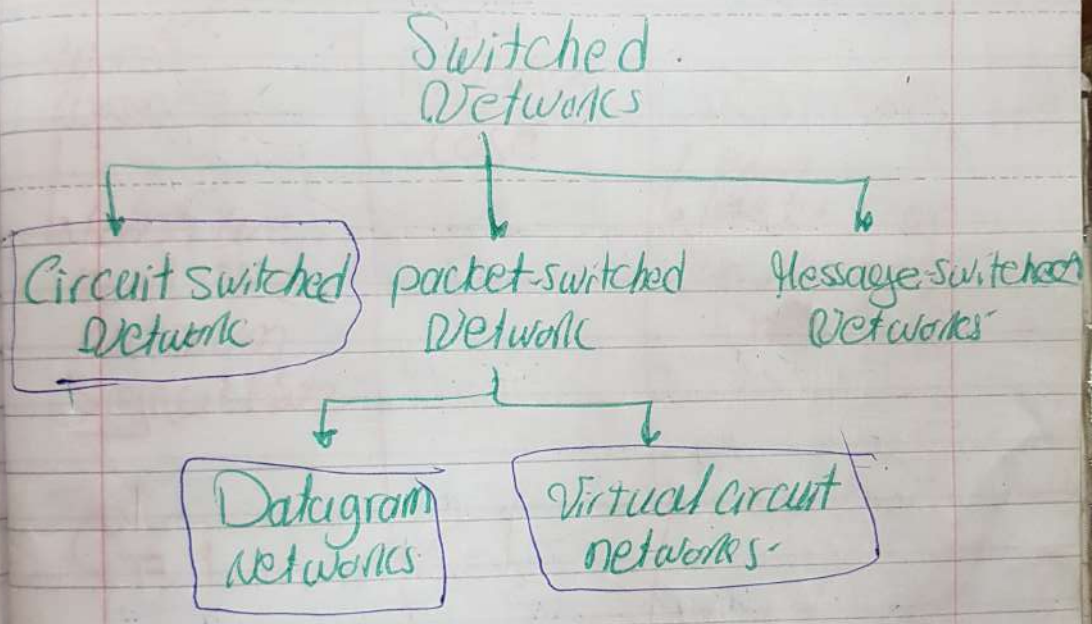
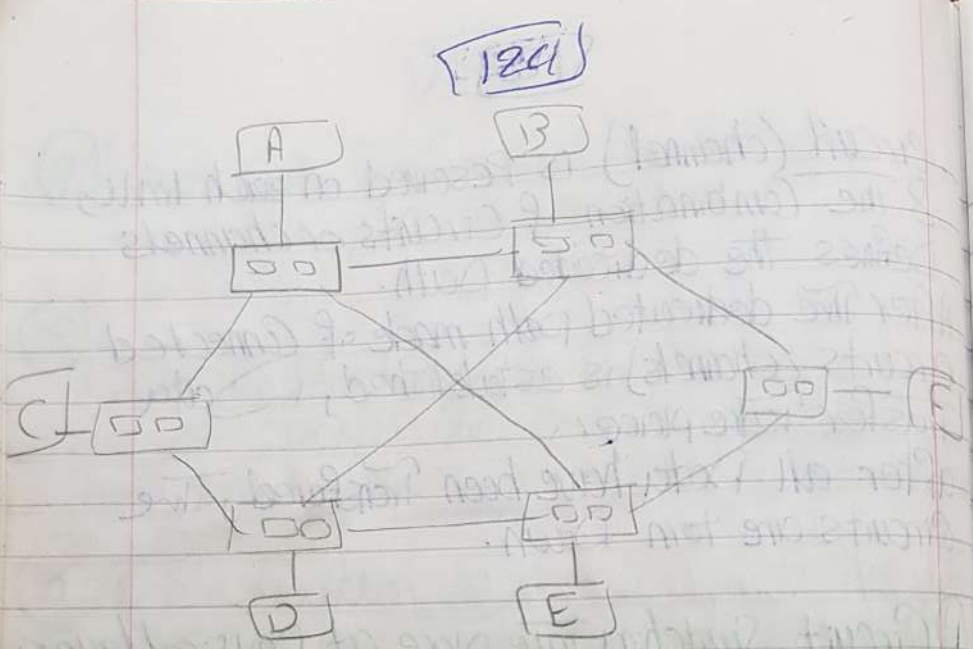
Ch 8. Switching



★ Switched Network

↳ A network consists of nodes called switches.

