Switching - Why switching is required?

Whenever we have multiple devices, we have the problem of how to connect them to make one one one communication possible.

One solution is point to point connection between each pair of devices. However this method is wasteful when applied to very large networks.

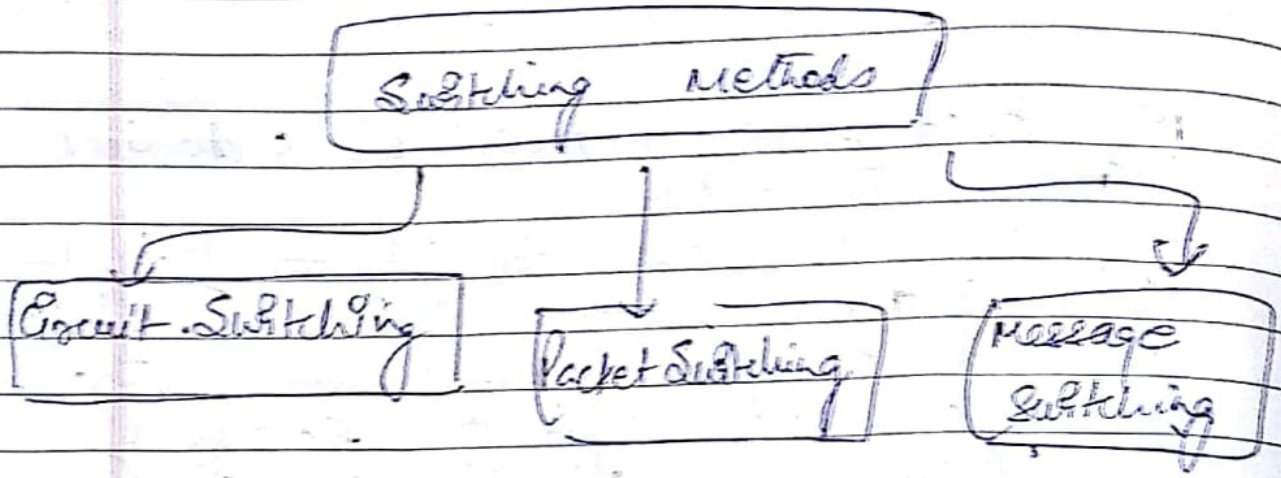
For Imagine a network of 6 devices A, B, C, D, E & F.
If device A has point to point link to devices B, C, D, E & F, whereas only A & B are connected, the links connecting A to each of the other devices are idle and wasted.

Other topologies such as bus topology which employ multipoint connections are ruled out because the distances between devices and the total number of devices increase beyond the capacity of media & equipment.

A better solution is Switching.

A switched network consists of series of interlinked nodes called "switches".

Switches are h/w and/or s/w devices capable of creating temporary connections b/w two or more devices linked to the switch but not to each other.



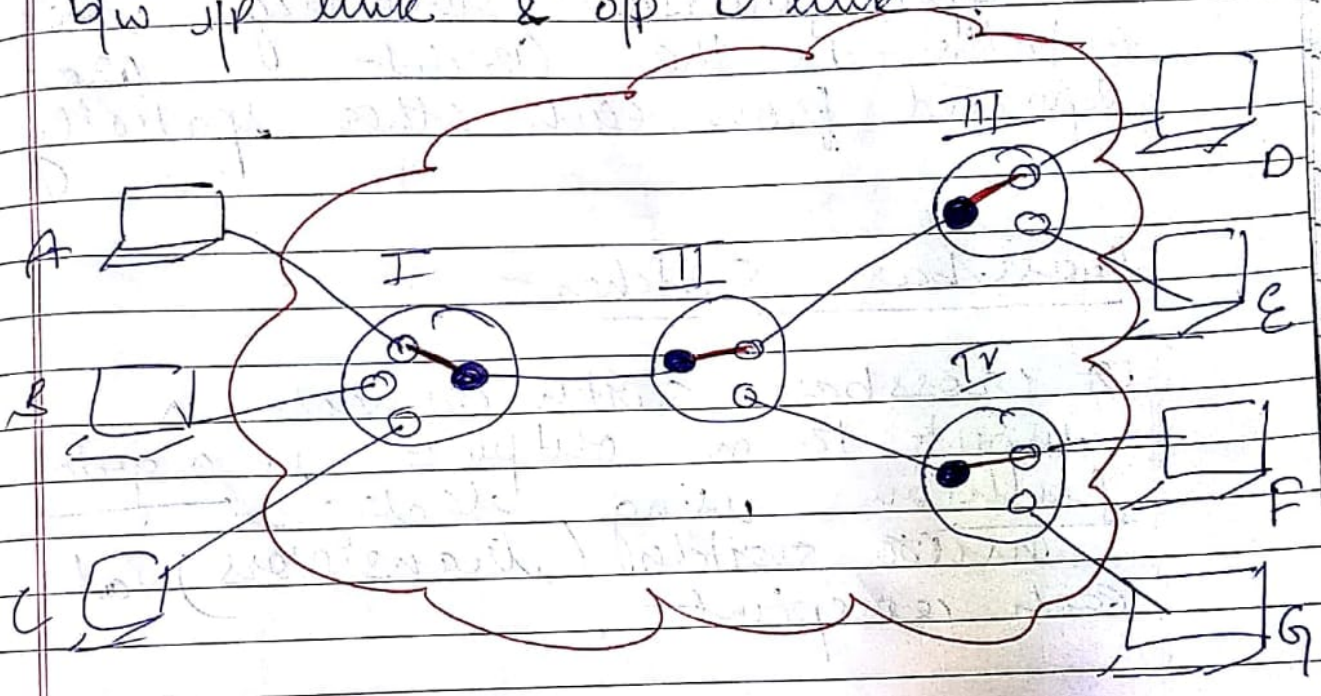

Circuit Switching - creates a direct physical connection b/w two devices such as phones or computers.

