TELECOMMUNICATION

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Communication:-

which is reliability,

History of communication:-

1837 → Telegraph
1876 → Telephone
1910 → US govt → regulations
1915 → Transcontinental Phone services
1951 → Direct dialed long distance service,
1960 → Data communication over telephone
1970 → online are the real time system (on line transations)
1980 → Personal computes
1984 → Cell Phone
1990 → LAN (local area Network)
1993 → Internet.

Communication Classification:-

→ Based on signal < Analog / Digital

→ Based on modulation usage < Base band (Ex) mick / Broad band

→ Based on medium < guided - (Ex) wire, optical comm/. / unguided - (Ex) Air, Mobile com/

- Based on frequency → VLF, LF, MF, VHF, UHF, SHF

K. Dhanunjana

EVOLUTION OF TELECOMMUNICATION:-

→ Historically, transmission of telegraphic signals over wires was the first technological development in the field of telecommunication.

→ First telegraphic introduced in 1837 in Great britain.
(It's can using small distance communication)

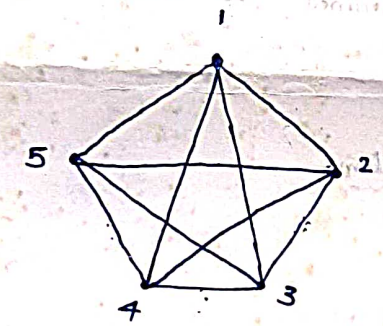
→ Next telegraphic introduced in 1845 in France

→ The Next development of communication in march 1876 introduced in Telephone in Alexander Graham bell

→ Telephone line using long distance communication which transfer the Voice signal.

→ Grahambell demonstrated a Point - to - Point telephone connection

→ The Network using Point - to - Point connections is shown in figure



Network with Point - to - Point links

→ The calling subscriber chooses the appropriate link to establish connection with the called subscriber.

→ In order to subscriber call to another subscriber means first to check the subscriber is engaged or not and get the aknowlegement signal. If the subscriber is free means to links to connect otherwise do not connect another subscriber

→ Let as consider ⑤ entites and 10 Point - to - Point links

General form of 'n' entites there are

$$\text{Links} = \frac{n(n-1)}{2} \text{ links}$$

where

n = entites

Let

n = 5

$$L = \frac{5 \times 4}{2}$$

10 links

Here

(i) first entites to all other entities to be connect we require (n-1) links

(ii) second entites is already connected to the first so we require (n-2) links

(iii) Third entites is already connected to the 1st & 2nd so we require (n-3) links

and so on .....

→ The total number of links 'L' works out as follows

$$'L' = (n-1) + (n-2) + \cdots\cdots + 1 + 0 = (n-1) * n / 2$$

→ For example the maximum links connected to 50 subscriber means we can using maximum pair wire need so this Problem provided using switching system (or) switching office (or) exchange office

→ So the subscribers don't connected directly to other. It's provided Switching system

→ Purpose of switching system :-

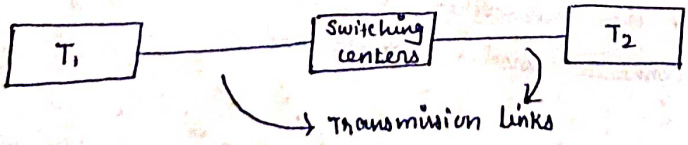
Switching system is to provide to pass information from any one of the terminal to other terminal selected by the originator.

→ Components of switching system:-

(i) Terminal
(ii) Transmission link
(iii) Switching centers

TERMINAL

They are the input output transducers which converts any signal into electrical signal at the transmitting end and back to voice signal at the Receiving end.



TRANSMISSION LINK

Transmission link is the mean thro which the control signal and the information bearing signal are transmitted from one terminal to the switching centre.

SWITCHING CENTRE:-

Their function is to receive the control signal and forward the information bearing signal to another terminal (destination)

→ First established manual operator switching system and to existence Automatic switching system can be classified as

(i) Electro mechanical
- Step by step systems (or) Strowger switching
- Cross bar systems

(ii) Electronic

Electro mechanical:-

① (i) step by step systems (or) strowger switching :-

To control functions of switching system performed by circuit associated with the switching elements.

(ii) cross bar systems:-

The control function of switching system performed by relays and latches.

② Electronic switching systems:-

* the control function of switching system performed by computer (or) processor. Hence these system are called stored program control (SPC) system.

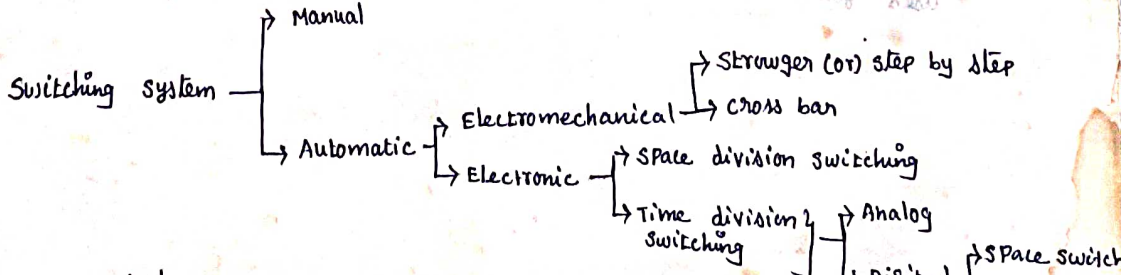
* If any other changing the facilities of the switching system to change over the program of SPC

* Electronic switching system classified into

(i) Space - division switching → Speech signal traveling b/w dedicated path

(ii) Time - division switching → Speech signal traveling b/w fixed intervals.

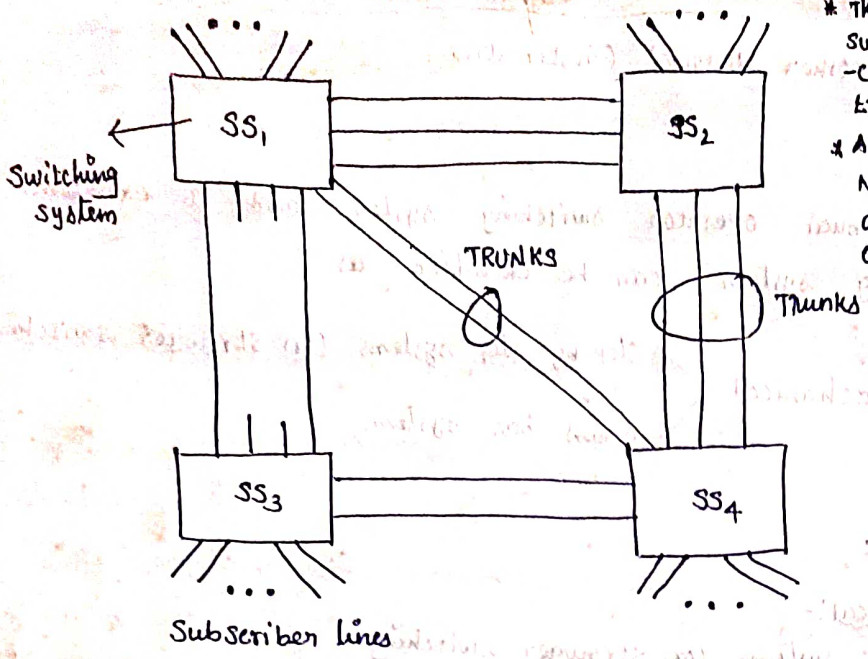
TYPES OF SWITCHING:-



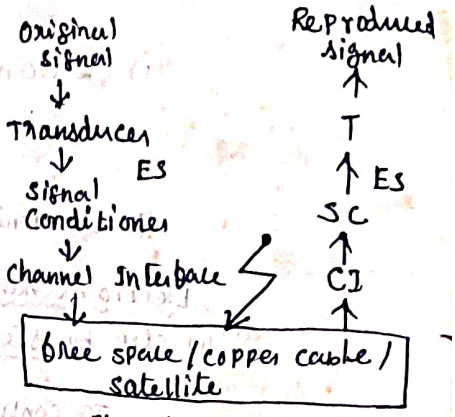
* Space switch:-
If the coded values are transferred during same time interval from I/P to O/P is called space switching

* Time switch:- The value are stored and transferred to the O/P at a later time interval is called time switching.

BASIC TELECOMMUNICATION NETWORK:-



* The number of switching systems increases, interconnecting them becomes complex.
* The design & analysis of switching system and telecommunication N/w are based on the traffic engineering concepts.
* A modern telecommunication N/w may be viewed as an aggregate of a large number of point to point electrical (or) optical communication.



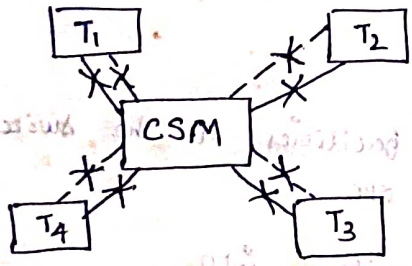
Electrical communication system

Note

- The links that run b/w the switching systems are called TRUNKS.
- The links that run to the subscriber Premises are known as subscriber lines.

BASICS OF A SWITCHING SYSTEM:-

Consider the general centralised switching centre



where

CSM – centralised switching m/c

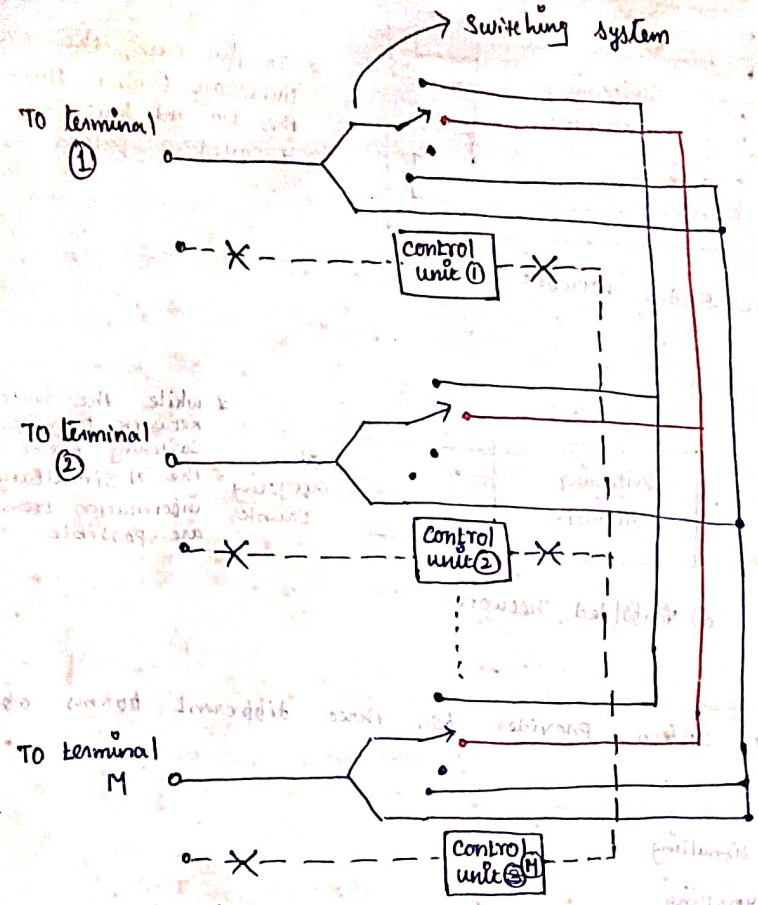
T – Terminal

- - - → information links

——→ Control signal links

⇒ There is also the two-way path for the transfer of control signal & message signal

⇒ In most of the practical problem the same physical channel is used for information & control signal transfer process.



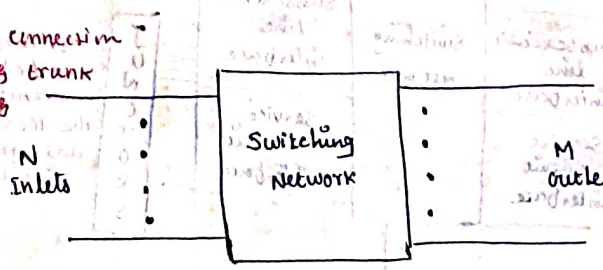
The above figure shows the simple model of centralised switching machine

- Here each terminal has own switch for the contact and the control signal path to its own control unit.

- Each switch has it connection to all other terminal; each control system has its access to other control unit. ~~If necessary cause the control unit of the calling terminal should know if the control unit of the called terminal is free & busy or.~~

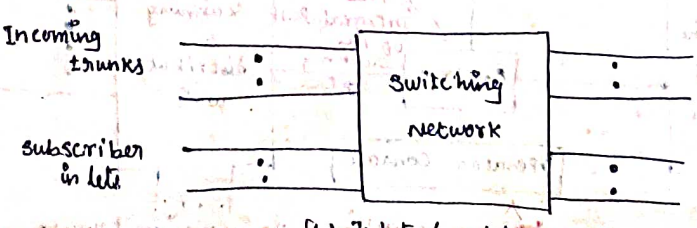
Types of Connection:- ① Local call connection b/w two subscribers in the system ② outgoing call connection b/w a subscriber and an outgoing trunk ③ Incoming call connection b/w an Incoming trunk and a local subscriber. ④ Transit call connection b/w an incoming trunk and an outgoing trunk

They are different switching network configurations:-



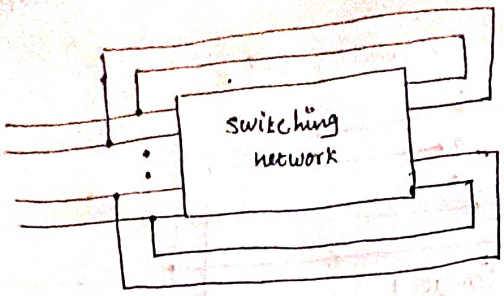
(a) Model of a switching network

* The major component of a switching system or an exchange is the set of I/P & O/P circuits called inlets & outlets, respectively.
* The hardware used of establishing such a connection is called switching N/w
* N = M so switching network is called a symmetric N/w



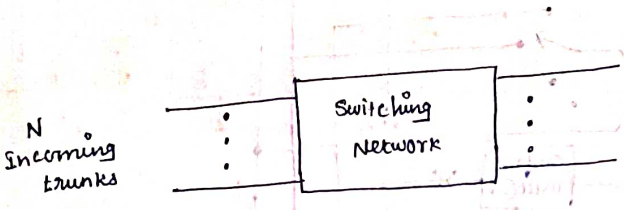
(b) Inlets / outlets connections

* The inlets & outlets may be connected to local subscriber lines & other exchange terminals



* In this case, the O/P lines are folded back to the I/P and hence the N/w is called a folded N/w.

(c) Folded network



* while the switching network provides the switching paths, it is the 'N' simultaneous information transfers are possible.