★ - Switches: are Devices capable of creating temporary connections between two or more Devices linked to the switch.



① Circuit Switched Networks

↳ It's a network made of a set of switches connected by physical links, in which each link is divided into n channels using (FDM, TDM).

* End systems (PCs / telephone) are directly connected to a switch.
When End system [A] needs to communicate with end system [M], system [A] Request a connection to [M] this Request must accepted by all switches as well as [M] itself. ⟶ (setup phase).

- Circuit (channel) is Reserved on each link, & The Combination of Circuits or channels Defines the dedicated path.
After The dedicated path made of Connected Circuits (channels) is established, Data Trasfer Take place.
- after all Data have been Trasfered, The Circuits are torn Down.

(1) Circuit Switching Take place at physical layer.

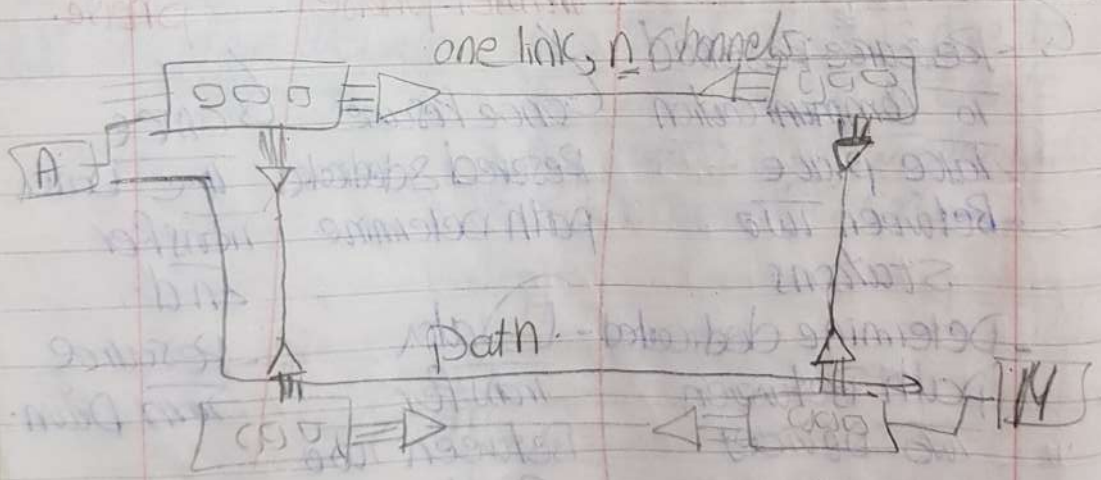
(2) Before Starting Communication, The stations (End systems) must make Reservation for The Resources to be used during The Communication
(channels → Bandwidth) (switch buffers)
(switch processing time.
(Switch I/O ports) → Connection oriented.

(3) Resource Reservation in setup phase.
once Resources Reserved, Data Transfer Take place Between Two stations

(4) once Data Transfer End the Resours torn Down (in Teardown phase).

(5) Data Transfered Between Two stations are Not packets the Data are Continuous flow sent by source & Recieved by the Destination.

(6) There is No Addressing meded During Data Transfer. the switches Route Data Based on their occupied FDM or Time slot (TDM).



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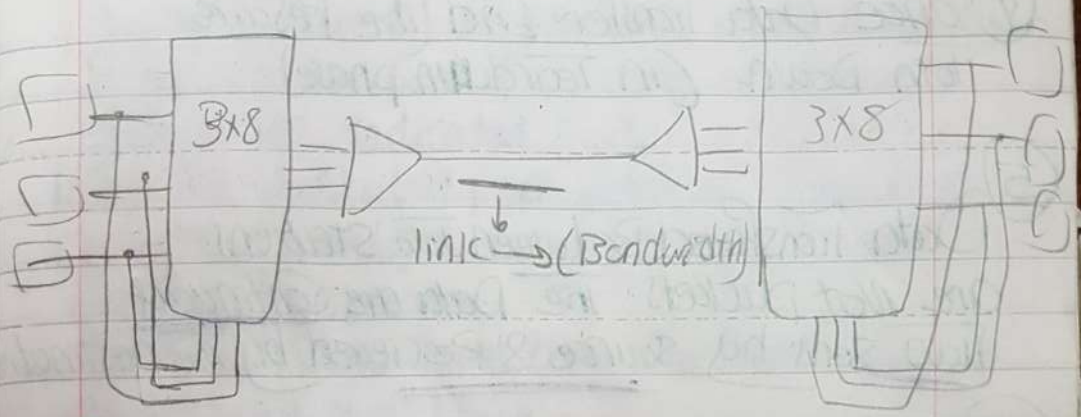


Circuit Switch Network phases

1) setup phase	2) Data Transfer phase	3) Teardown phase.
- Resource Reserved To Communication Take place Between Two Stations - Determine dedicated path Between Two Devices	Once Resources Reserved & dedicated path Determine. - Data transfer Between Two Stations	Once The Data Transfer End. - Resource Torn Down.