Eg figure 14.1 instead of point to point connection between three computers on the left A, B & C to the four

computers on the right (D, E, F & G) requiring 12 links, we can use 4 switches to reduce the no. & total length of links.

Computer A is connected through switches I, II, III to computer D. By moving the levers of the switches any computer on the left can be connected to any computer on right.

A circuit switch is a device with n inputs & m outputs that creates a temporary connection b/w i/p link & o/p link



# Circuit Switching

- Space division switching
- Time division switching

## Space Division Switches –

- Cross bar switches
- Multi-stage switches.

In space division switching, the paths in the circuit are separated from each other spatially.

## Cross-bar Switches –

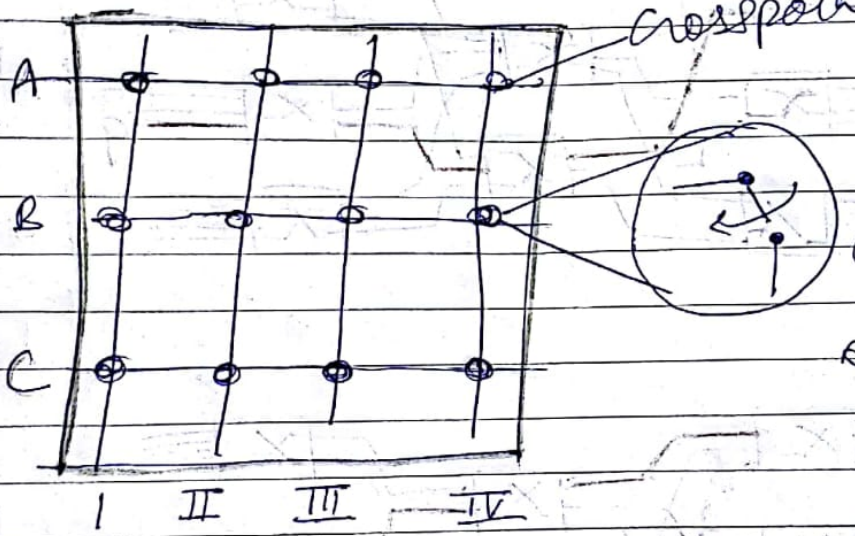
A crossbar switch connects n inputs to m outputs in a grid fashion using electronic micro switches (transistors) at each crosspoint.

Connecting n inputs to n outputs using a crossbar switch requires nxn crosspoints.

Eg to connect 1000 inputs to 1000 outputs requires a crossbar with 1000000 crosspoints.

This factor makes the crossbar impossible because it makes the size of crossbar huge.

Such a switch is also inefficient because statistics show that in practice fewer than 25% of the crosspoints are in use at a given time. The rest are idle.

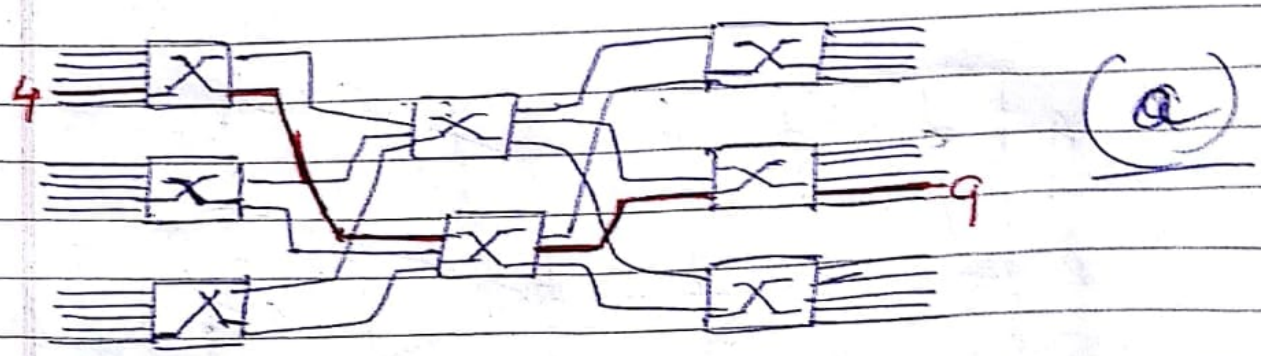


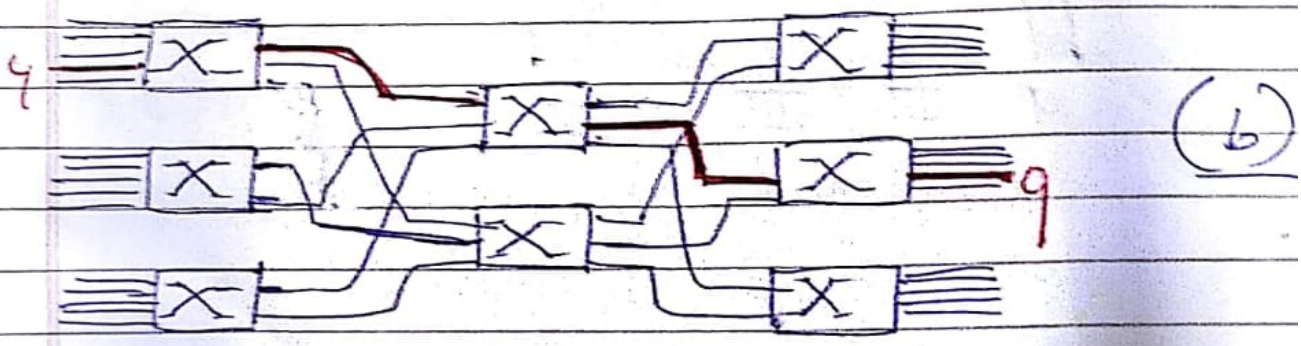
## Multi-Stage Switches -

The solution to the limitations of crossbar switch is to use multi-stage switches, which combine crossbar switches that in turn are linked to a hierarchy of other switches.