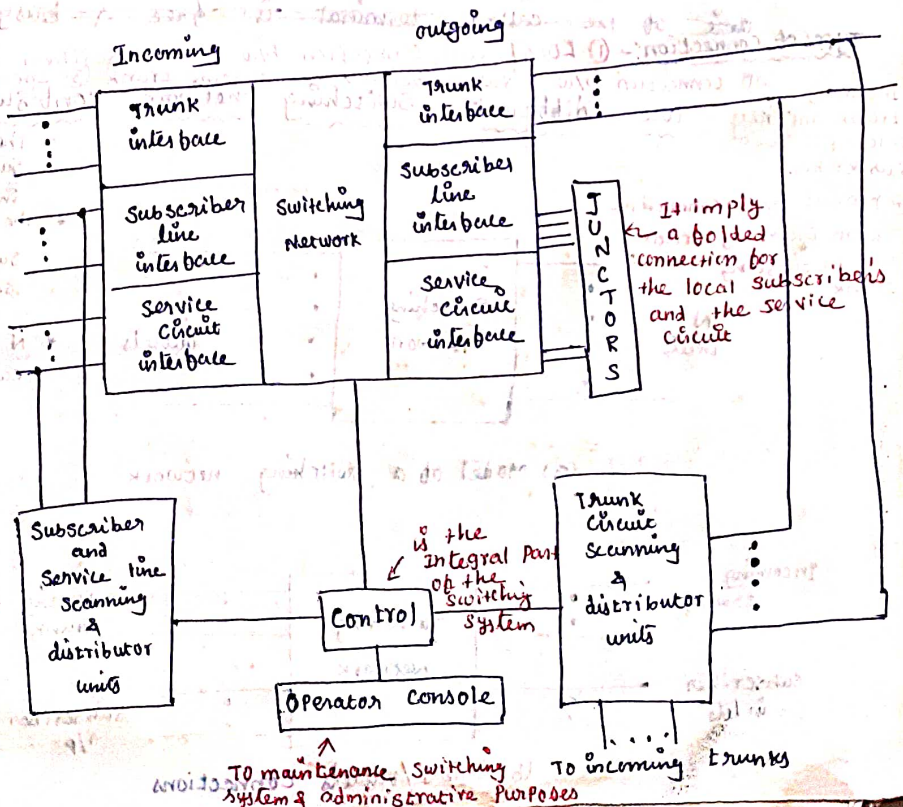
(d) Nonfolded network

- Accordingly, a switching system provides for three different forms of signalling.
  - (1) Subscriber loop signalling
  - (2) Interexchange signalling
  - (3) Intra exchange (or) register signalling

- A switching system is composed of elements that perform switching control and signalling functions.

→ The subscriber lines are terminated at the subscriber line interface circuits and trunks at the trunk interface circuits

→ They are some Service lines used for maintenance and ~~interface circuits~~ testing purposes.

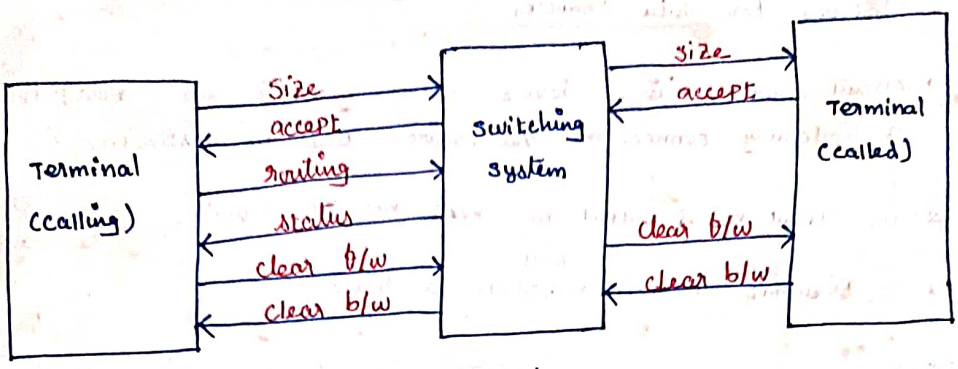


Control System:-
* In this system functional consists of Integral part of the switching system is called direct control
* control system functional outside the switching N/w is called common control system
* Direct control (1x) strowger switching
* common control (2x) cross bar, and electronic switching (SPC switch)

Line scanning units and sence signalling information from respective line

SIGNAL EXCHANGE DIAGRAM:-

The very first step in any system design is to consider the range of control signal that has to be interchanged. This information is given in the form of signals. Different techniques can be used to code these signals



- the analysis is two types ① calling mode
  ② called mode

- In calling mode

① The user sends a size signal to the called terminal via the switching system to indicate that it wishes to make a connection or pass a message.

② The system responds to the size signal by the accept signal

③ The calling terminal then transmitts a routing signal

④ The routing signal is answered by the status signal like the line busy, line free, line answered, no/.. invalid.

⑤ If the need for the connection is over, the terminal sends the clear forward signal

- In called mode

① Signal transfer from the system

② The size signal is responded by the accept signal

③ At the end of the communication period, the terminal is send a "clear forward" signal to indicate the end of connection.

④ In some system a "clear backward" signal is sent from the called terminal, to the system and to the calling terminal if the user of the called terminal is the first to terminate the communication path.

CIRCUIT SWITCHING

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

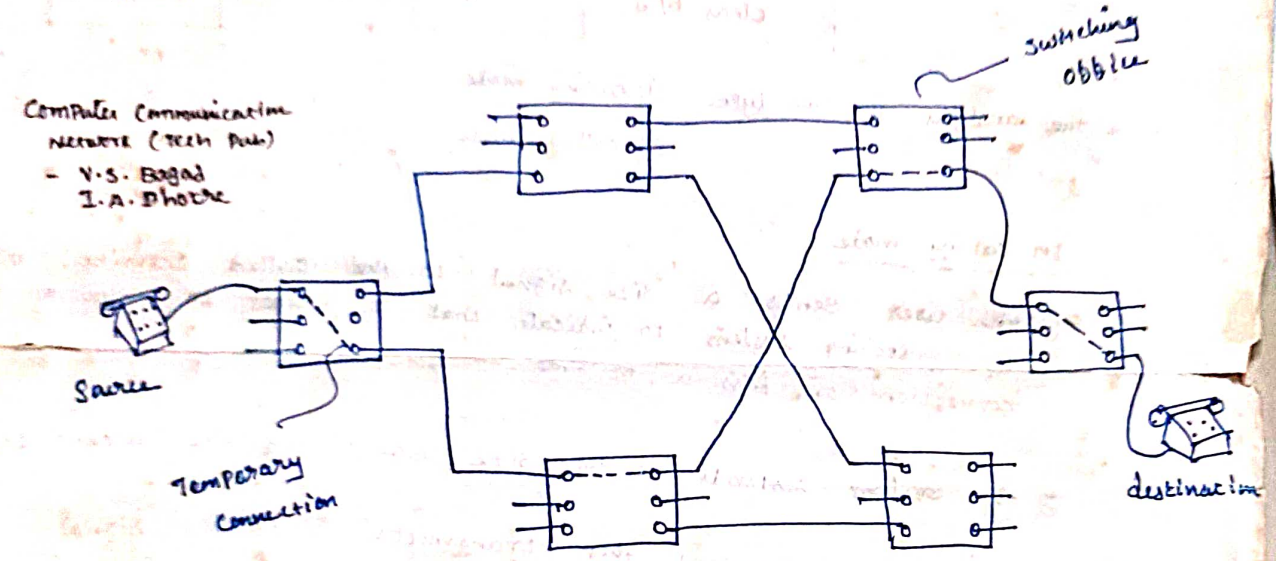
* In order to setup a direct connection over many links v/s to message signal passing through the networks.

* It is therefore used in voice networks mainly and not in networks designed for data transfer

* Circuit switch is a device with n inputs and m outputs that creates a temporary connection b/w source and a destination.

* The Input n & output m need not be equal

* To transmit information first finds a route.



* The connections established with help of switching system.

* The basically circuit switching involves three phases

(i) The source, request the network for the route (∵ the network assigns a route)

(ii) Data transfer now occurs this time holding time

(iii) It's Data transfer is completed the path setup disconnected

* Circuit switching is usually accomplished by TDM

* The time taken for the data transfer (T) is expressed as

$$T = T_p + T_d + T_r$$

where

T_p = Path setup time $= (N-1)\,T_{rs}$

$T_d = M/R$

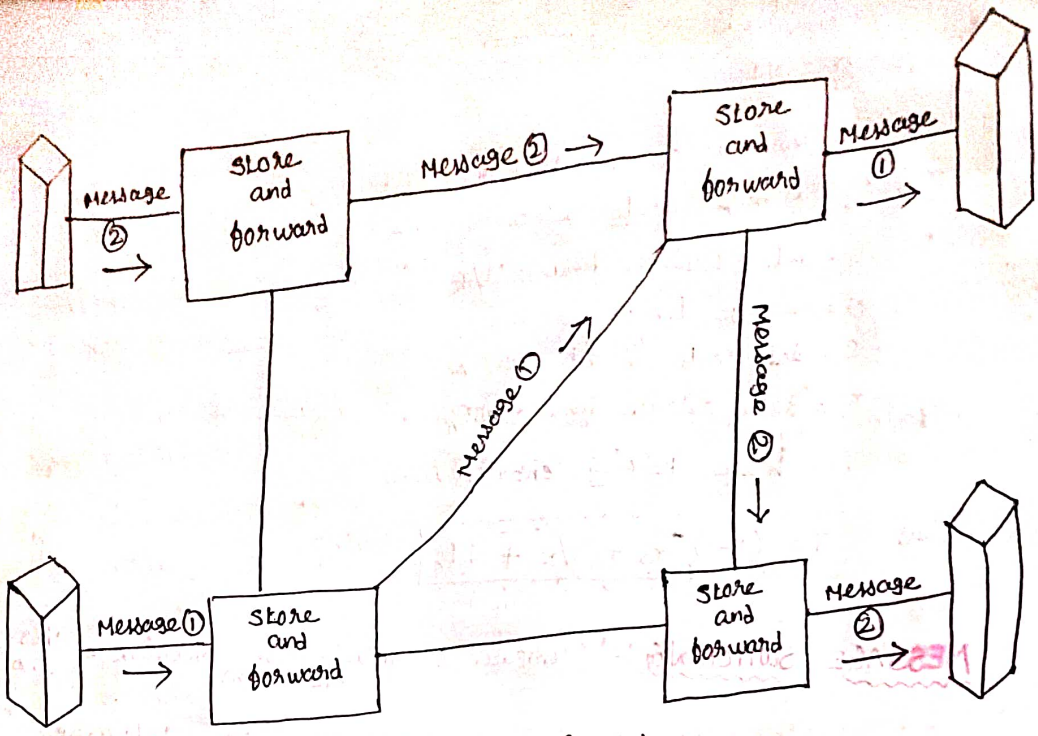
$T_r = NT_h$

N = Number of switches in the path
T_{rs} = Average route selection time
T_d = data transfer time = M/R
M = Message length in bits
R = data rate in bits per sec
T_r = data release time = NT_h
T_h = house keeping entries time

Thus $\boxed{T = (N-1)T_{rs} + M/R + NT_h}$

MESSAGE SWITCHING :- (Computer Communication Network – V.S. Bagad I.A. Dhotre (Tech Pub))

* Message switching is used to describe the telegraph network.
* In this switching system used no physical copper path is established in advance b/w sender and receiver.
* Message switching sender side block of data to be sent, it is stored in the first switching office (ie) router and then forwarded later.
* Message signal data to sent each block is received in its entirely
* A network using this technique is called a store and forward network.
* The message was punched on paper tape off line at the sending office and then read & transmitted over a communication line at the next office along the way.
* Receiver side message punched out paper tape at the receiveing office.
* the message switching there is no limit on block size and a single block may it passing to the router, router line for minutes.
* Message switching does not involve a call setup
* It can achieve a high utilization of the transmission line.



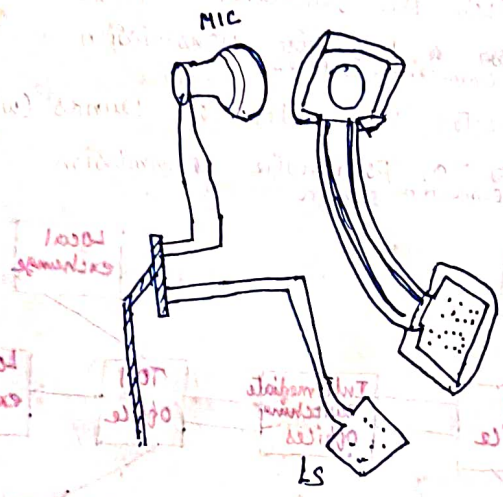
Message Switching diagram

COMPARISON OF CIRCUIT SWITCHING & MESSAGE SWITCHING:-

CIRCUIT SWITCHING	MESSAGE SWITCHING
① There is Physical connection b/w transmitter and receiver.	① No Physical Path is set in advance between transmitter & receiver
② All the packet uses same Path.	② Packets are stored and forward
③ Needs an end to end Path before the data transmission.	③ same as Packet Switching No needs of end to end Path before data transmission.
④ charge is based on distance and time, but not on traffic	④ charge is based on numbers of bytes and distance.
⑤ waste of B.w is possible	⑤ No waste of B.w
⑥ It cannot support store and forward transmission	⑥ It also support store and forward transmission.
⑦ Not suitable for handling interactive traffic	⑦ suitable for handling interactive traffic.

TELEPHONE HANDSET:-

* The telephone is a familiar end instrument in telecommunication system.
* The telephone is basically a transducer, Transducer is a device that converts one form of energy into a different form.
* The transmitter of telephone converts sound energy into electrical energy.
* The receiver converts electrical energy into sound waves.
* The below figure shows the handset assembly of telephone.
* The handset consists of transmitter & receiver.



Handset assembly of telephone

TRANSMITTER:-

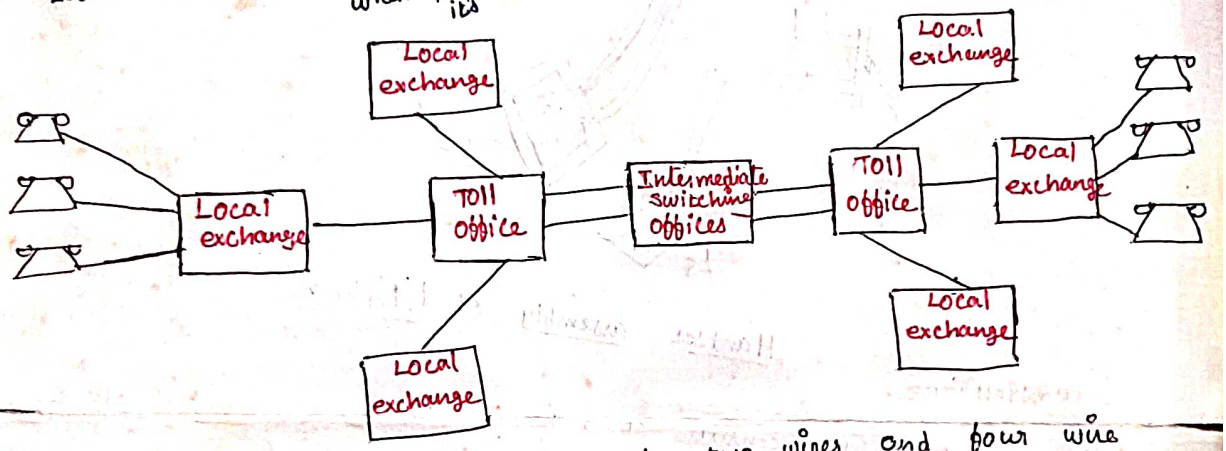
* The transmitter consists of a box containing a powder of small carbon granules
* The carbon granules to compress (or) allow them to expand to the box containing.
* when the carbon granules decreases (or) increases in the box.
* The carbon granules conduct electricity and the resistance offered by them is dependent upon the density.
* The varying electrical signal is similar to the varying sound signal
* The electrical signal is generate analog signal → the signals amplitude modulator using the Analog signal.