① Efficiency

- Circuit switched Networks are not Efficient
- once the Resources are Reserved to Communication Between two Station.

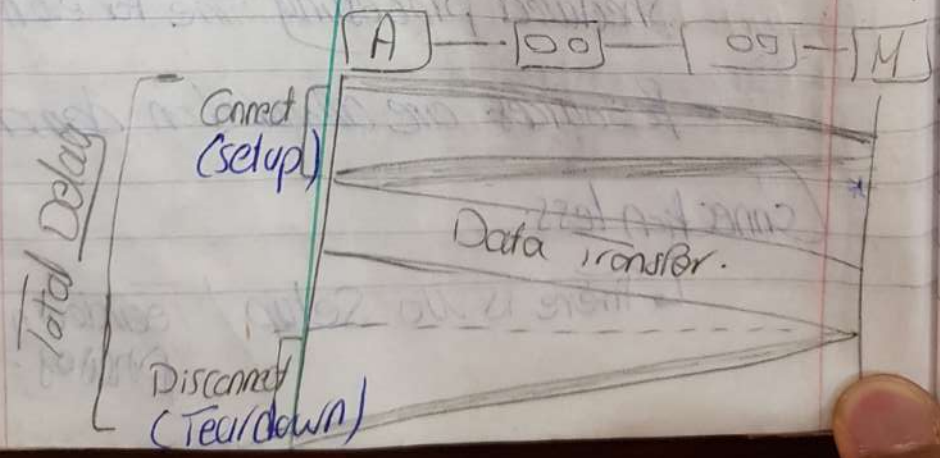
These Resource aren't available to other Communicatren.

Ex: Telephone Network.

Delay

- A circuit-Switched Network. Delay is minimal.
- During Data Transfer. the Data aren't delayed at each switch.
- There is No waiting time at each switch.

The total delay is due to ① the time needed to create the Connection ② Transfer Data ③ & Disconnect Circuit.



(2) Datagram Networks

- When we need to send Messages from source to Destination, the Message is passing through a packet-switched network, Message is Divided into packets (fixed/variable) size.
The size of the packet is Determined by network protocol.

* In packet Switching :
  - No Resource allocation for a packet.
  (There is no Reserved bandwidth on the link, and there is no Sheduled processing time for each packet.
  - Resources are allocated on demand.

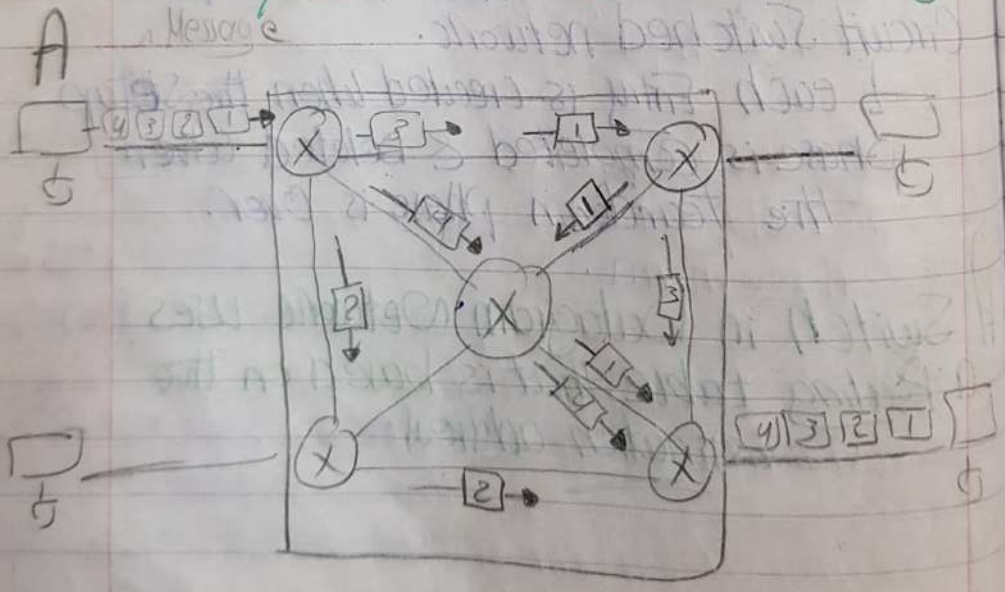
* Connection less.
  - There is no Setup / Teardown phases.