Normally the middle stage has fewer switches than do the first & last stages

## Multipaths



Multistage switches provide several options for connecting each pair of linked devices.

~~Fig (a)~~

In the figure (a) below, a pathway is established b/w input line 4 and output line 9. The path uses the lower intermediate switch and that switch enters output line to reach last stage ~~switch~~ switch connected to line 9.

In figure (b) below, shows the pathway between the same input line 4 and same output line 9 using upper intermediate switch.

Let us compare the no. of crosspoints in a 15 x 15 single stage crossbar switch and 15 x 15 multistage switch —

1. Three 1st stage switches, each with 10 crosspoints (5 x 2) for a total of 30 crosspoints at the first stage.

2. Five second stage switches, each with 9 crosspoints (3×3) for a total of 15 crosspoints at the second stage.

3. Three third stage switches, each with 10 crosspoints (5×2) for a total of 30 crosspoints at last stage.

In a single stage crossbar switch we need 225 (15×15) crosspoints. & in multi-stage switch, we need 75 crosspoints.

Blocking :- This savings comes with the cost. The reduction in the number of crosspoints results in a phenomenon called as "blocking" during the periods of heavy traffic.

Blocking refers to time when one input can not be connected to output because there is no path available b/w them.

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# Time division Switches

TSI

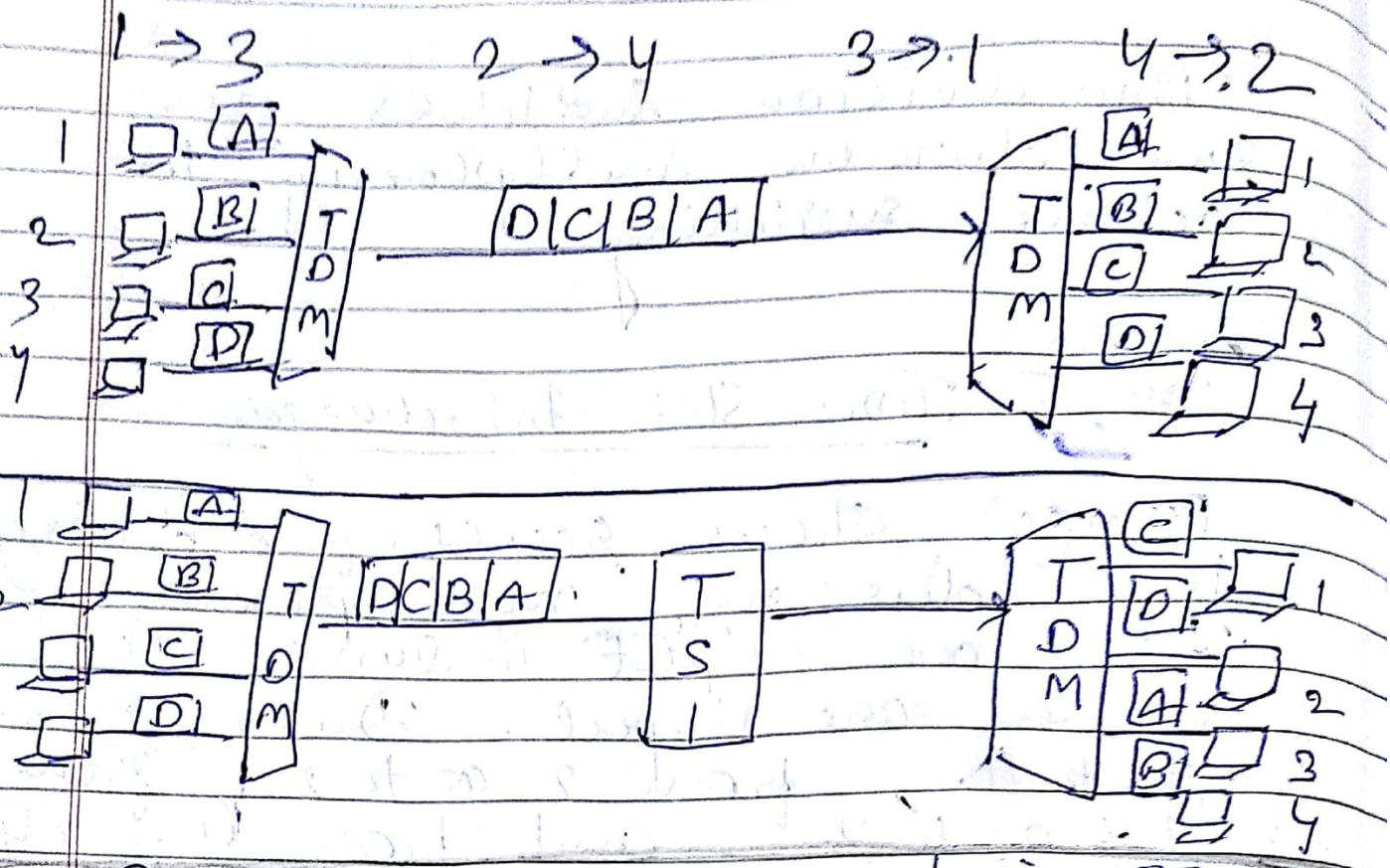
TDM bus

Time division switches uses time division multiplexing to achieve switching.