RECEIVER:-

* calling subscriber handset is coupled by wires to a receiver of the handset (is called subscriber)
* The receiver is an electromagnet with an accompanying magnetic diaphragm.
* The electromagnetic usually have two coils of about 100 turns with nominal resistance of 400Ω
* The receiver diaphragm must always be displaced in one direction from its unstressed position.

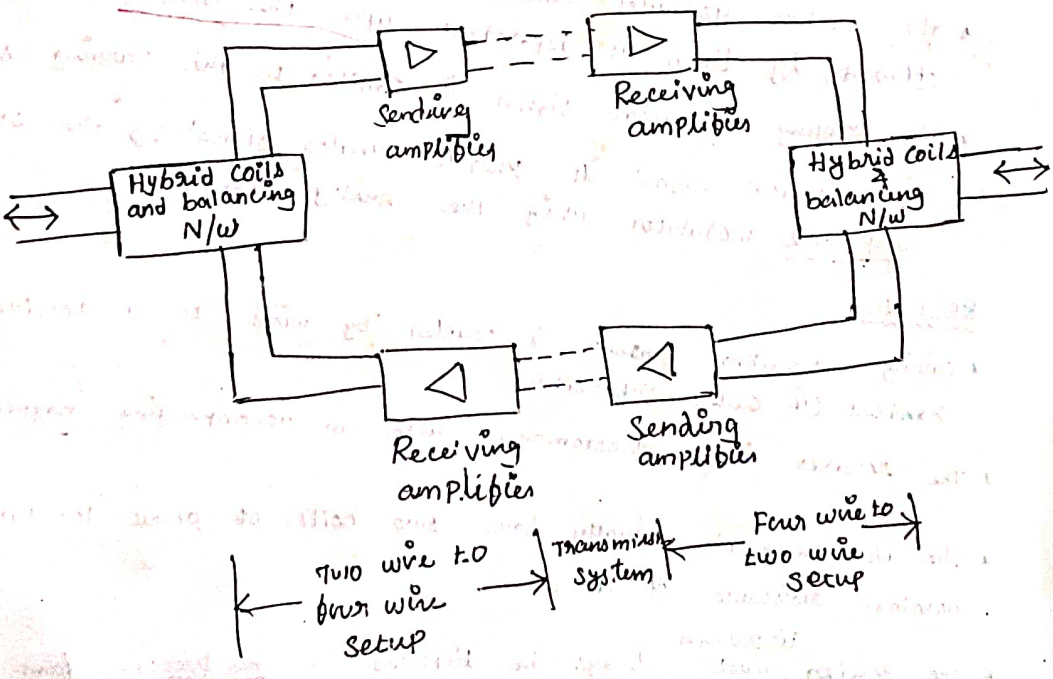
FOUR WIRE CIRCUITS :-

* The term four wire implies that there are two wires carrying the signal in one direction and two wires carrying them in opposite direction
* In normal telephone service used local loops are two wire circuits, on which transmitted signal both direction.
* If the distance b/w the subscribers we need amplifiers (repeaters) are necessary to compensate the attenuation
* The amplifiers are unidirectional, for two-way communication so. this problem Provided by using four wire communication is necessary.
* The local exchange will switch the subscriber loop to a toll connecting trunk. when its connection support two-wire transmission
* The toll offices are interconnected with inter toll trunks (which connects towns & cities) when its connection support four-wire transmission



The simple arrangement of the two wires and four wire transmission

* The four-wire circuit has repeaters for each direction of transmission.



BLOCK DIAGRAM

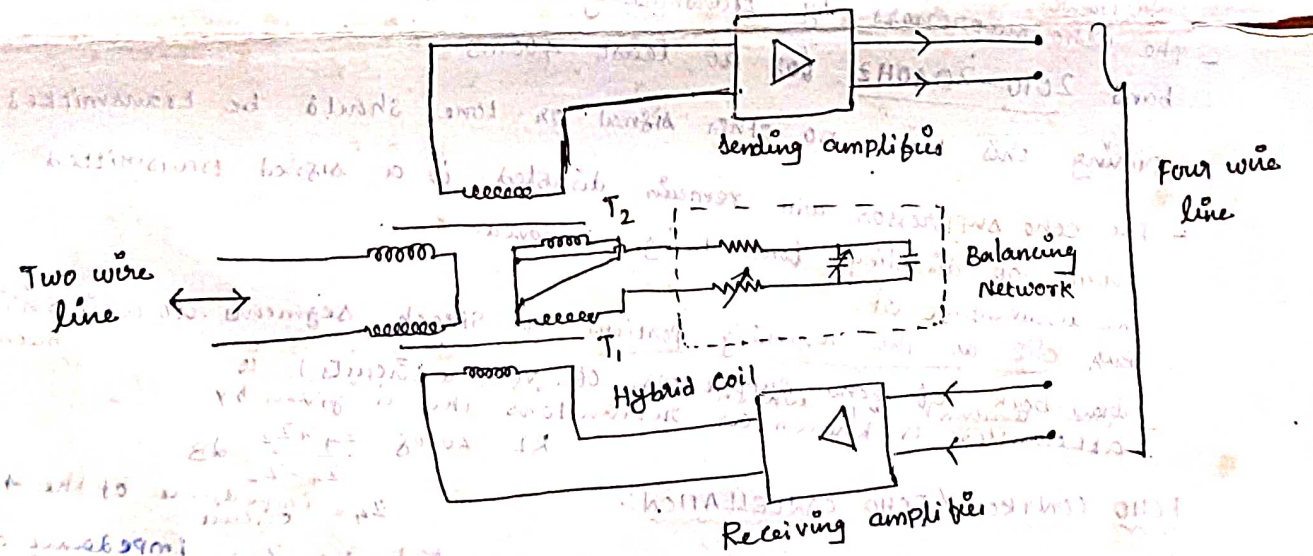
the two directions of transmission use different frequency bands. So they do not interfere with each other.

* At the toll office, the two wires are converted into four wire for long transmission. with help of hybrid coil conversion

— x —

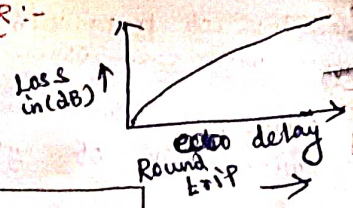
HYBRID TRANSFORMER:-

* To connecting the two wire circuit to the four wire circuit, a loop may created ~~a signal called circulated around the loop. the circuit as~~ continuous oscillation known as ~~the~~ singing.
* The hybrid transformer consists of (two cross connected transformer) & balancing network its to eliminates the signaling problem.
* Hybrid circuits have been traditionally implemented with specially interconnected transformer. More recently, used electronic hybrids have been developed.
* Cross connected transformer winding results in zero current in the line balanced impedance
* The power is divides equally b/w input send amplifier & O/P receive amplifier.
* It's avoiding 3dB losses in each direction (ie) sending & receiving transmission line.



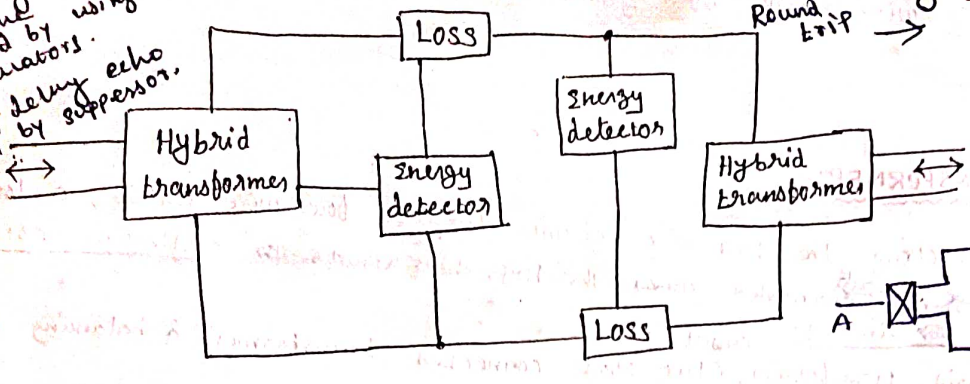
HYBRID TRANSFORMER CIRCUIT:-

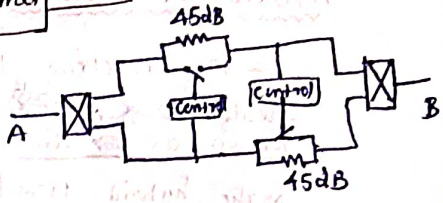
ECHO CANCELLER / ECHO SUPPRESSOR :-



① ECHO SUPPRESSOR :-

→ Short delay echos are controlled by using attenuators.
→ Long delay echo control by suppressor.





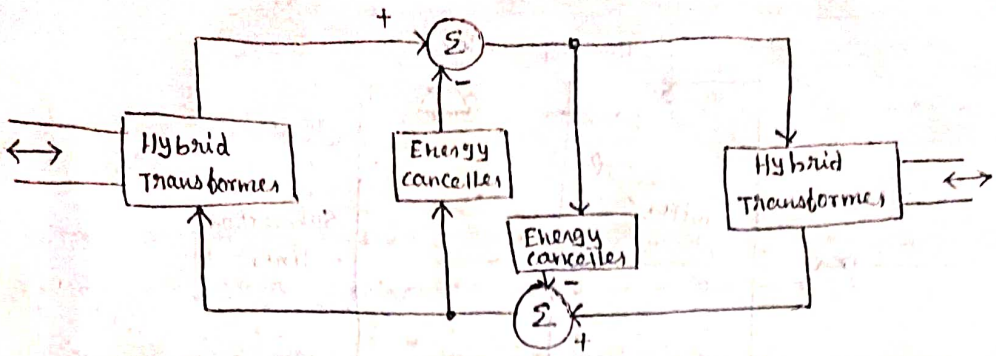
- In this devices are used to control the echo signal
- echo suppressor operates in four wire circuits by measuring the Speech Power using energy detector.
- The power level is exceeds a threshold level means to increasing the echo level.
- echo level blocked by the high level of attenuation - threshold level
- and suppresses echo would also suppress data
- When the method used full duplex transmission line.
- The echo suppressors by transmitting a single frequency tone in the band 2010 - 2040HZ for at least 400ms
- During this time no other signal or tone only should be transmitted
- The echo suppressor will remain disabled if a signal transmitted within 100ms of disabling tone being removed.
- The disadvantage of
- A clip at the beginning portions of speech segments at echo suppressor method.
- The amount by which the reflected signal is attenuated is known as return loss this is given by

$$RL = 20 \log \frac{Z_1 + Z_2}{Z_1 - Z_2} \text{ dB}$$

Z_1 = impedance of the 4-wire circuit
Z_2 = impedance of the 2-wire circuit.

ECHO CONTROL / ECHO CANCELLATION :-

- In this method used recent electronics technology
- Echo canceller operates by simulating the echo path to subtract a properly delayed and attenuated copy of the transmitted signal
- Echo canceller do not physically insert attenuators of transmission medium.
- Attenuated signal Subtracted from the incoming signal
- It is mainly used to satellite Network.



BLOCK DIAGRAM OF ECHO CANCELLER

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THE STROWGER STEP BY STEP SWITCHING SYSTEM :-

* The electromechanical switching system were developed around 1880 – 1890 to eliminate the limitations of manual exchanges.

* To establish automatic exchanges to improve the speed and carry more leads (subscribers) and also in this technique most pupular used Strowger step by step switching system

* In this system, a moving wiper (with contacts in the end) moved upto and around a bank of many other contacts, making a connection with any one of them.

* Strowger formed his company " Strowger Automatic telephone Exchange" in OCT 1891

* Advantages:- ① high system availability
② comprehensibility
③ cheapness and simplicity

Basic Elements of Strowger switching system :-

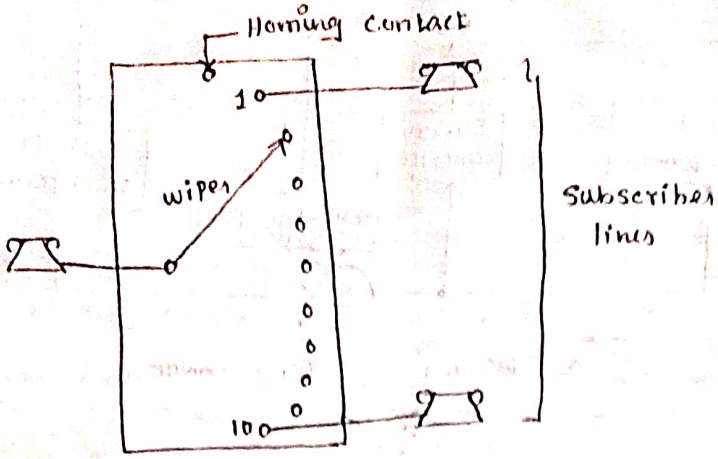
There are two types of basic elements

① uniselectors
② Two motion selectors

uniselectors:-

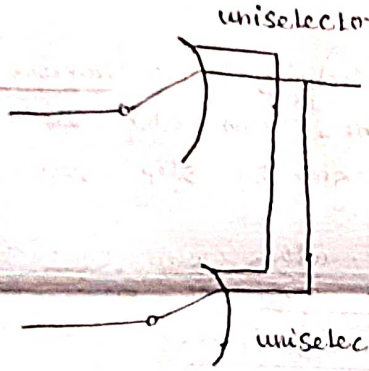
* uniselectors one which has a single rotary switch with a bank of contacts

* Depending upon the number of switching contacts 10 outlet's (or) 24 outlet's using uniselectors



(a) 10 contact uniselector

* Several uniselector's can be graded together so that multiple incoming circuits can be connected to multiple outgoing circuit.



(b) graded uniselector

* The contact arm (wiper) moves across a fixed set of switch contacts
* Each contact connected to an outgoing channel. So a caller choose the corresponding outgoing channel
* Let as consider '10' subscriber means by dialling any digit from '1' to 10
* uniselector is operated by mechanism of a rotary switch.
* The wiper contact (electromagnet) energised and deenergised to moving the position. For example (3 times by appling 3 pulses) the wiper moves by '3' contacts.

CROSSBAR EXCHANGE:-

(2) TWO MOTION SELECTORS:-

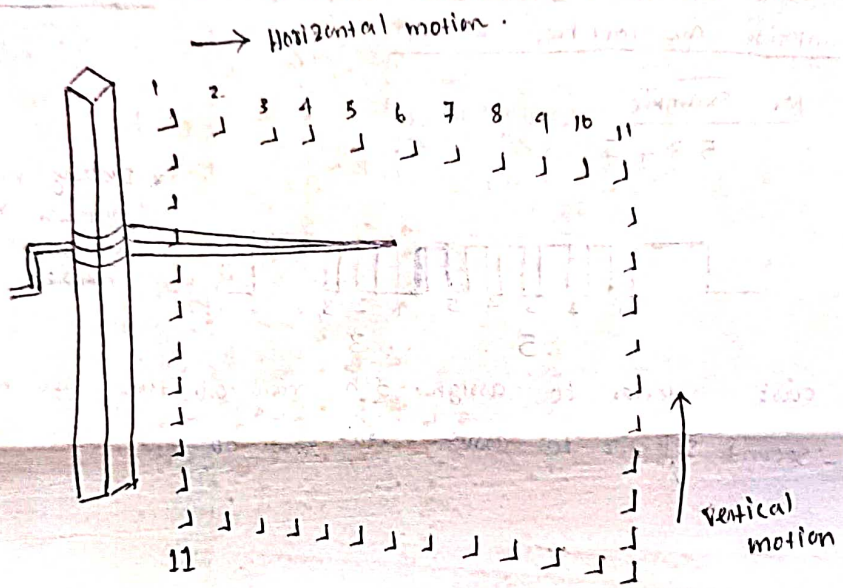
* A two motion selector is a selector in which a set of wipers is moved in two different planes by means of separate mechanisms

* In this technique provided numbers of outlets can be increased significantly.