1. Datagram Switching is done at the Network layer.

2. In Datagram network, each packet is treated independently of all other.

- If a packet is part of a Multi-part transmission, the network treats it as done.

packets ——— referred as Datagram



Routing Table: (Switching Table).

1) Is Dynamic & update periodical.

2) Table Consist of:
   - The Destination address.
   - The Corresponding forwarding outputs port.

This is Different from the Table of Circuit Switched network.
- each Entry is created when the setup phase is completed & Deleted when the teardown phase is over.

A Switch in Datagram Network uses a Routing table that is based on the Destination address.

* Destination Address

- Every packet in a datagram network carries header contain destination Address.
- When the switch recieves the packet Examin the Destination Address.
- Switch find the corresponding port
  ↳ consulted to
  through which the packet should be forwarded

* Efficiency

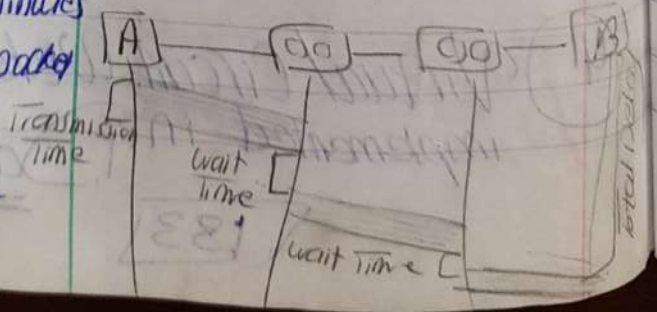
↳ It's better than the circuit switched network.

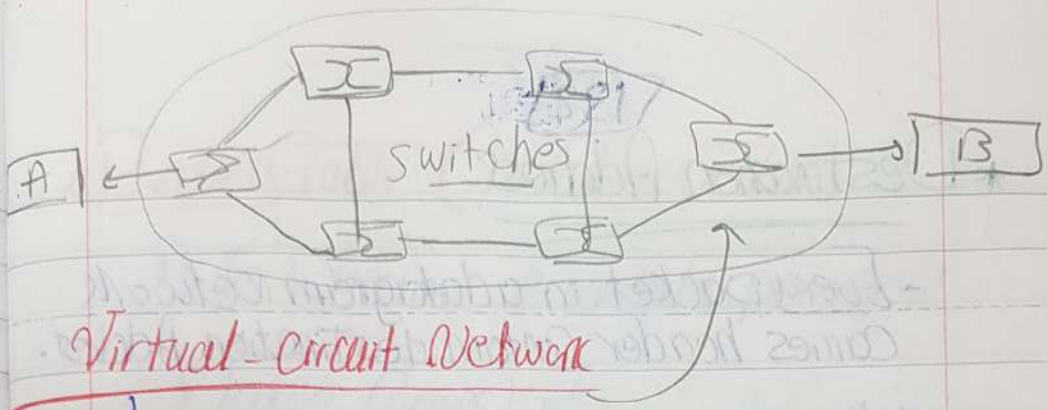
- If source sends a packet & there is a delay few minutes before sending another packet can be sent.

The Resources can be Reallocated.

* Delay

- The Delay is Greater than in circuit switched.
- The Delay isn't uniform for the packets of a message





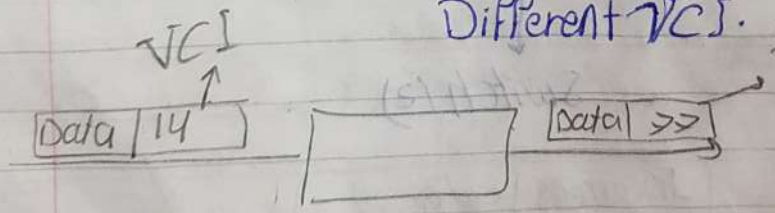
Virtual-circuit Network

- It's across between a circuit switched network & Datagram network.
- It has same characteristics of both.