## TSI : Time Slot Interchange

Figure(a) shows result of ordinary time division multiplexing. Data are output in same order as they are input. Data from 1 go to 1, from 2 go to 2, from 3 go to 3 and from 4 go to 4.

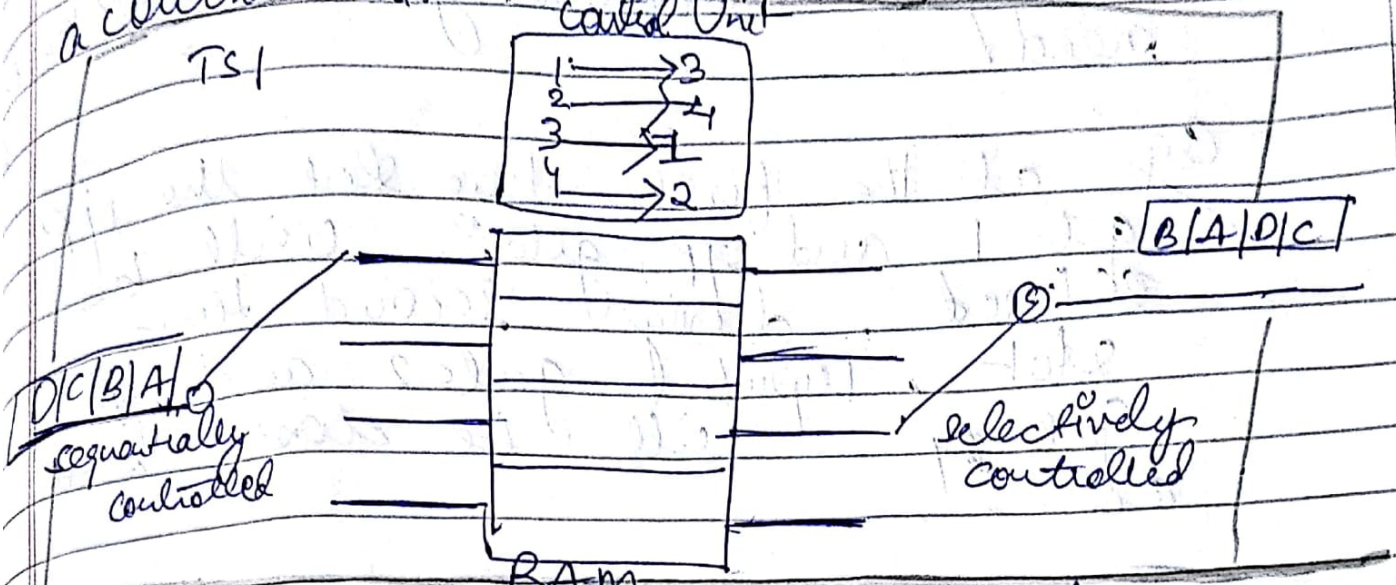
Imagine that each input lines wants to send data to an output line according to the following pattern.




For that we insert a device TSI, Time slot interchange into the link. A TSI changes the ordering of the slots based on the desired connections.

When demultiplexer separates the slots, it passes them to the proper outputs.

A TSI consists of RAM with several memory locations. The RAM fills up with the incoming data from time slots in order received. The slots are then sent out in an order based on the decisions of a control unit.