* The wipers are then required to move both horizontally & vertically direction. is called two motion selector.

* The wiper two motion selector has access to two switching contacts.

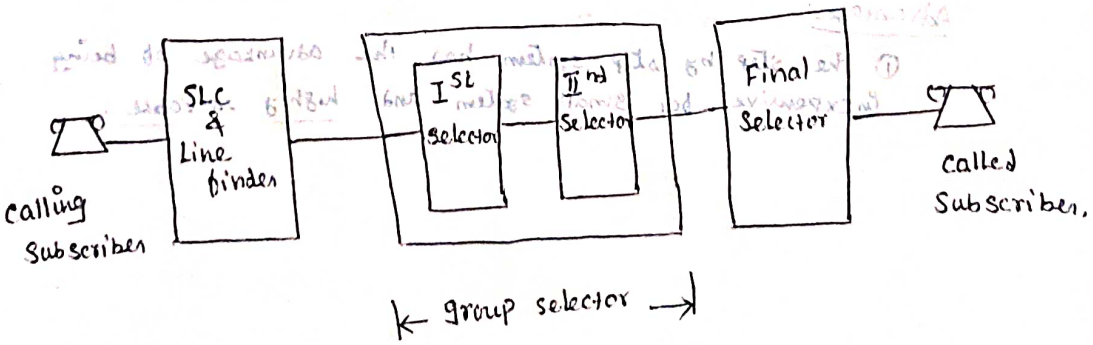
* Actually there are 11 vertical position & 11 horizontal contacts used But lowest vertical position & first horizontal in each vertical level are home position.



Two motion Selector

Step by step switching:-

- In general, the strowger switching system consists of subscriber's line circuit, line finder & allotter circuit, group selector and final selector.



BLOCK DIAGRAM OF STROWGER SWITCHING SYSTEM

(i) Subscriber line circuit (SLC) :-

- Every subscriber is connected to his local exchange by one pair of wires.
- The single pair carries the voice both direction.
- If there are 1000 subscriber on that exchange and also need 1000 SLC's

(ii) Line finder & Allotter :-

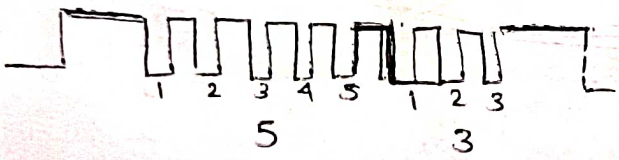
- As there are many subscribers, but only a few selector established calling subscriber to called subscriber.

(iii) Group selector :-

- Depends on the subscribes number, the group selector may comprise one (or) two selector.

For Example

5 3 4 5



* Dialing number first (5) number means it assign a five negative Pulses

- First selector to assign 5th row of the two motion selector.
- Second selector to assign 3rd row of the two motion selector.

(iv) Final selector :-

- The final selector takes care of the last two digit.
- The Dialling of the switch 4 row & 5 column of the rotates the switch.
- If the called subscriber line is free, then the path setup is completed other wise busy means returned to the caller.

Advantages :-

① The step by step system has the advantage of being inexpensive for small system and highly reliable.

Disadvantages:-

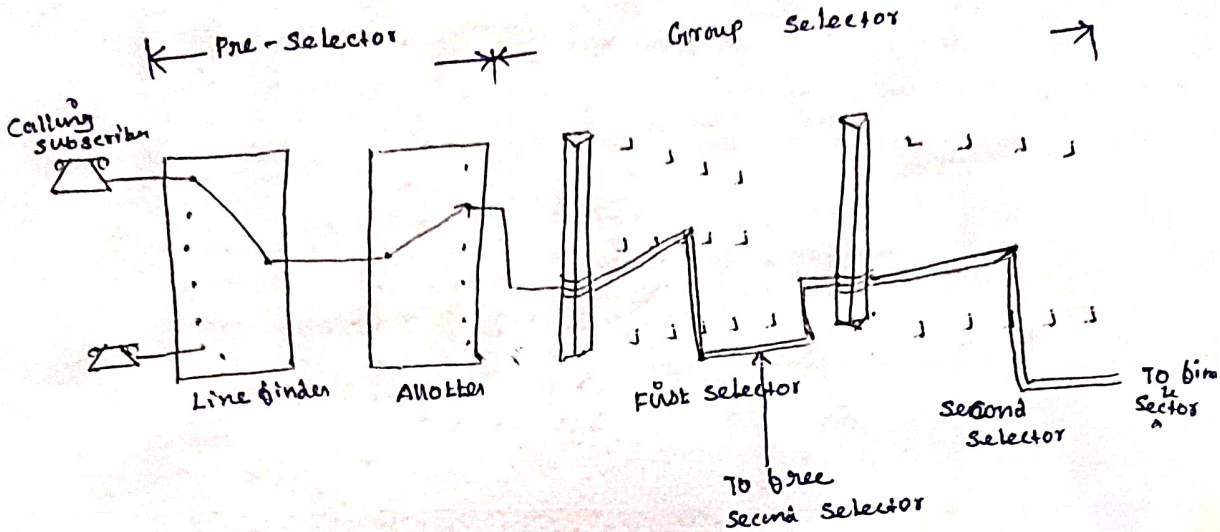
① Regular maintenance.

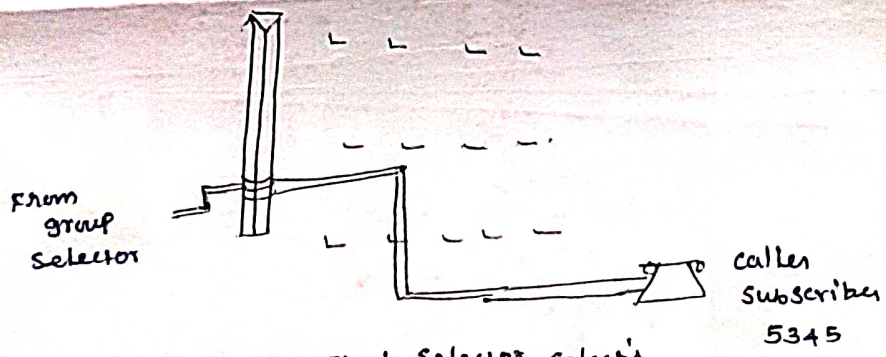
② It is not feasible to select an alternate route for interoffice calls.

③ Life time of the system less.

④ Capacity of the system reduced.

⑤ The strowger system can accept only 7 to 9 pules in 1 second





Final Selector selects subscribers link

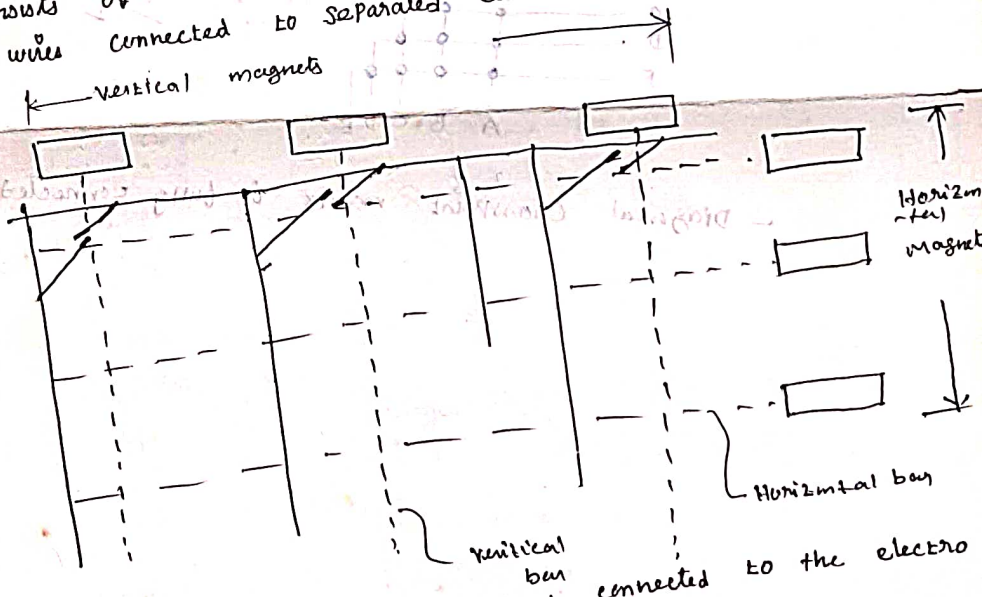
Routing of a local call in strowger switching system.

CROSSBAR EXCHANGE:-

- The crossbar switch basically consists line link frames trunk, and common control equipments.
- The fundamental concept of cross bar switching uses common control networks.
- The common control networks enables the exchange to perform event monitoring, call processing, charging, operation, and maintenance.
- The common control method of switching overcomes the disadvantages of step-by-step switching
- The common control makes no call processing until it receives entire number

SWITCHING MATRIX:-

- The basic cross bar matrix requires atleast M x N sets of contact
- In this technical used to perform any one of the contact
- It consists of horizontal & vertical wires (show a solid line) both wires connected to separated contact points of switches



- when both horizontal and vertical bars connected to the electro magnet.
- Electro magnet energized & denergized with rebening the Horizontal & vertical magnets inputs.
- If the energized means contact closed together,
- If the denergized means contact open together,
- If the connection establised means first energised Horizontal bar, and then vertical bar is energised

- Cross bar switching known as a non-blocking cross bar configure for 'N' subscriber means N^2 switching elements required.

Examples

N = 100 ⇒ Total switching element 10,000

- Advantages

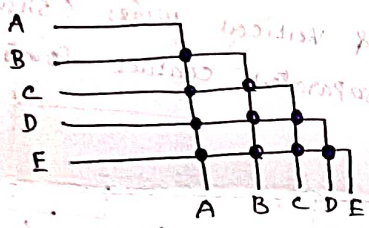
Cross bar economic, only small private exchanges requiring small switches.

DIAGONAL CROSS POINT MATRIX:-

- The Diagonal cross point 5 subscribes Diagram shown in figure.
- The number of cross points are reduced to $N(N-1)/2$

where N → number of subscribers

- It is also called triangular matrix or two way matrix



$\frac{100*99}{2} = 4950$

$\frac{100*99}{2}$

9900/2

5×4 = 20 = 10

5×4 = 20 = 10

- Diagonal Crosspoint matrix is fully connected.

K. Dhanunjayam

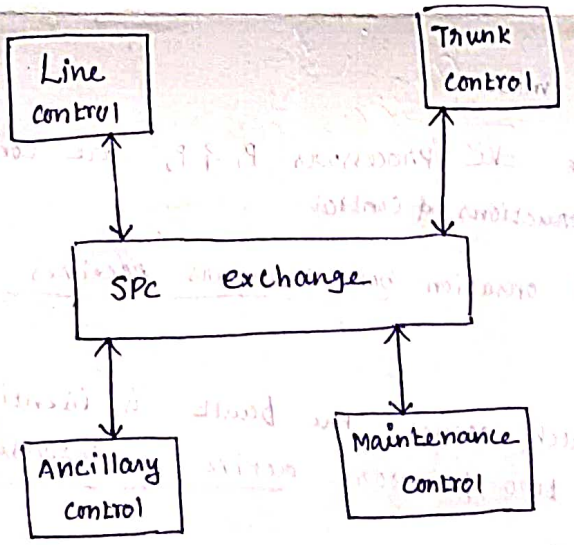
SPC EXCHANGE :-

- In last two sections the Strowger's step by step switching system and Crossbar switching system were studied.
- In each case, electromechanical components were used for both switching and control elements
- In 1965, Bell system established first computer switching system. which uses a Stored Program digital computer for its control functions
- SPC Provides significant advantages to end users & enables easier number changes, automated call tracing message unit, billing etc

Basic of SPC :-

- In SPC, a Programe or a set of instruction are stored in its memory and executed automatically one by one by the Processer
- Any other change the switching operation means to change over the Program to control the operation.
- using SPC, 20mA transmitter (old transmitter need 23mA) with 52V battery feed and longer subscribes loop can be achieved.

Basic view of SPC telephone switch :-



- In this system more than one system are used for the reliability.
- The SPC system uses distributed software and hardware architecture.

* There are two types of SPC exchanges, namely centralised SPC and distributed SPC.

Centralized SPC

- Early electronic switching system are centralised SPC exchanges and used a single processor to perform the exchange function,

- Now a days centralised SPC uses dual processor for high reliability

- All the control equipments are replaced by the processors.
- A dual processer architecture may be configured to operate
  1. Stand by mode
  2. Synchronous duplex mode
  3. Load sharing mode.

① Stand by mode:-

- In this mode, any one of the processors will be active and the rest is standby

- In this technical mode the active processor fail means to uses a secondary storage common on both processors.

- They do not connect directly two processor. only transfer the control signal.

② Synchronous duplex mode:-

- In this mode the Processors P_1 & P_2 are connected together to exchange instructions & control

- During normal operation both processors receives all information signa & exchange

- If the mismatch occurs, the fault is identified by the comparat that times two processor active as individually.

- After rectification of fault to processor synchronous each of them.

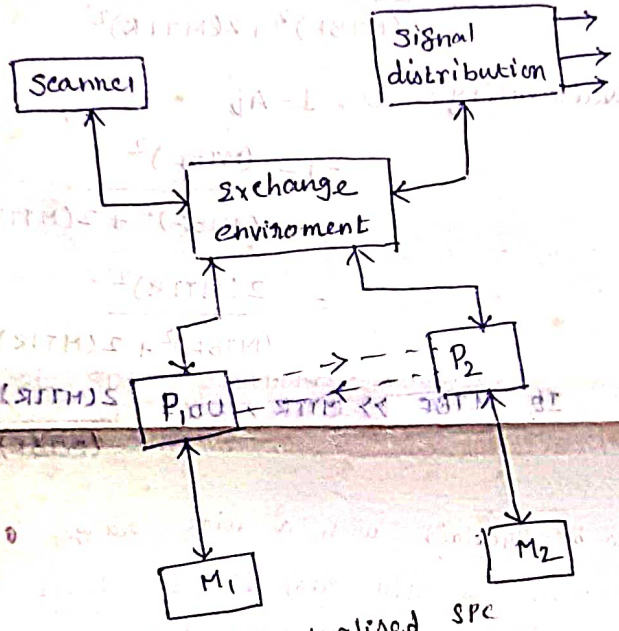
Sharing mode:-

- In this mode the comparator is removed & alternatively an exclusion device (ED) is used

- In this mode both the processor are active simultaneously and share the resources of exchange

- Any one processor fail means other processor takes over the entire load of the exchange

- In normal operation → each processer handles one half of the calls.