1. There is setup, Data Transfer & Tear down phase
2. Resources can be allocating during the setup phase & can be allocate on Demand.
3. All packets follow the same path established during the connection.
4. Virtual Circuit Network is implemented in Data link layer.

* Addressing in Virtual Circuit Network:

- Global Address
  - The address that can be unique for each node in the scope of the network.
- Virtual Circuit Identifier
  - Identifier that is actually used for Data Transfer (VCI)
  - It is small number that has only switch scope.
  - It's used by a frame between two switches.
  - When a frame arrives at a switch it has VCI & when leaves has Different VCI.

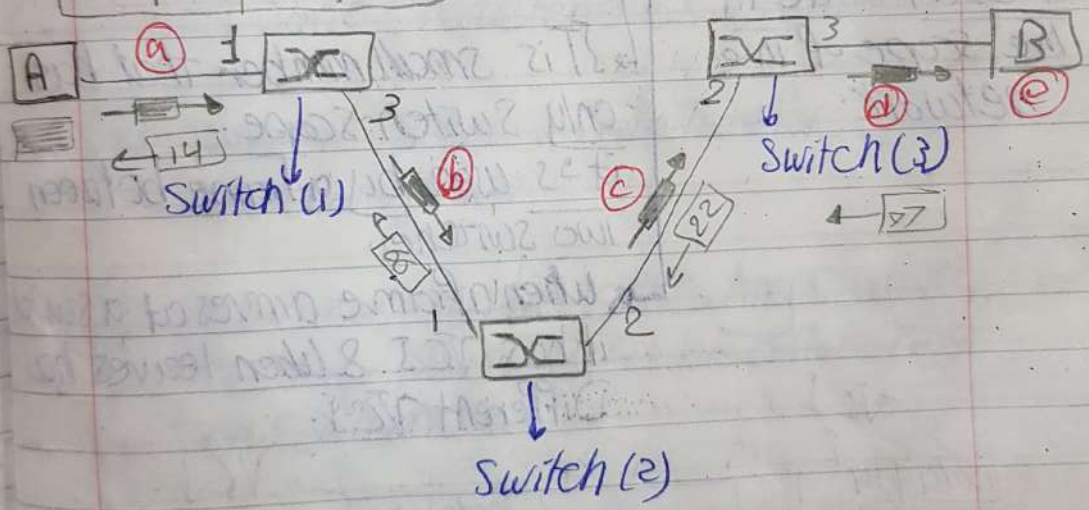


Three phases:

① Setup phase:
- Setup Request
- Setup Acknolodgement.

Incoming		outgoing	
port	VCI	port	VCI
1	14	3	66

Incoming		outgoing	
port	VCI	port	VCI
2	22	3	77

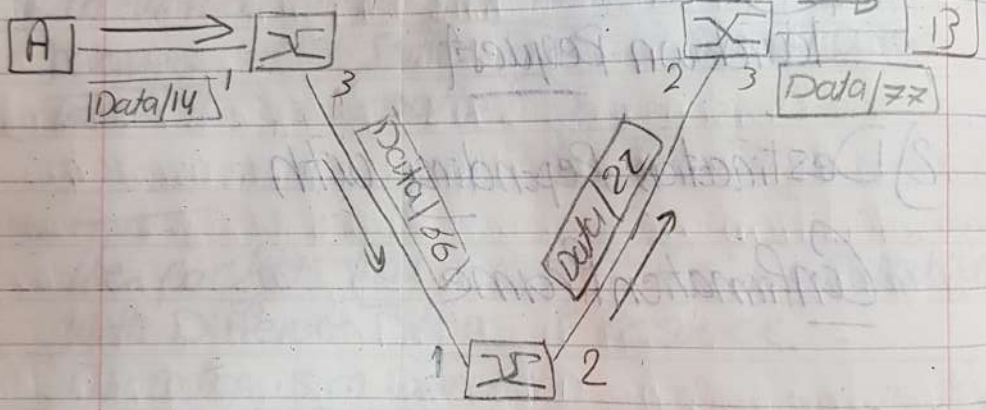


Incoming		outgoing	
port	VCI	port	VCI
1	66	2	22

(2) Data Transfer phase:

Incoming		outgoing	
port	VCI	port	VCI
1	14	3	66

Incoming		outgoing	
port	VCI	port	VCI
2	22	3	77



Incoming		outgoing	
port	VCI	port	VCI
1	66	2	22

Source-To-Destination Data Transfer in VCN (Virtual Circuit Network)

(3) Teardown phase

Source After sending all frames to Receiver.