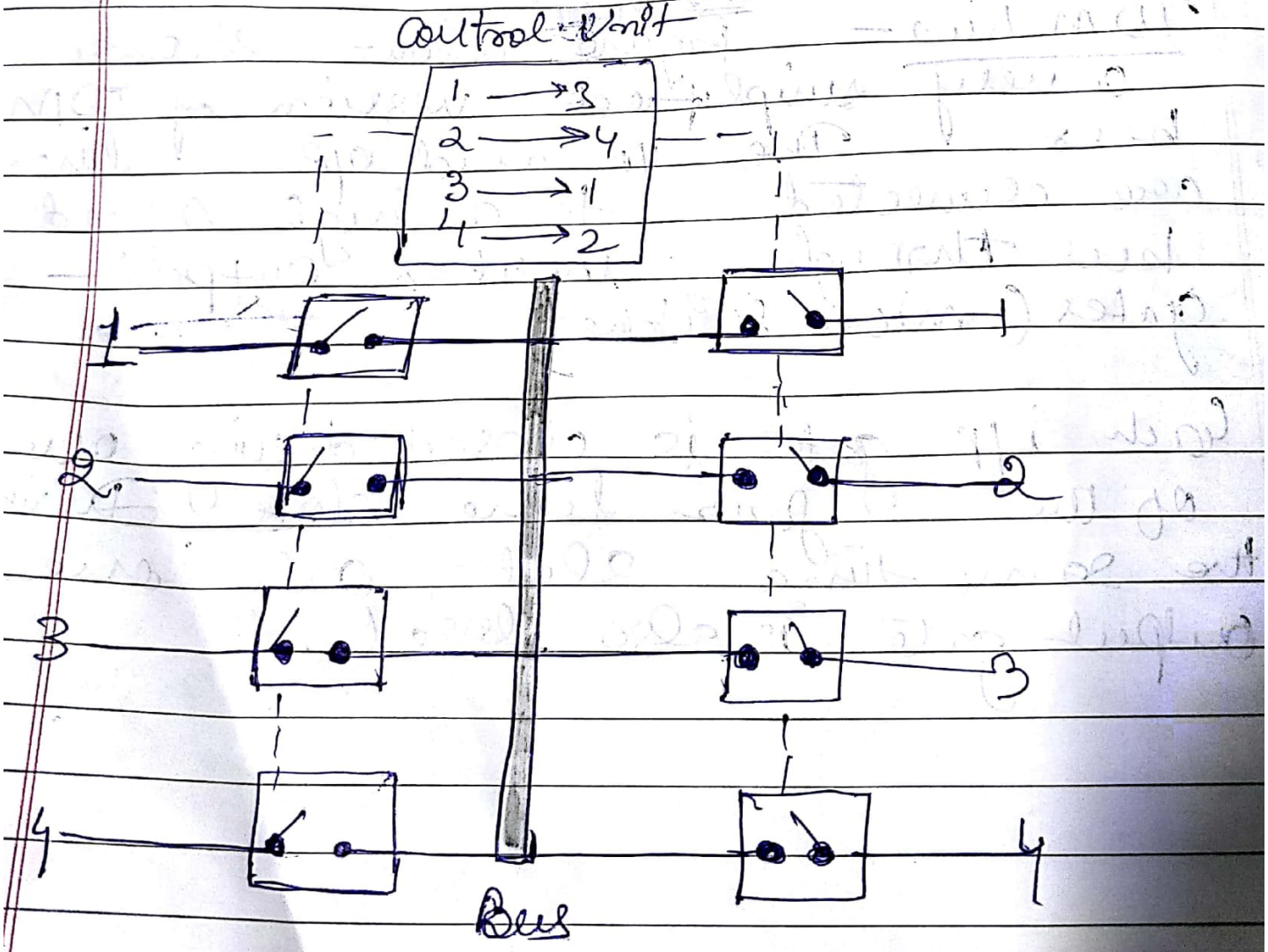

TDM bus - Figure below shows a very simplified version of TDM bus. The i/p and o/p lines are connected to a high speed bus through input & output gates (micro switches)

Each i/p gate is closed during one of the four time slots. During the same time slot, only one output gate is also closed.

The pair of gates allow a bus of data to be transferred from one specific i/p line to one specific o/p line using the bus.

The control unit opens & closes the gate according to the switching need.

Eg at the first time slot the i/p gate 1 and o/p gate 3 will be closed, during second time slot, i/p gate 2 and o/p gate 4 will be closed & so on.....



Packet Switching -

Disadvantages of Circuit switching

a. Circuit switching was designed for voice communication & so less well suited to data and non voice transmissions. Non voice transmissions tend to be bursty, meaning that data come in spurts with idle gaps b/w them.

When Circuit switched links are used for data transmissions, the line often remains idle and its facilities wasted.

b. Circuit Switching is inflexible. Once a circuit has been established, that circuit is the path taken by all the parts of transmission, whether or not it remains the most efficient or available.

c. Circuit Switching sees all the transmissions as equal. Any request is granted to whatever link is available. But often with data transmission, we want to be able to prioritize - for eg we say xmission x can go anytime but xmission z

Is time dependent & must go immediately.

→ A better solution for data xmission is of "packet Switching"

In a packet Switched Network, data are transmitted in discrete units of potentially variable length blocks called as packets.

Packet Switching

- Data gram Approach
- Virtual Circuit Approach
  - SVC
  - PVC

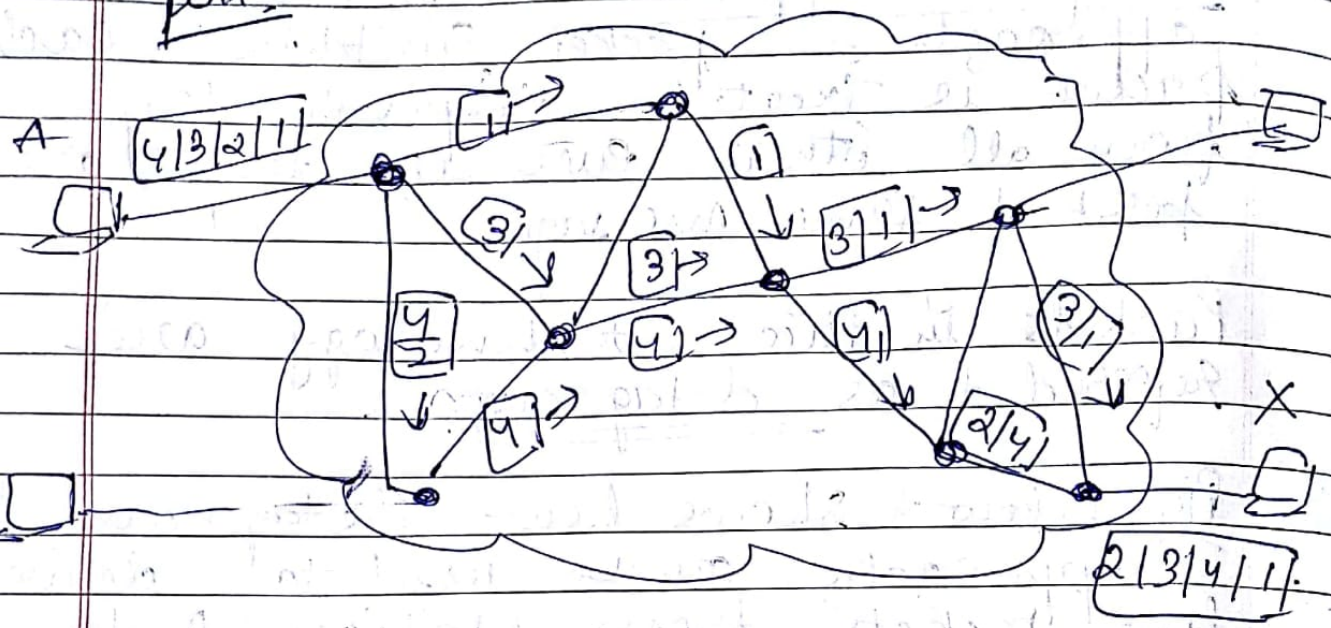
Datagram Approach :- In datagram approach to packet switching, each packet is treated independently from all others even if they are part of same message.