Centralised SPC

Availability :-

Single processor

$$\text{Availability } (A) = \frac{MTBF}{MTBF + MTTR}$$

where

MTBF – Mean time b/w failures

MTTR – Mean time to repair

unavailability = 1 – A

$$U = 1 - \frac{MTBF}{MTBF + MTTR}$$

$$U = \frac{MTTR}{MTBF + MTTR}$$

If MTBF >> MTTR, $U = \frac{MTTR}{MTBF}$

$$U = \frac{MTBF + MTTR - MTBF}{MTBF + MTTR}$$

Dual Processor:-

A dual Processor system is said to have failed only when both Processor fails and the total system is unavailable.

$$(MTBF)_D = \frac{(MTBF)^2}{2MTTR}$$

where

$(MTBF)_D$ = MTBF of dual processor

MTBF = MTBF Single Processor

Availability $\rightarrow A_D = \frac{(MTBF)_D}{MTTR + (MTBF)_D} \rightarrow (1)$

Sub $(MTBF)_D$ value in (1) eq

$$A_D = \frac{(MTBF)^2}{(MTBF)^2 + 2(MTTR)^2}$$

unavailability :- $U = 1 - A_D$

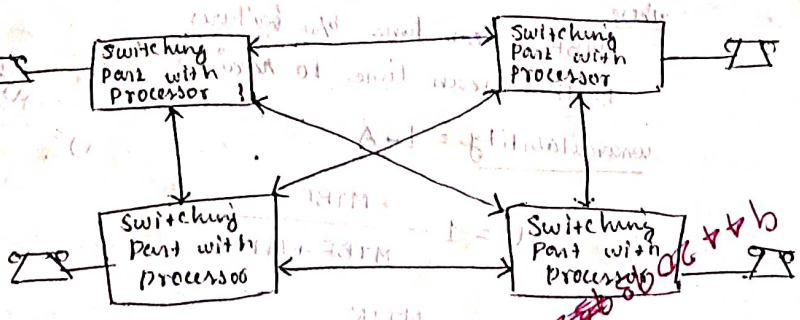
$$= 1 - \frac{(MTBF)^2}{(MTBF)^2 + 2(MTTR)^2}$$

$$= \frac{2(MTTR)^2}{(MTBF)^2 + 2(MTTR)^2}$$

If MTBF >> MTTR, U = $\frac{2(MTTR)^2}{(MTBF)^2}$

Distributed SPC

- The customers to be provided with a wide range of services
- But central processors is still required to direct the regional processors and to perform more complex tasks
- The distributed SPC offers better availability and reliability and than the ~~centralised~~ SPC. Entire exchange control func.. may de composed either Horizontally (or) Vertically for Distributed SPC



Distributed SPC

End

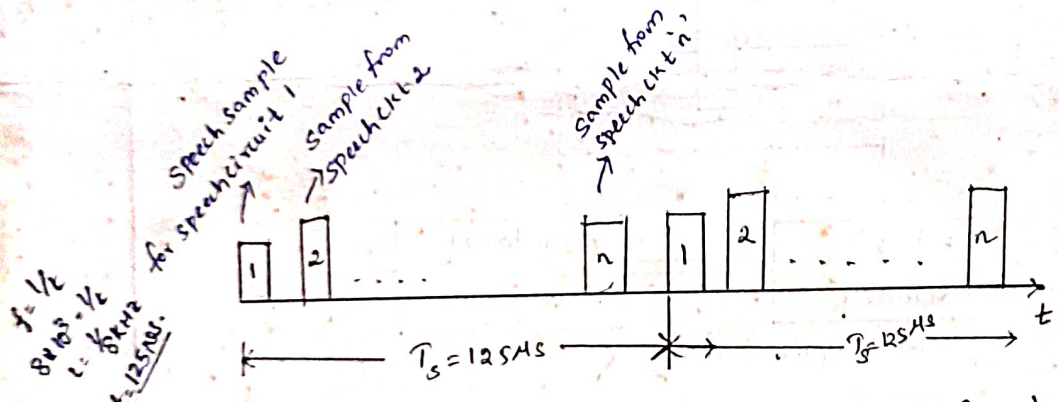
Unit- 2.

Digital Switching System.

(1)

In Space division Switching, a switching element once alloted remains dedicated to a connection for entire duration. ie., a switching element cannot be shared by Many active speech circuit, At a time a switching element is dedicated only to one active speech circuit.

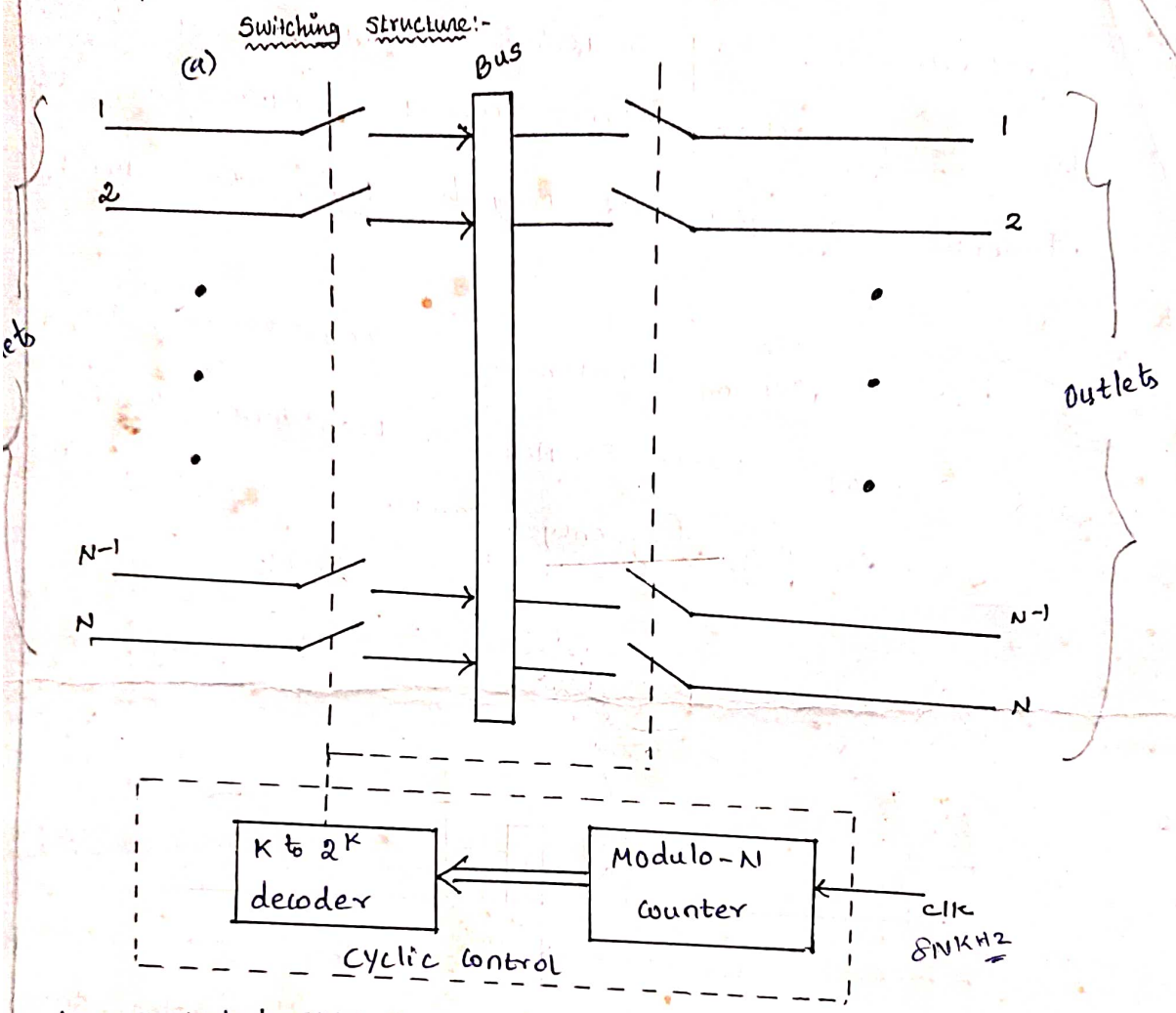
In time division switching, Speech signal are Sampled and Sent as PAM Samples (or) PCM binary words. with 8 KHZ Sampling frequency, sample occurs every 125 μs.



During one Sample Period, Speech Samples from many Circuits can be switched by single switching element. In other words, a switching element can be shared by number of simultaneously active speech circuits. This is the principle of "Time division Switching"

Time Division Space Switching :

A simple N x N time division space switch can be shown in fig below. its equivalent ckt is



The Network is has one link (bus) interconnecting N inlets and N outlets. The speech is carried as PAM samples (or) PCM binary words. If PAM samples are switched, the switching is known as Analog Time division Switching, If PCM binary words are switched, then switching is called Digital Time division switching.

The number of Simultaneous Conversations (SC) that can be supported on the Network is given by (2)

$$SC = \frac{125}{t_s}$$

t_s = time (in Micro seconds) to setup a connection and transfer the sample value.

There are 4 control Mechanisms:

(1) cyclic controlled Time division Space switching.
(2) Input controlled " " " "
(3) output controlled " " " "
(4) Memory controlled " " " "

① Cyclic Controlled Time division Space switching:

It is the simplest form of control, Here any inlet 'i' is always connected to outlet 'i' ie., inlet 1 is connected to outlet 1. In this case there is a fixed one to one correspondence between inlets and outlets. The cyclic control is organized by Modulo-N counter and K to 2^K decoder.

where 'N' and 'k' are related by

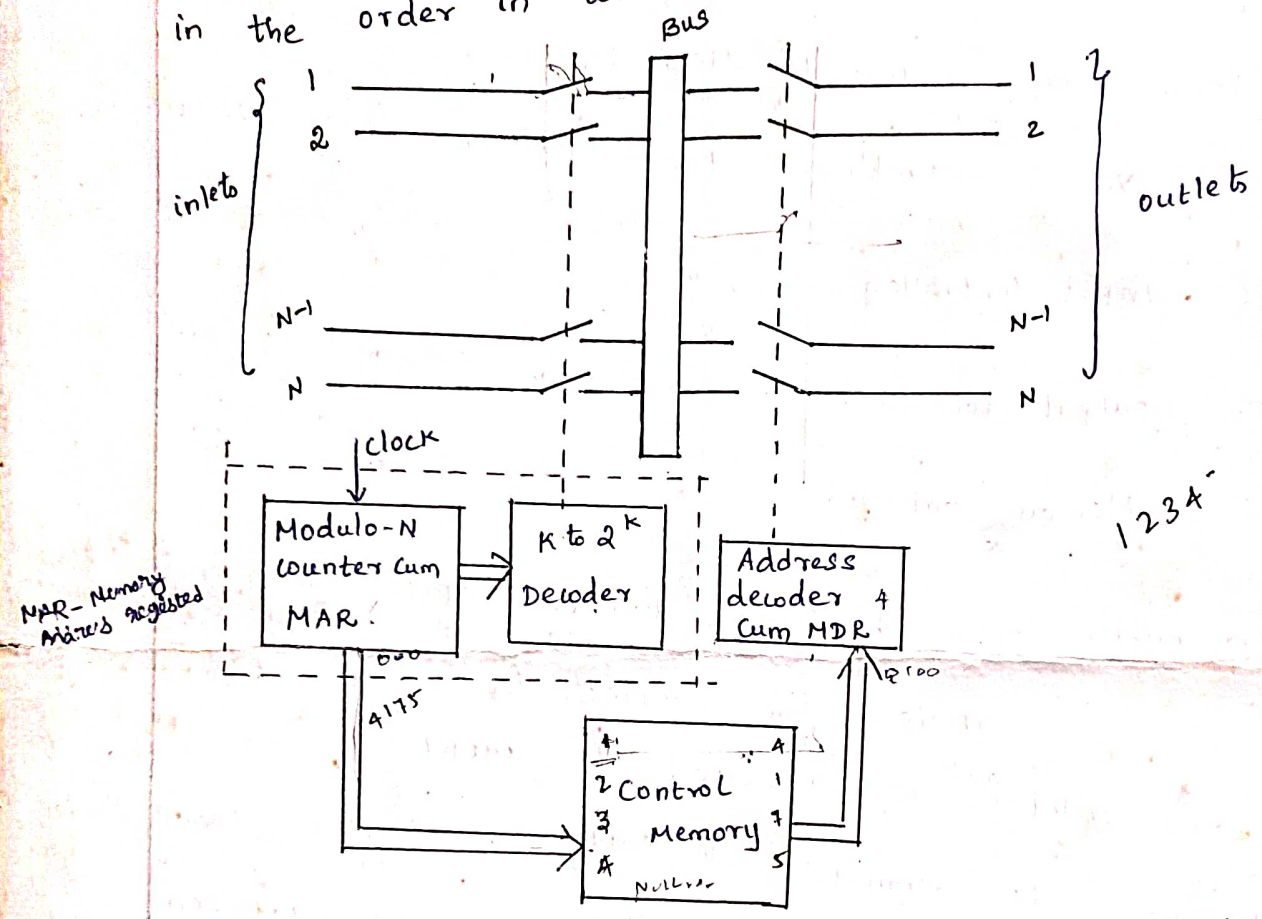
$$[\log_2 N] = k$$

[ ] → is cieling function that gives the lowest integer equal to or higher than quantity inside the symbol.

In this control there is no switching in true sense.

(2) Input Controlled (or) Input driven Time division Space for

Here input side is cyclically switched and a is a Control Memory on output side which cont addresses of outlets stored in successive locatio in the order in which they are to be connected.



For Eg: an address sequence 4-1-7-5 is stored in locations 1, 2, 3 and 4 of Control Memory implies that inlet 1 is connected outlet 4, inlet 2 to outlet 1 inlet 3 to outlet 7, inlet 4 to outlet 5.

The switch is called input-controlled as outlet is choosen, depending on the inlet that is being scanned a any instant.