1) Source sending special frame called Teardown Request

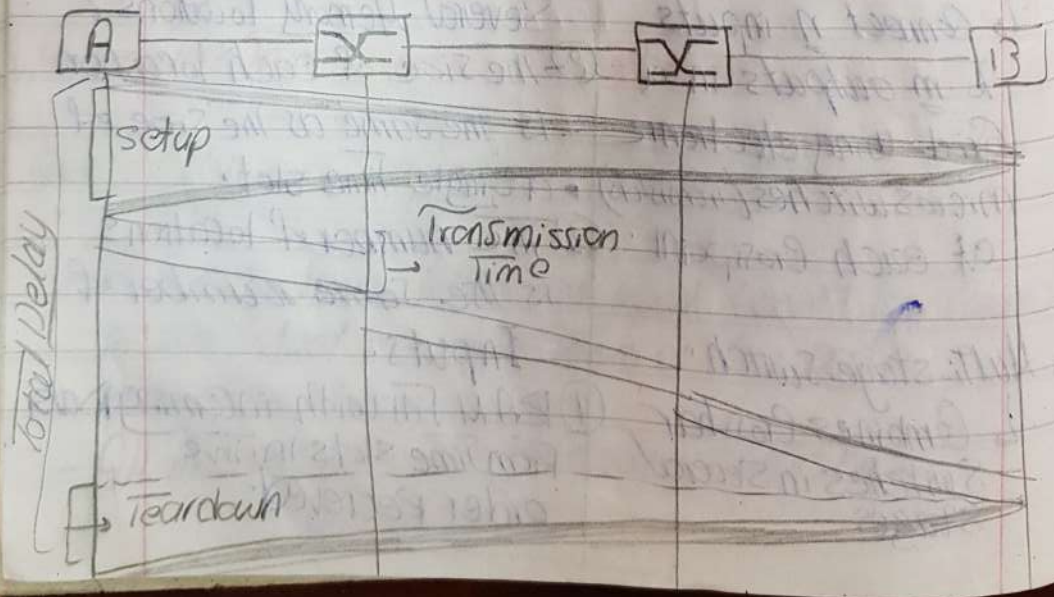
2) Destination Responding with Confirmation Frame

3) All Switches Deletes the Corresponding Entry from their table.

* Efficiency:
- Resource Reservation in VCN can be Reserved in setup phase or allocate on Demand
  - Circuit switched
  - packet-switched

* Delays
- In virtual-circuit switching, all packets belonging to the same source & Destination travel the same path. But:

The packets may arrive at the Destination with Different Delays if Resource allocation is on Demand.



★ Structure of Switch:

① Circuit-Switched Network:
- 1) Space Division Switch
- 2) Time Division Switch.

Space Division

- In Space Division the paths in the Circuit are separated from one to another.

★ Cross bar Switch.
↳ Connect n inputs To m outputs in a Grid using electronic microswitches (Transistors) at each Crosspoint.

★ Multi-stage Switch.
↳ Combines Crossbar Switches in several stages

Time Division

Use TDM (Time Division Multiplexing inside a switch.
That Most popular Technology called: TSI (Time slot Interchange)

① TSI → Consist of RAM with Several Memory locations.
② The size of each location is the same as the size of a single Time slot.
③ The number of locations is the same number of Inputs.
④ RAM Fill with incoming Data from Time slots in the order Recieved.

* Three-stage switch

N → input lines
n → ~~Group~~ of n lines
Group
k → number of Crossbar
For each Group (n)
- Size of crossbar
(n * k)

Total Number of
Crosspoints =

$$2kN + k\left[\frac{N}{n}\right]^2$$

↳ smaller than number of Crosspoints in single stage (N^2)

(5) Slots are then sent out in an order based on the Decisions of a Central Unit.

* According to Close Criteria

$$n = (N/2)^{\frac{1}{2}}$$

$$k > 2n - 1$$

Total Number of Crosspoints

$$\geq 4N \cdot [(2N)^{\frac{1}{2}} - 1]$$

* Blocking in switched Networks:

↳ Refers to Times when one input Can't be Connected to one output Because There is No path Available Between Them.
- All The possible intermediate switches are occupied.

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Structure of packet switches:

- A switch used in a packet-switched network has Different structure.

