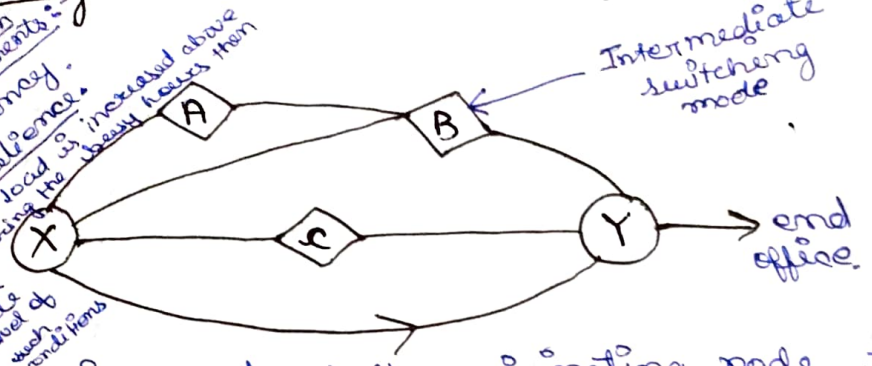
* Signaling functions:-
control signals affect many aspects of network behavior, including both network services visible to the subscriber and

* To cope with the growing demands on public telecommunications nw, all providers have moved away from the static hierarchical approach to a dynamic approach. A dynamic approach is one in which routing decisions are influenced by

*Routing in Circuit Switching:-

#Key word → connection oriented

two main requirements:
① efficiency.
② Resilience.
↳ If the load is increased above the level during the busy hours then the network should provide do a reasonable level of service under such conditions



* Route 1:- XABY
2:- XBY
3:- XCY
4:- XY → preferred (less no. of hopes).

* It is the duty of the originating node to select one of the possible routes out of the given possible routes. {min. number of hopes}. The dedicated path established between the sender and Receiver is maintained for entire duration of conversation (data transfer) if no error is occurred.

* Problem arises if the decision is to be taken during the transmission

* control signalling:- In a circuit-switched network, control signals are the means by which the network is managed and by which calls are established, maintained and terminated.

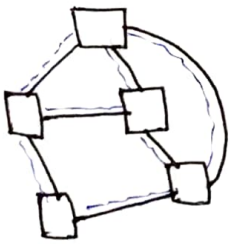
* location of signalling:-
→ control signals needs to be considered in two context:
① Signaling between subscribe and the network.
② Signaling within the network.

page no. 248-249

*Inchannel signaling:-
→ Two types :- ① In band ② out of band.
Same channel is used to send both data signal and command signal.
→ In a channel a part of the spectrum is used to send data signals and another part is used to send control signals.

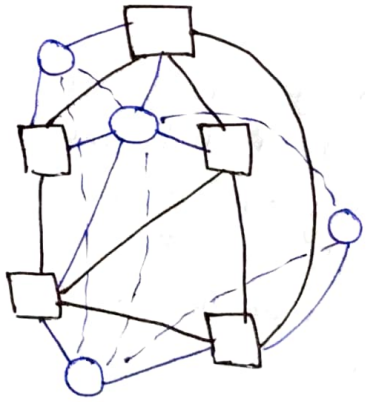
*common channel signaling:-
→ ① Associated Mode.
② Disassociated Mode.

* Associated Mode:-



——— : For control signals.
——— For data signals.

* Disassociated Mode:-



separate
*one network is used to carry data signals and another separate network is used to carry control signals and both the network are connected also.

* Date:- 15/11/22

* Elements Routing:-

① Performance criteria:-

- No. of hops (should be min^m)
- cost. (min^m hops/nodes)
- Delay.
- Throughput.

* Decision time:-

③ • Packets (datagrams).
→ routing decision is taken individually for each and every packet.

② • session (virtual circuit).
→ routing decision is taken collectively for all the packets from source to destination at the time of establishing route

③ Decision Place:-

* each node. (distributed)
* central node. (centralized)
* originating node (source)

④ Network Information Source:- (Based on the topology, what topology is used) (traffic load, cost of links).

> None.
> Local.
> Adjacent node.
> Node along route.
> All nodes.

⑤ Network Information update timing:- (update timing depends upon the routing strategy).

> continuous
> periodic.
> Major load change. (~~traffic change in load.~~) (if a particular route is over congested, it should be immediately informed).
> ~~Topology~~ change. (Node addition/removal).

* For a fixed strategy, the information is never updated.
* For an adaptive strategy, information is updated from time-to-time to enable the routing decision to adapt to changing conditions.

* Routing Strategies:- (Based on the condition, if the routing table changes, we called it as Adaptive routing).

① Fixed Routing.

A single permanent route is configured/selected for each source-destination pair of nodes in the network with fixed routing, there is no difference between routing for datagrams and virtual circuits.

Adv:- * It's Simplicity.
* work well in a suitable network with a stable load

disadv:- * lack of flexibility.
* does not react to network congestion or failures

② Flooding.

* other than incoming link, packet is forwarded to all outgoing links.

(Based on Non-Adaptive Routing) means A packet is sent by a source node to every one of it's neighbors

* Packet must have some unique identifier so that the node discard all but the first copy.

ex * A simpler technique is to include a hop count field with each packet. each time a node passes on a packet, it decrements the count by one. when the count reaches zero, the packet is discarded

③ Adaptive.

* Advantages:-
* Increases Performance
* can aid in congestion control (Balancing load).

* Disadvantages:-
(1) It may lead to congestion
(2) Routing decision is very complex, because decision is taken at one place and info. is collected from another place.

The more info. that is exchanged, and more frequently it is exchanged, the better will be the routing decisions that each node takes.
on the other hand, this info. is itself a load on the network, causing a performance degradation.

④ Non-Adaptive

Date:- 17/11/22

* View Serializability:-

* Seri