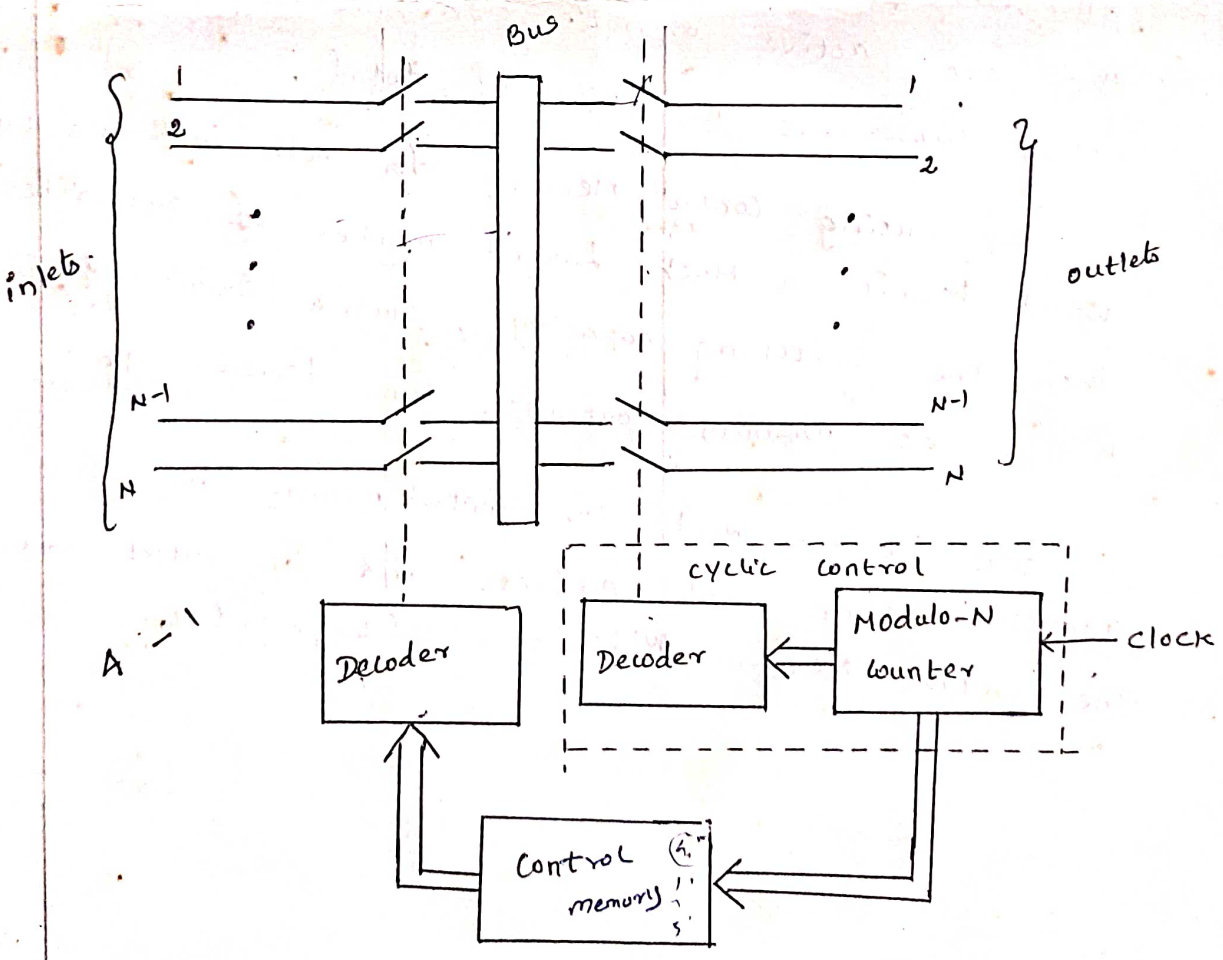
The Modulo-N counter acts as Memory address Register of Control Memory. Control Memory has N words and width of $[\log_2 N]$ bit which are used to address the N outlets.

For an active inlet i, the corresponding outlet address is stored in i^{th} location in control Memory. It is read out and passed to address decoder which acts as Memory data Register (MDR) of control Memory, which enable proper outlet to be connected to bus.

if inlet is not active, corresponding location in Memory has "NULL Value", so disabling outlet.

③ Output Controlled Time division Space switching:

Here output is ~~cyclical~~ cyclically switched and control Memory is in input side. In this case Switch is said to be output controlled because each location of control Memory is rigidly associated with given outlet.



③ Memory Controlled Time division space switching:

For both input and output. Controlled configuration number of inlets or outlets N, which is equal to switching capacity (sc).

$$N = SC = \frac{125}{t_i + t_m + t_d + t_t}$$

$t_i \rightarrow$ Time increment Modulo-N counter.

$t_m \rightarrow$ Time to read control Memory.

$t_d \rightarrow$ Time to decode address and Select the inlet or outlet

$t_t \rightarrow$ time to Transfer the sample value from inlet to outlet

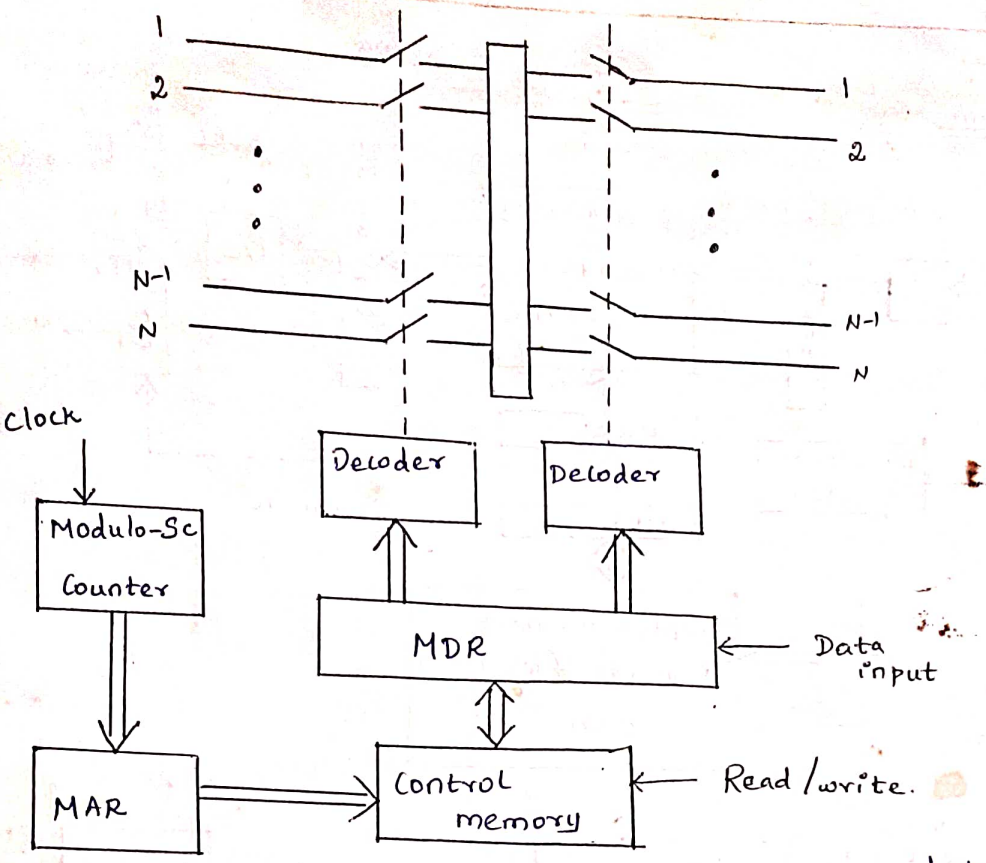
clock rate used = 8N KHz.

④ Memory Controlled: Time division Space Switching:

The use of cyclic control demands that all lines to be scanned irrespective of whether they are active or not. In pratice, The number of active subscribers is 20% of total.

By using control Memory for both inlets and outlets would permit a Much Larger number of subscribers than the switching capacity. Such a configuration is known as "Memory Controlled time division Space switching"

Here each word of control memory has two addresses: an inlet address and an outlet address. The control Memory width is $2[\log_2 N]$ bits.



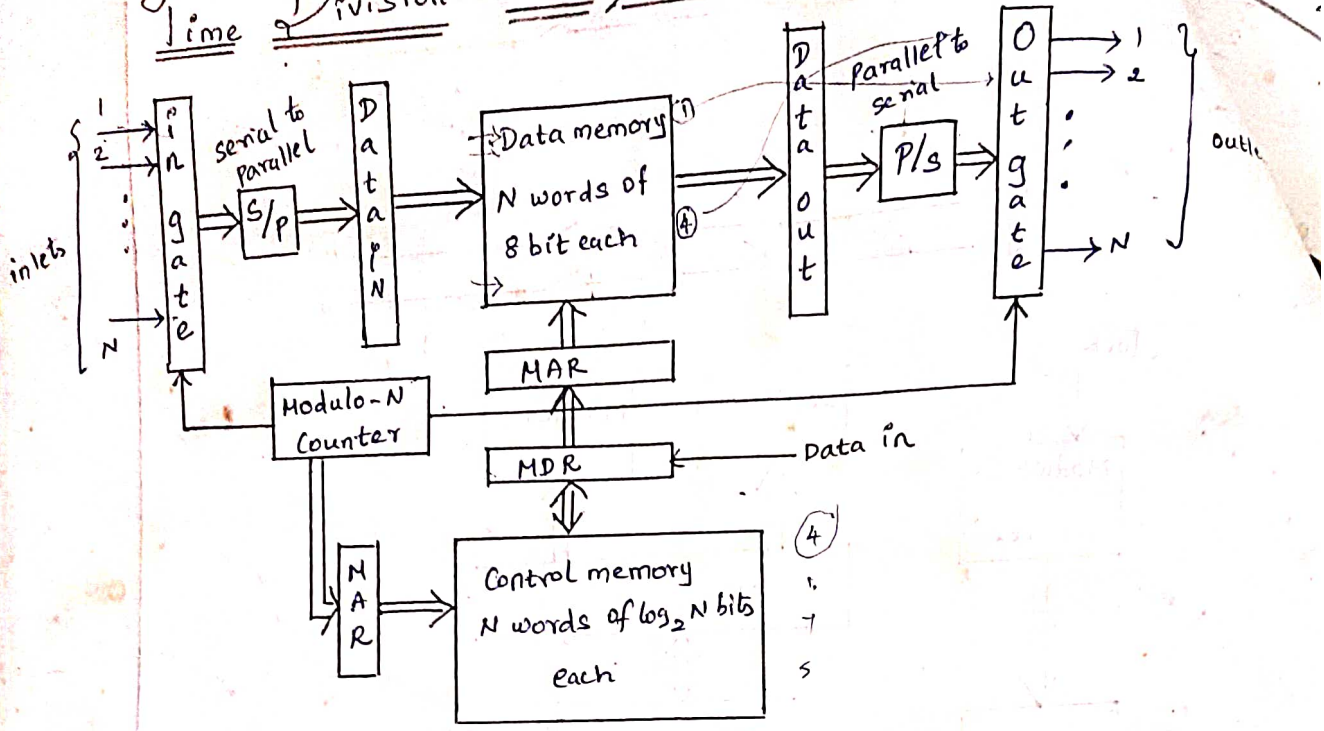
When a Connection is to be Setup between inlet 'i' and outlet 'j', two addresses are entered in Control Memory via data input facility and the locations are Marked busy. when Conversation terminates these addresses was replaced by "NULL Values" and locations are Marked free.

Here Clockrate = 8 sc KHz.

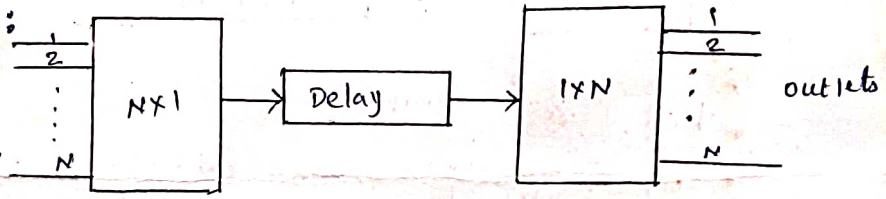
$$SC = \frac{125}{t_s}$$

$t_s = t_i + t_m + t_d + t_t$ as discussed earlier.

Time Division Time Switching:



Equivalent Circuit:



↳ Here the I/p Sampled Values of Speech are PCM but not PAM samples

↳ In this organisation, data coming from inlets are stored in data memory and later read out at corresponding outlets. It is necessary to perform Serial to Parallel Conversion and Parallel to serial Conversion at inlets and outlets.

↳ There is a time delay between acquistion of sample at the inlet and its delivery at the outlets, Signyfying these aspects. Memory based Scheme is known as "Time division time Switching."

Time division Time Switch can be Controlled in 3ways

1. Sequential write / random read
2. Random write / sequential read
3. Random input / Random output

⇒ In first two methods :- of control, sequential / random read / write operations refer to read / write operations associated with data memory. Here inlets and outlets are scanned sequentially.

⇒ In the last case, inlets and outlets are scanned randomly, and the data memory is accessed sequentially.

(i) Sequential Write Random Read :-

It operates in two modes
* phased operation — During the first phase → It's stored data
  During the second phase → Data transfer corresponding location
* slotted operation

1st phase - one memory write operation is involved.
2nd phase - Two memory Read operation is involved.

phased operation:

It operates in Two phases

During the first phase, inlets are scanned one after the another and datas are stored in Datamemory. There is one - one correspondance between inlets and datamemory location. [ie., inlet 'i' stores the data in location 'i' of data memory].

There is a control Memory which stores the address of inlets corresponding to outlets.

During the second phase, inlets addresses are read out from the control memory, the corresponding locations in data memory are accessed and the data transferred to the outlets in sequence.

Any inlet can be connected to any outlet, inlet addresses are randomly distributed in control memory.

During first phase, one memory write operation is involved. During second phase Two memory Read operations are involved.

Time taken for 2 phase operation, $t_s = Nt_d + N(t_d + t_c)$

$t_d \rightarrow$ time taken to read/write data memory

$t_c \rightarrow$ time take to read/write control memory.

$t_s = 3Nt_m \qquad (t_d = t_c = t_m)$

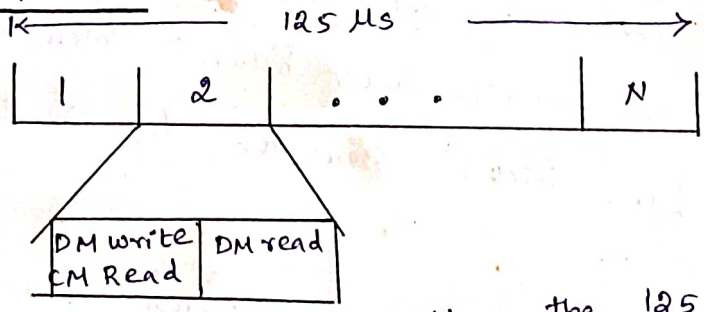
$t_m \rightarrow$ Time to read control Memory,

No. of subscribers $N = \dfrac{t_s}{3t_m} = \dfrac{125}{3t_m} \qquad (t_s = 125\,\mu s)$

The number of subscribers can be increased by overlapping the read cycles of data memory and control memory in second phase

where $N = \dfrac{125}{2t_m}$.

Slotted operation:



In slotted operation the 125 μs period is divided in to N subperiods of duration $125/N$. In each sub period following operations are performed

(i) Read inlet i and store the data in data memory location i

(ii) Read the location i of control memory which contain the value, say j

(iii) Read the data memory location j and transfer the data to outlet i.

(ii) Random write / Sequential Read :

The control memory contains the addresses of outlets corresponding to inlets

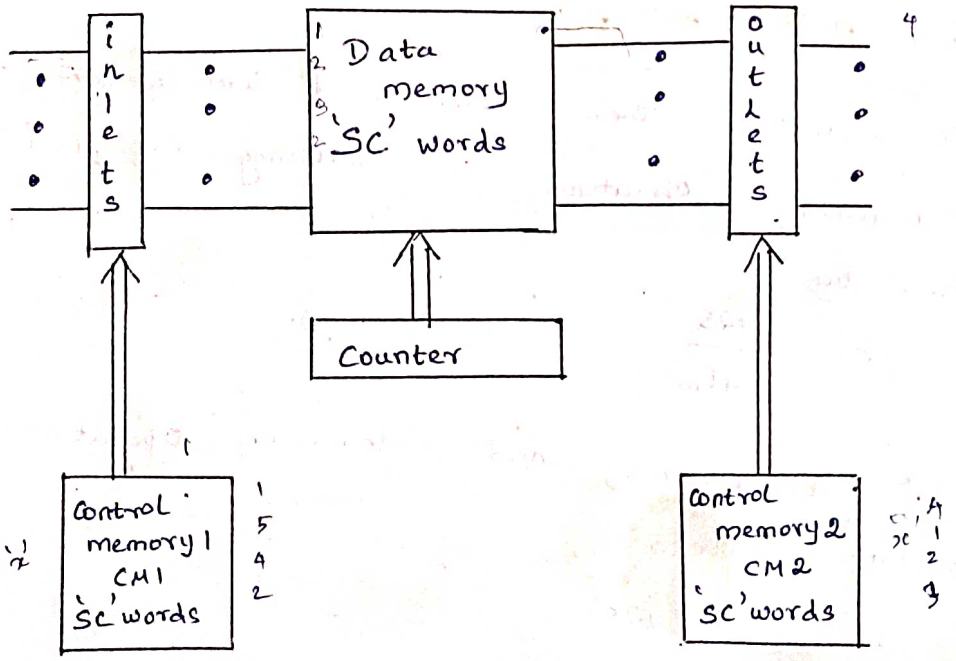
In first phase, control memory is read and inlet data is written into the data memory location specified by the contents of control memory. Here inlets are scanned sequentially, but data are written into the datamemory randomly.