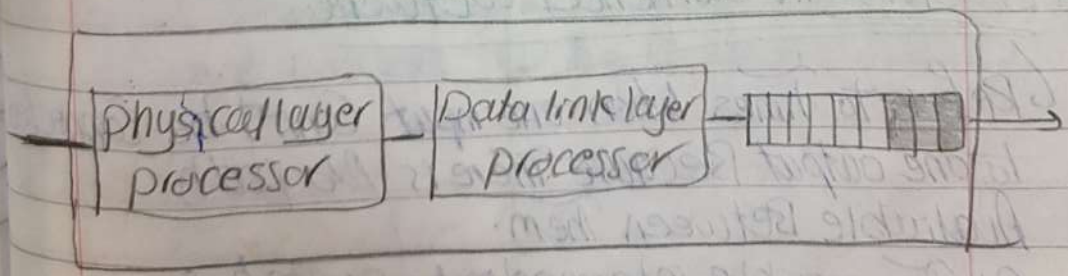
It has Four Components.

① Input ports:

- An input port performs the physical & Data link Functions of packet swit.

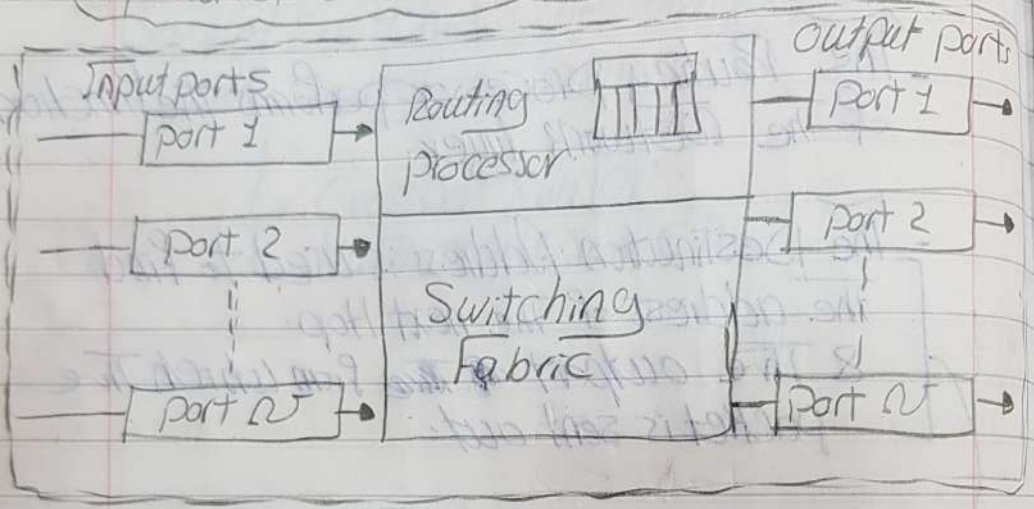
- Input port has buffer (Queues) to hold the packet befor its Directed to the switching Fabric.

Input port



(48)

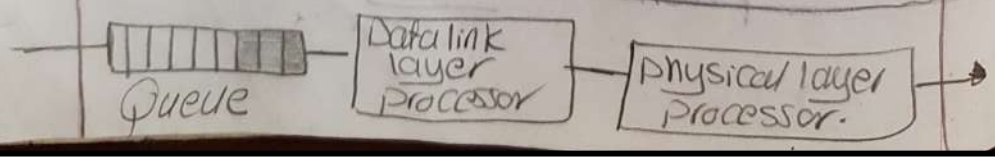
Packet Switch Components



② output ports:

- perform the same functions as input port. But in the reverse.
  - ① packets are queued
  - ② the packets in encapsulated in a frame
  - ③ physical layer functions are applied to the frame to create signal to be sent.

Output ports



(3) Routing Processor:

- The Routing processor performs the functions of the Network layer.

- The Destination Address is used to find the address of the next Hop & the output from which the packet is sent out.
  - Sometimes called Table lookup.

(4) Switching Fabrics.

- The Most Difficult task in packet switch is to Move Data from input Queue to output Queue.
  The speed with which this is Done affects the size of the input/output Queue & the overall Delay in packet Delivery.

1.4.4.5

- Packet switches use variety of switching fabrics
  - Crossbar switch.
  - Multi-stage switch.