Packets in this technology are referred to as datagrams.

Fig below shows how datagram approach can be used to deliver four packets from station A to station X. In this example, all four packets (or datagrams) belong to the same message but may go by different paths to reach the destination

This approach can cause the datagrams of a transmission to arrive at their destination out of order.

It is the responsibility of transport layer in most protocols to reorder the datagrams before passing them on to the destination post.



Virtual Circuit Approach – In this approach, the relationship b/w all packets belonging to a message or session is preserved.

A single route is chosen b/w the sender & receiver at the beginning of the session. When data are sent all packets of transmission travel one after another along that route.

Virtual Circuit Transmission

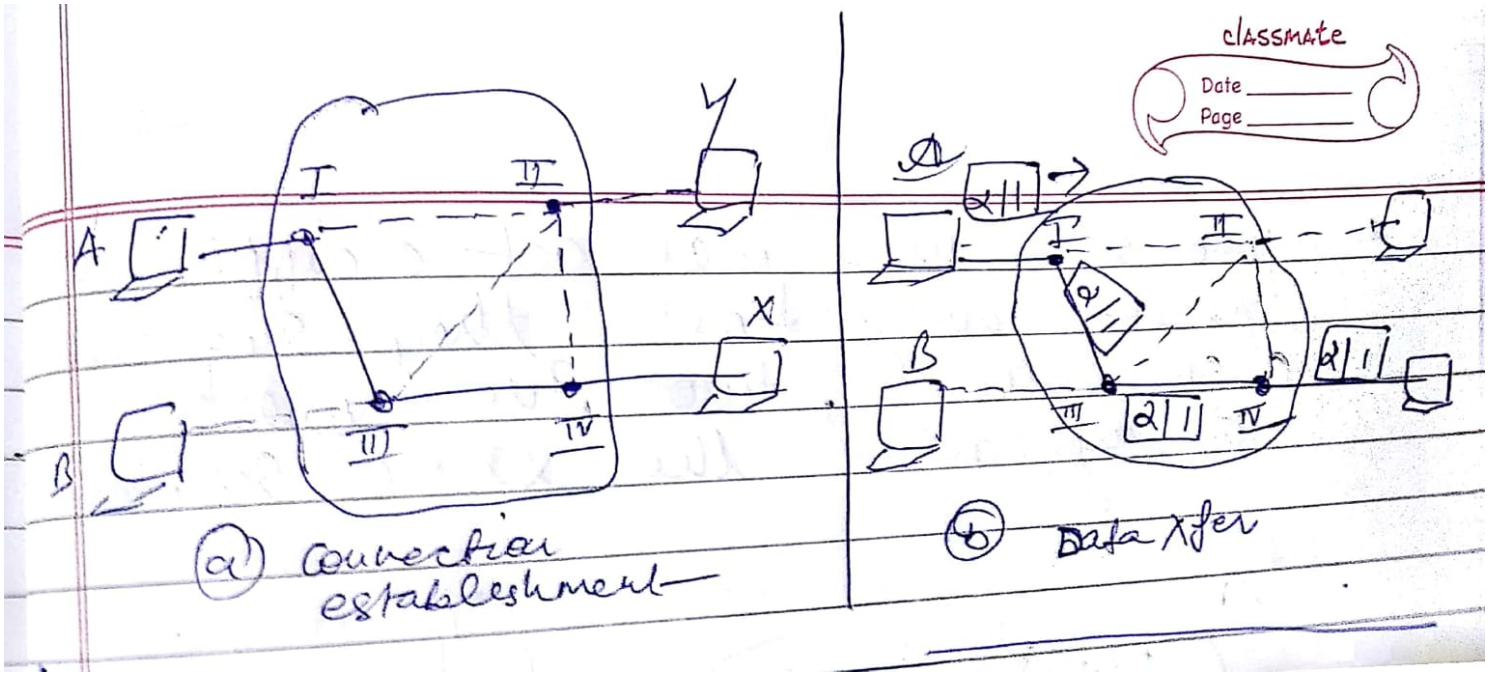
- SVC – Switched virtual circuit
- PVC – permanent virtual circuit

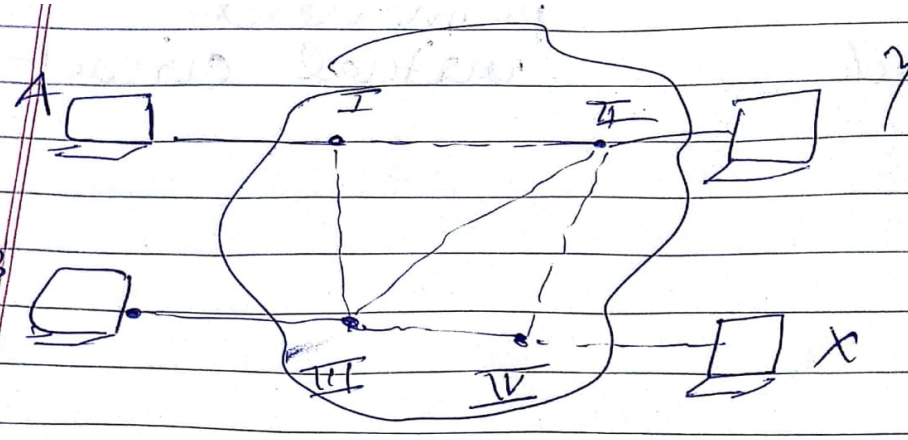
SVC - format is comparable to dial up lines - In this method virtual circuit is established & exists only for the duration of specific exchange

~~Eg → Station A wants to send the data to Station B~~

Eg: Station A wants to send four packets to station X. Once the connection is in place, the packets are sent one after another & in sequential order.