In the second phase, Data memory is read out sequentially and the data sent to the outlets sequentially.

There is one to one correspondence between outlets and data memory locations.

(3) Random input / Random output :

This form permits large number of subscribers than its switching capacity, but Switch is Blocking in nature.



Functionally, there are two control memory which stores the addresses of active inlets and active outlets respectively.

There is one to one correspondence between the locations of two control memories. If the address of inlet is stored in location 'x' of control memory '1' (CM1), then outlet address is also stored in location x of control Memory 2 (CM2).

Operation of random input / random output takes place in two phases.

In first phase, addresses of active inlets are read out from control memory1 and the data from respective inlets are stored in data memory sequentially starting from first location.

In the second phase, addresses of active outlets are read out from control memory 2, and data are sent out from data memory to respective outlets.

In each phase, there is one read (Control memory) and write (data memory) operations, so Switching Capacity (SC) is given by

$$SC = \frac{125}{4t_m}$$

If control memory and data memory operations are overlapped, then

$$SC = \frac{125}{2t_m}$$

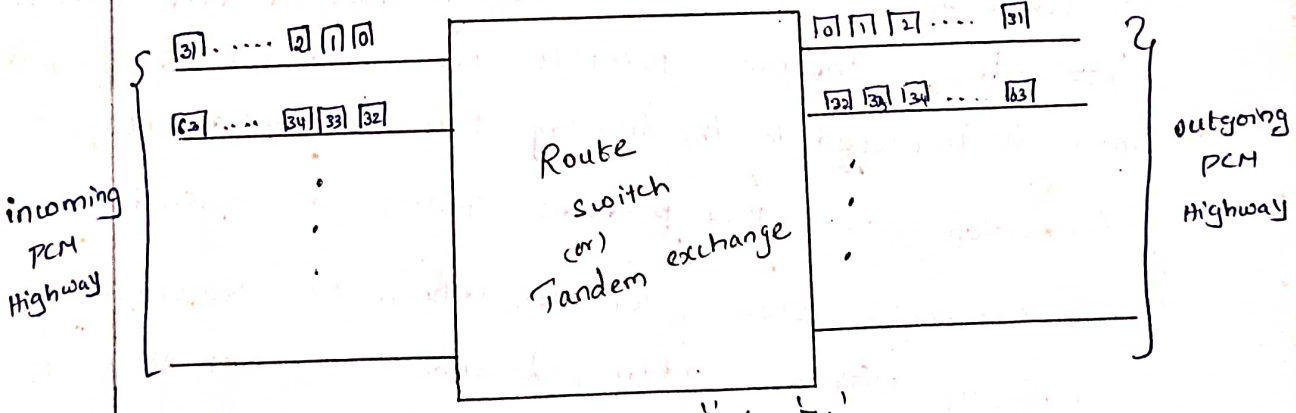
Space & Time Switches

A tandem switching centre [which inter connects several local exchanges] , or route switch of local exchange must be able to connect "any channel on one of its incoming PCM highways to any channel on one of its outgoing PCM highways"

~~Inter~~ Incoming & outgoing PCM highways are spatially seperated, so space switch is needed to connect its incoming & outgoing PCM highways.

Switching Network must be able to receive PCM samples in one time slot and re-transmit in different timeslot, so Time switch is needed

Thus route switch of local exchange (or) Tandem exchange performs both Space switching & Time switching.

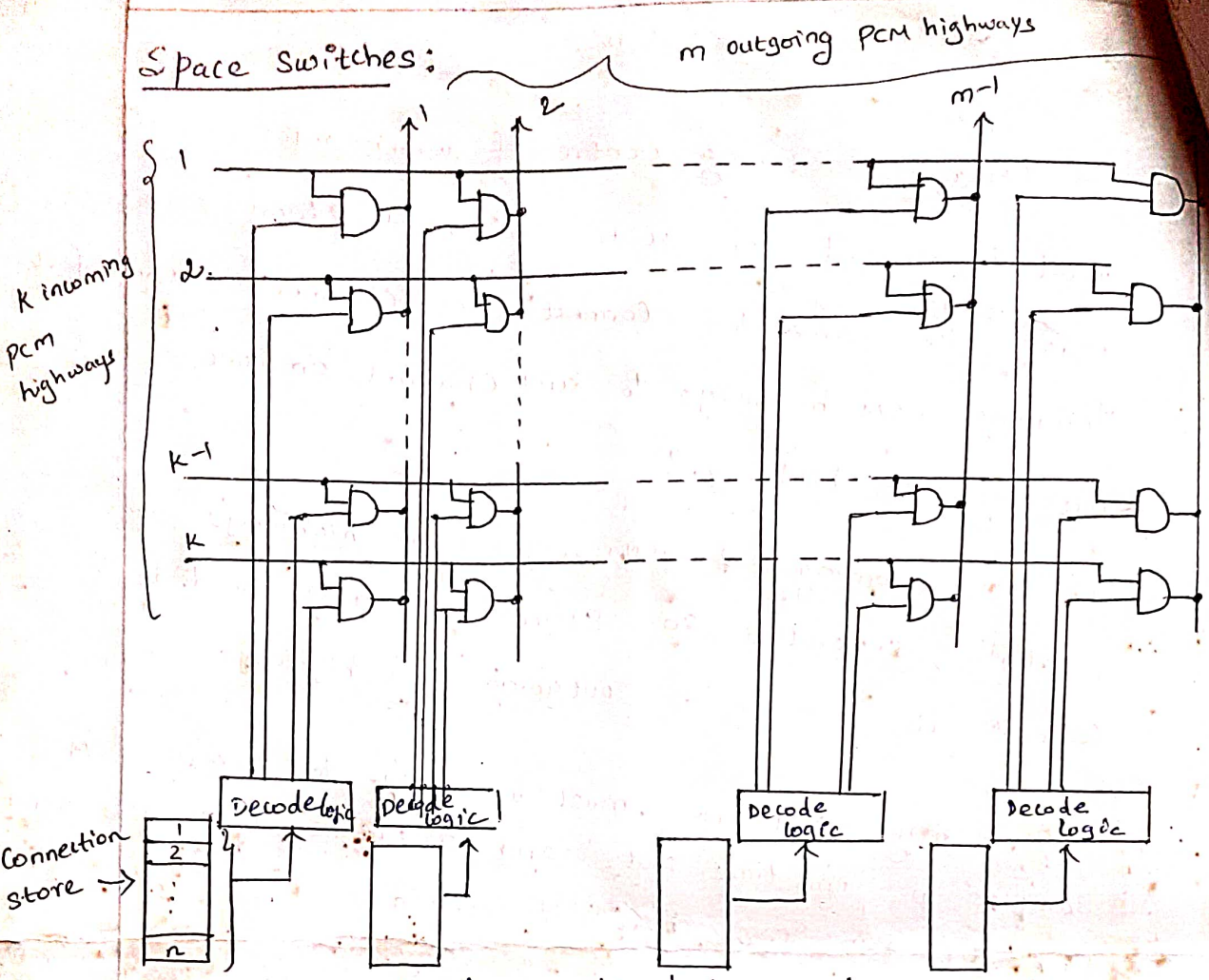


In order to connect channel '1' to '34'.

Space switch is needed to connect incoming PCM highway '1' to outgoing PCM highway 2.

Time switch is needed to change the 2nd time slot to 3rd time slot.

Space Switches:



Connections can be made between incoming and outgoing PCM highways by means of a crosspoint matrix of a form shown in figure.

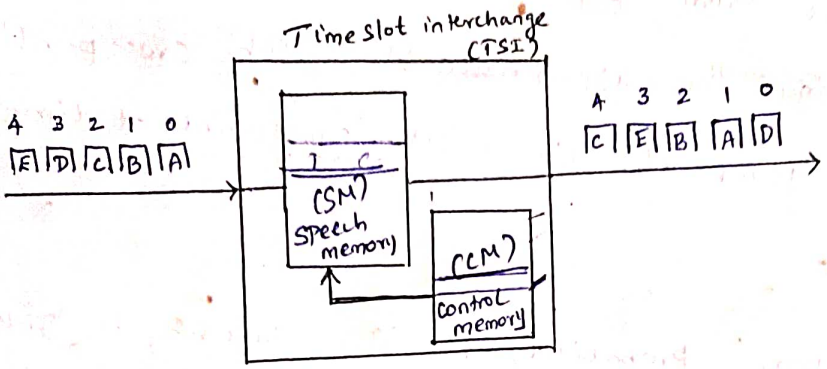
Different channels of an incoming PCM frame may need to be switched by different crosspoints in order to reach different destinations. The cross point is Two input AND gate. one input is connected to the incoming PCM highway and other to "Connection store" that produces Pulses at required instant

The connection store for each column of crosspoints is a memory with an address location for each time slot, which stores the number of cross point to be operated in that time slot. The number is written to connection store by controlling processor.

Since a cross point can make different connection in each of 'n' time slots, it is equivalent to 'n' crosspoints in space division network.

Time Switches:

The principle of time switch is shown in figure. It connects an incoming n-channel PCM highway to an outgoing n-channel PCM highway



Timeslot interchange is carried out by means of two stores speech memory and control memory. The ~~control memory~~ ~~determines~~ Each incoming time slot is stored in sequence in a speech memory. The control memory determines in which order the time slots are to be read from speech memory

STS & TST Switching:

(i) STS (Space-Time-Space) switching

Each of 'm' incoming PCM highways can be connected to 'k' links by crosspoints in A switch. and the other ends of the links are connected to m outgoing PCM highways by crosspoints in 'c' switch. Each link contains a Time switch.

To make a connection between Timeslot X of an incoming PCM highway and time-slot Y of an

outgoing PCM highway, it is necessary to select a link having address X free in speech memory and address Y in control memory. The time switch is then set to produce a shift from X to Y. The connection is completed by operating the appropriate A-switch cross point at time X and appropriate C-switch cross point at time Y in each frame.

Blocking probability of STS switching is given by

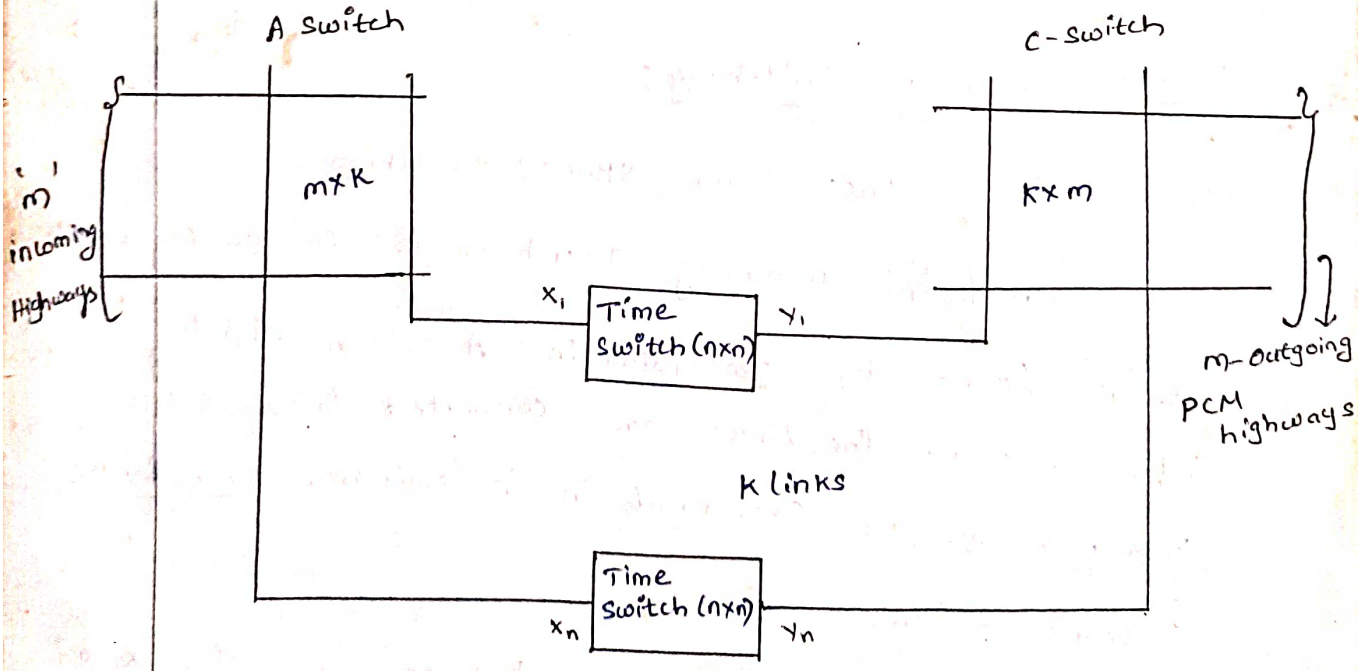
$$B = \left[1 - \left(1 - \frac{P}{\beta}\right)^2\right]^K$$

P → Probability that a link is busy.

$\beta = \frac{K}{N}$ → factor by which the percentage of links that are busy is reduced ($\beta < 1$)

K → no. of center stage TSM.

STS switching :



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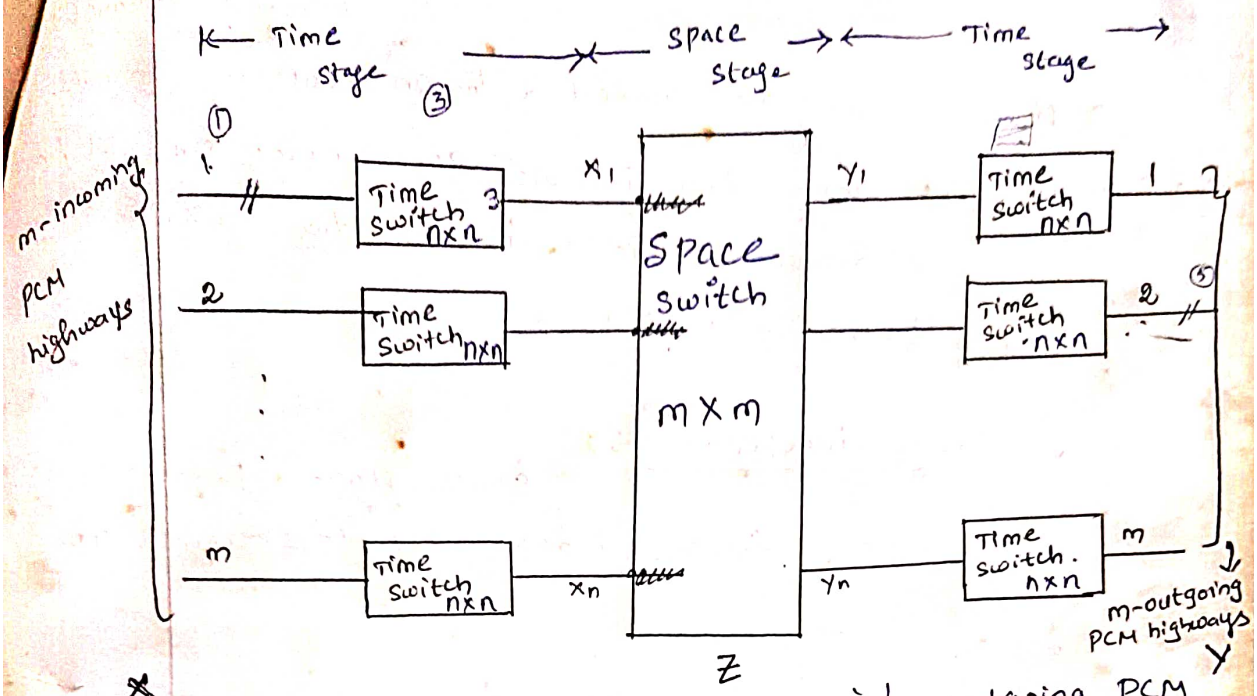
TST switching (Time - Space - Time switching)

(9)



Each of 'm' incoming and 'm' outgoing PCM highways is connected to a time switch. The incoming and outgoing time switches are connected by a space switch.