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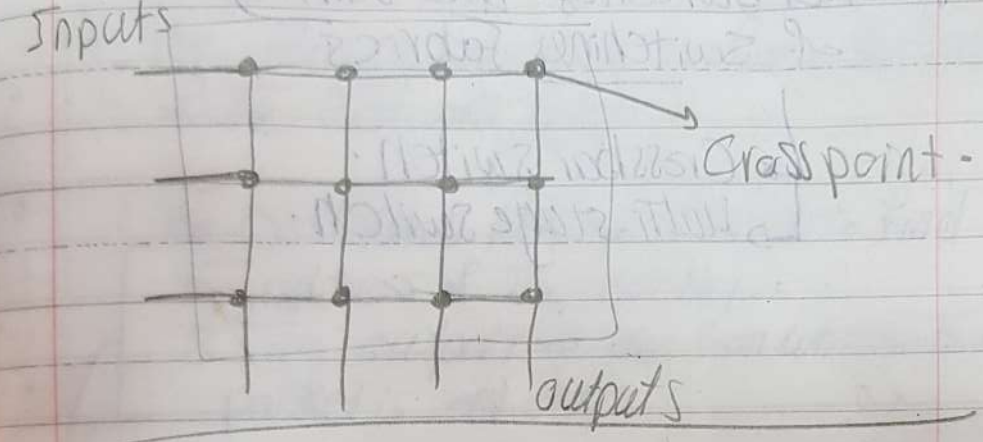
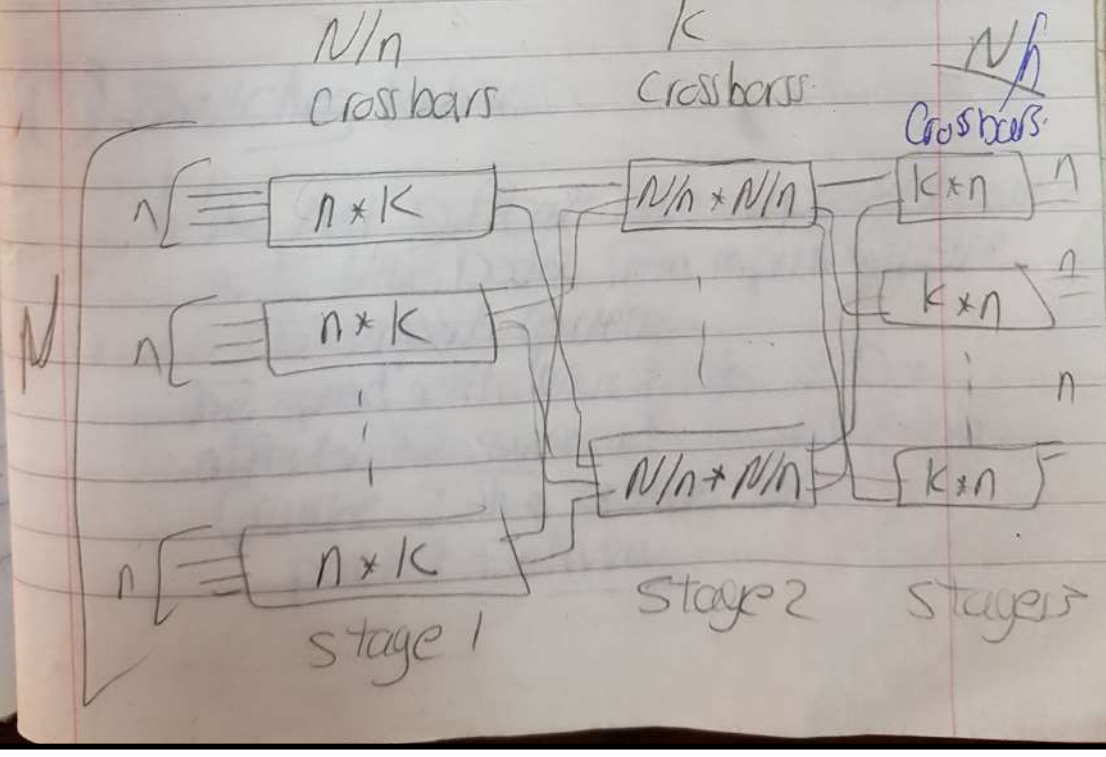
Crossbar Switch (Three inputs & Four outputs)



* Multi-stage Switch



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$N \longrightarrow$ input lines

$n \longrightarrow$ Group of input lines

K = number of Crossbar for each Group of n

Size of Crossbar = $(n * k)$

Total number of Crosspoints

$$2KN + K\left[\frac{N}{n}\right]^2$$

According Clos Criterion

↳ (Try to Reduce number of Crosspoints)

$n = (N/2)^{\frac{1}{2}}$ $\quad k > 2n-1$

Total number of Crosspoints $\geq 4N\left((2N)^{\frac{1}{2}} - 1\right)$