When the last packet has been received & if necessary acknowledged, the connection is released.

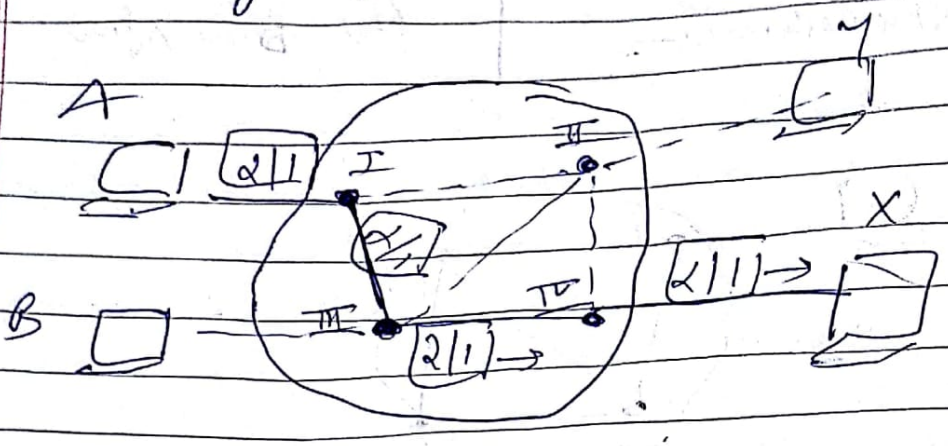

A
B
I
II
III
IV
X
Y
(a) Connection establishment
(b) Data Xfer




Connection Release.

PVC - are comparable to leased lines. In this method same virtual circuit is provided between two users on a continuous basis.
The circuit is dedicated to specific users. No one else can use it. And because it is always in place, it can be sent without connection establishment & connection termination.

* two SVC users may get a different route every time they request a connection, two PVC users always get the same route.



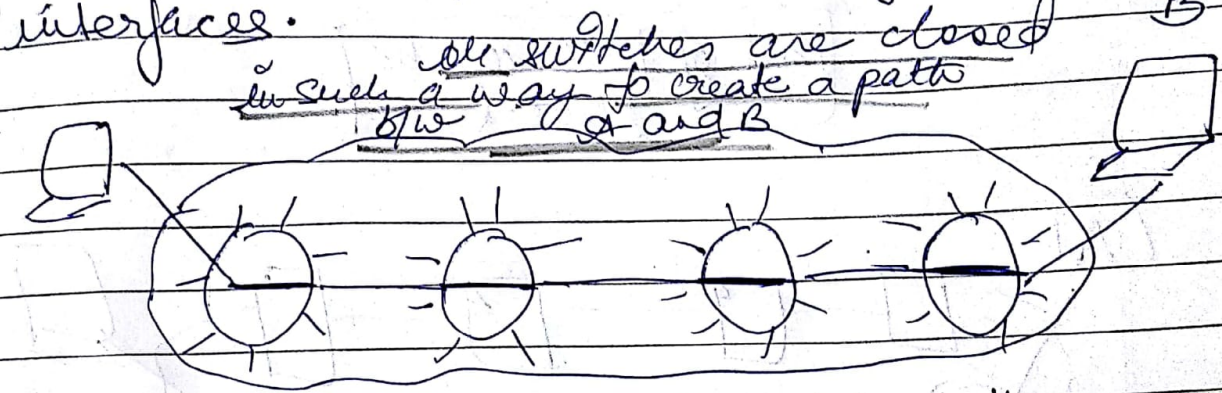

Permanent Connection for the duration of lease

CSC V/C VCC.

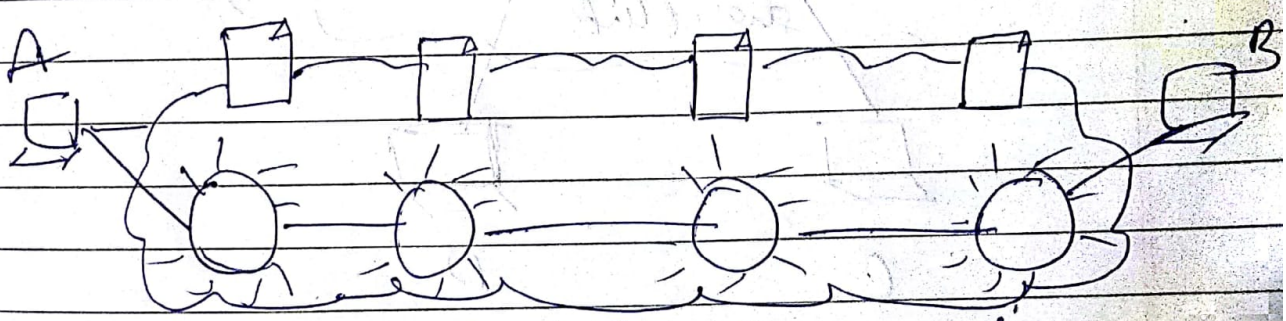
CSC - Circuit Switched Connection
VCC - Virtual Circuit Connection

Path v/s Route:- A CSC creates a path between two points. The physical path is created by setting the switches for the dial up line or duration of the lease. (leased line)

VCC creates a route between two points. This means that each switch creates an entry in its routing table for the duration of session (SVC) or duration of lease (PVC)
Whenever the switch receives the packet belonging to virtual connection it checks the table for the corresponding entry & routes the packet out of one of its interfaces.




(a) Circuit Switched Connection

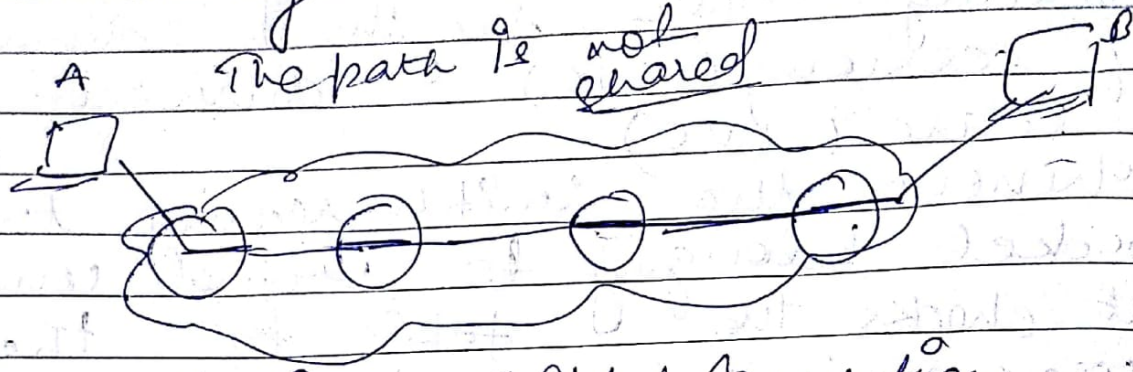



b. Virtual Circuit Connection

2. Dedicated v/s sharing —

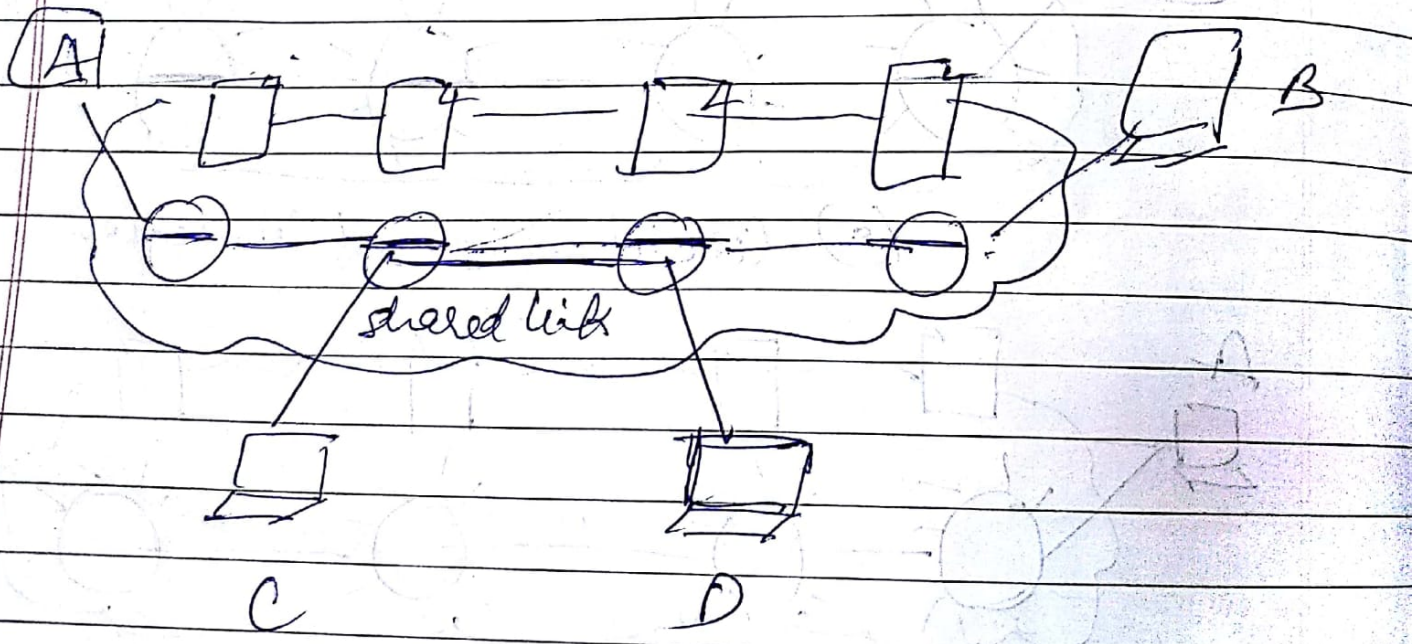
In a circuit switched connection, the links that make a path are dedicated, they can not be used by other connections.

In (VCC) Virtual Circuit Connection the links that make the ~~path~~ ~~are dedicated~~ route can be shared by other connections.




a. Circuit Switched Connection

Part of path can be shared



Message Switching — is best known by the descriptive term Store & forward.

In this mechanism, a node receives a message, stores it until the appropriate route is found / free, then sends it along.

There is no direct link between the sender and the receiver of a transmission & message is delivered to the node along one path then routed along another to its destination

In MS, the messages are stored & relayed from secondary disk (storage)

While in PS, the packets are stored and forwarded from primary storage (RAM)