To Make a connection between time slot x of incoming highway and time slot y of an outgoing highway, it is necessary to choose a time slot z which is free in the control memory of incoming highway and the speech memory of outgoing highway. The Connection is established by setting the incoming time switch to shift from x to z time slot, setting outgoing time switch to shift from z to y timeslot and operating Crosspoint at time z in each frame.

Features Of TST Switches

* **Low Blocking Probability :** An incoming channel time slot may be connected to an outgoing channel time slot using any possible space array time slot. There are many alternative paths between two subscribers. Thus blocking probability is Reduced.

* **Stage independancy :** space stage operates in time-divided fashion, independently of external TDM links.

* **Implementing advantage :** For large switches with heavy traffic loads, TST have good implementing advantage

* **More cost effective** than STS switching.

Blocking probability $B = \left\{ 1 - \left(1 - P_T/_L \right)^2 \right\}^L$

$L = 2T - 1$

$T \rightarrow$ no. of Timeslots of time switch

$L \rightarrow$ no. of space slot of space switch

HARDWARE CONFIGURATION:

The computer controlled switching is in general referred as electronic switching system (ESS). ESS offers the greatest potential for both voice and data communications. A computer based common control switching equipment implies two distinct type of units. They are

(i) control unit. (ii) Switching Network.

The common control receives, stores and interprets dial pulses and then selects an available path through the switching hardware to complete connection. The switching network can be used to connect many lines by one common group of control devices referred as control unit.

Thus the control unit is the brain of a switching system. A control unit completes its function in a small fraction of a second for a single call.

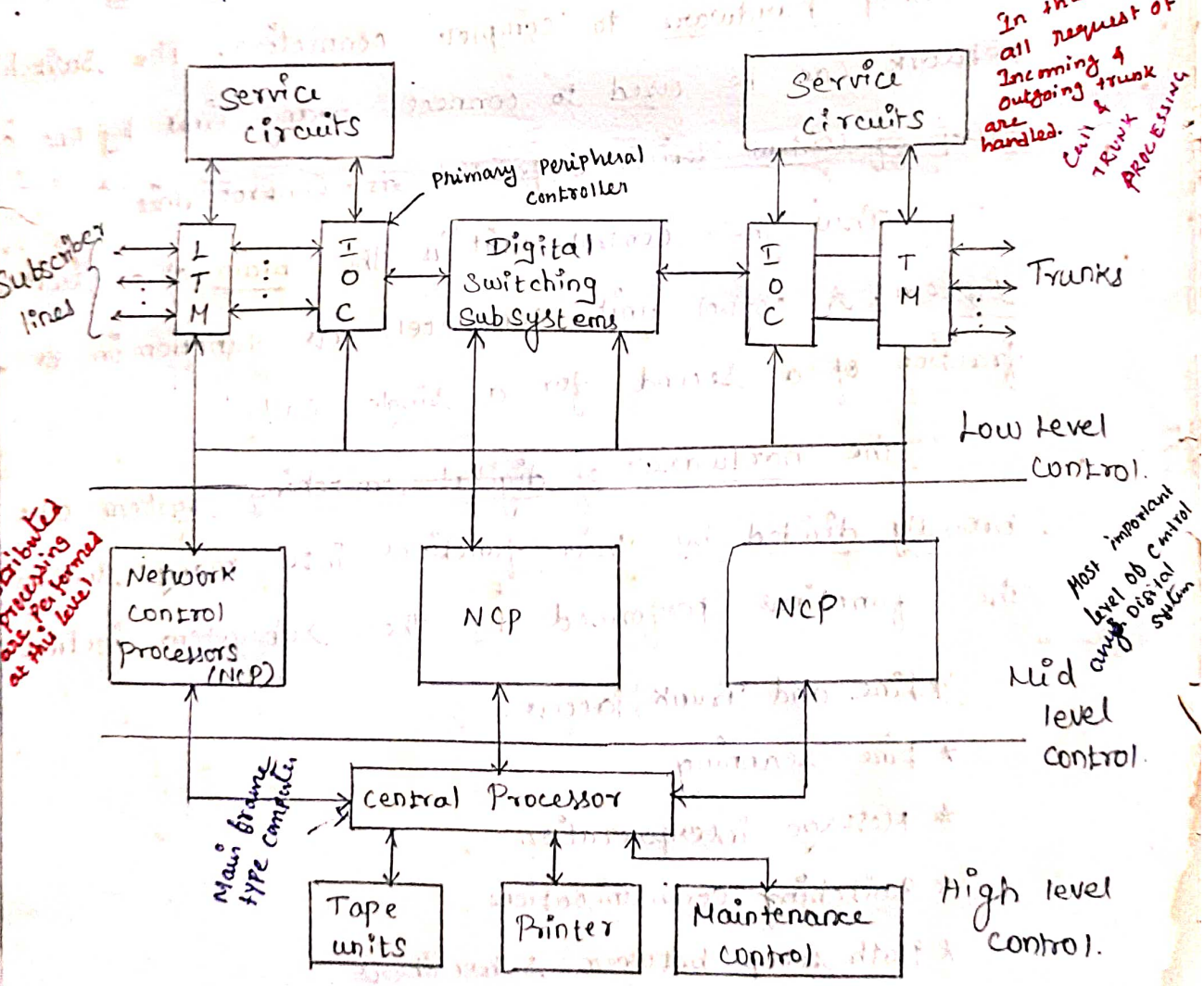
The hardware of digital switching system are broadly divided by their functions into many subsystems. The functions performed by the subsystem includes,

* Line and Trunk access.
* Line scanning
* Message interpretation.
* Switching communications.
* Path setup between subscribers.
* Line supervision
* Line Termination
* Billing
* System maintenance.

These subsystems are classified into various levels of control.

1. Low level control.
2. Mid level control
3. High level control.

However, various switching system may have different kind of arrangements of the subsystems. Most digital switching systems have a quasi-distributed hardware architecture, as the control of the switching functions are made through an intermediate processors.



LTM → Line Terminating modules.

TM → Trunk modules.

IOC → Input/output controller

NCP → Network control processors.

1. Low level control :-

This level associated with subscriber lines, trunks, selective circuits, Input/output controller & digital subsystems. The LTM & TM are microprocessor based and communicate with subsystems through the IOC.

The IOC interpret the incoming messages and takes necessary actions and communicate to NCP. All subscriber lines connected to digital switching system through the main distributing frame (MDF) are continuously scanned to detect the state of the subscriber.

When the customer lifts his handset, the line scanning program detects this state and reports to the IOC. The IOC is the primary peripheral controller and it controls all peripherals associated with call or trunk processing. At this level, all the requests of incoming & outgoing trunks are handled.

2. Mid level control :-

This level is associated with NCP. The IOC is controlled by the NCP. Many NCP's are used depends on the size of the digital switching system. A dedicated bus system is usually required for the processors to communicate with one another. Specific messaging protocols are used to communicate between processors. Thus this is the most important level of control any digital switching system. Distributed processing are performed at this level.

3. High Level control :-

This level associated with central processor which organizes the entire Network control subprocessors. It includes many subsystems like call accounting subsystems (CAS), Call processing subsystems (CPS), Digital Switching subsystems (DSS), Local administration (LA), Message Txn. subsystems (MTS) etc.

This central processor is normally a main frame type computers. Thus all basic ~~compo~~ controls of a digital switching system are incorporated at this level.

In real time operation, the processor determines the state of a call by reading data from memory. The store areas include,

Line Store :- In this memory, the status of the line is stored. The status may be busy, free or disconnected.

Call record :- All the call processing data's such as origin, Path, duration and clearing of a call are stored.

Translation tables :- Most switching system require a look-up table in order to decode ~~di~~ routing digits into suitable routings. Hundreds of translation tables are built for a switching system which stores data for equipment number (EN) to directory number (DN) and for DN-to-EN translation.

Map of the Switching Network :-

There are two techniques for selection junctors.

1. Map-in-Memory.
2. Map-in-network.

1. Map-in-Memory :-

In this, memory contain a bit for each link.
If it is set to 1, the link is free.
If it is set to 0, the line is busy.

2. Map-in-Network :-

In this, the junctor itself contains a one bit memory element, which is read by the path setup program to check whether it is free.

This consumes more time, but more advantages when several processors controlling the system.

SOFTWARE ORGANIZATION AND PROCESSING :-

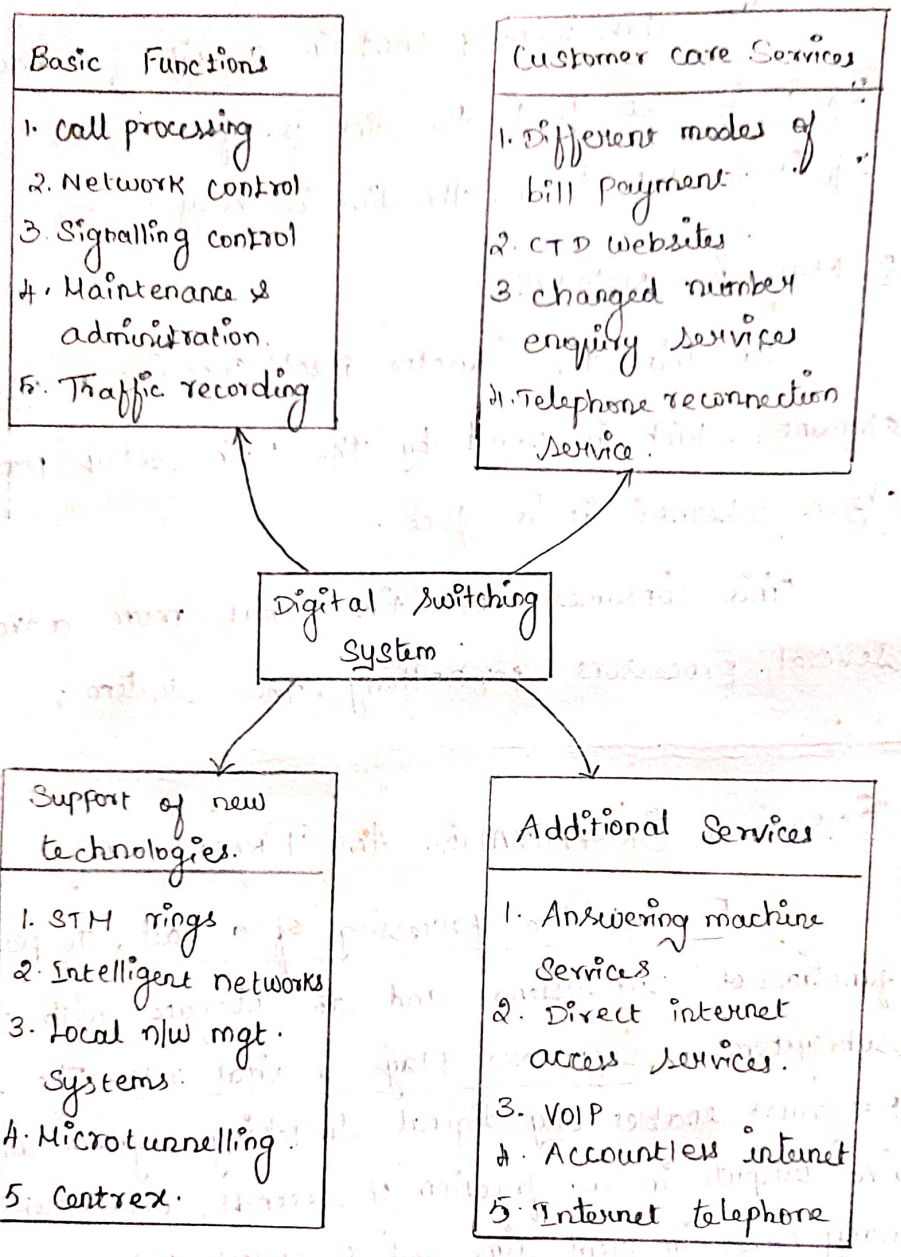
For effective processing of a call, to perform various functions of subsystems and to interface with the other subsystems, softwares plays a vital role. The software programs enables any digital switching system input data, to give outputs in a fraction of seconds, concurrent processing of many calls in real time and performs many features other than simple pathset between subscribers for conversation.

Need for Software :-

Other than call processing, any exchange is to serve the subscriber various facilities and many administrative tasks.

To carry

Figure shows various activities of a switching system.



To carry out these activities efficiently & effectively, the use of software is unavoidable.

To perform the above tasks, a large amount of software is required. However, the software for basic functions are must and remaining services are optional and requires software depends on the location of switching system.

App. 70% → Basic functions. Only 0.1% of the total processing time is used by 30% of remaining service oriented S/w packages.

Software Classification and Interfacing :-

Classification :-

At various levels of hardware architecture, the softwares are used. Thus, many of DSS employ some system level software. Basic software systems are classified as:

1. Maintenance Software.
2. Call Processing Software.
3. Database / Administration Software.
4. Feature Software.

Above software packages are divided into program modules. Each module dealing with specific task. Several modules are grouped together to form functional units. Various factors are associated with the development of software product. It includes the location of telephone exchanges, customer needs, internal requirements, parameterised design.

1. Maintenance Software :-

There are various activities and tests involved to maintain a switching system. Some of them are :

* Supervision of the proper functioning of the exchange equipment, trunks and subscriber lines.
* Monitoring the database of line and trunk assignments.
* Efforts for the system recovery in case of failure.
* Automatic line tests, which permits maintenance persons to attend several exchanges from one control location.

* Effective diagonestic programs and maintenance Strategies used to reduce the maintenance cost.

Preventive maintenance programs are activated during the normal traffic. If a fault occurs, the OS activates the maintenance program to recover the system.

Effective preventive & maintenance programs and strategies helps in proper maintenance of DSS with reduced maintenance cost.

2 Call Processing Software :-

The call processing functions are controlled by a central processor. Other functions carried out by the central processor are maintenance & administration, signalling, n/w control. Thus the call processing programs are usually responsible for call processing and to interface with the translation data, office data, automatic msg acounting and maintenance programs.

The translation data is generated by telephone compa related to subscriber.

The office data is related to a particular digital switch

The call processing programs can be derived from State-transition diagrams in Specification & description language (SDL).

The SDL description in text form, is machine rea and stored in memory in the form of data structures

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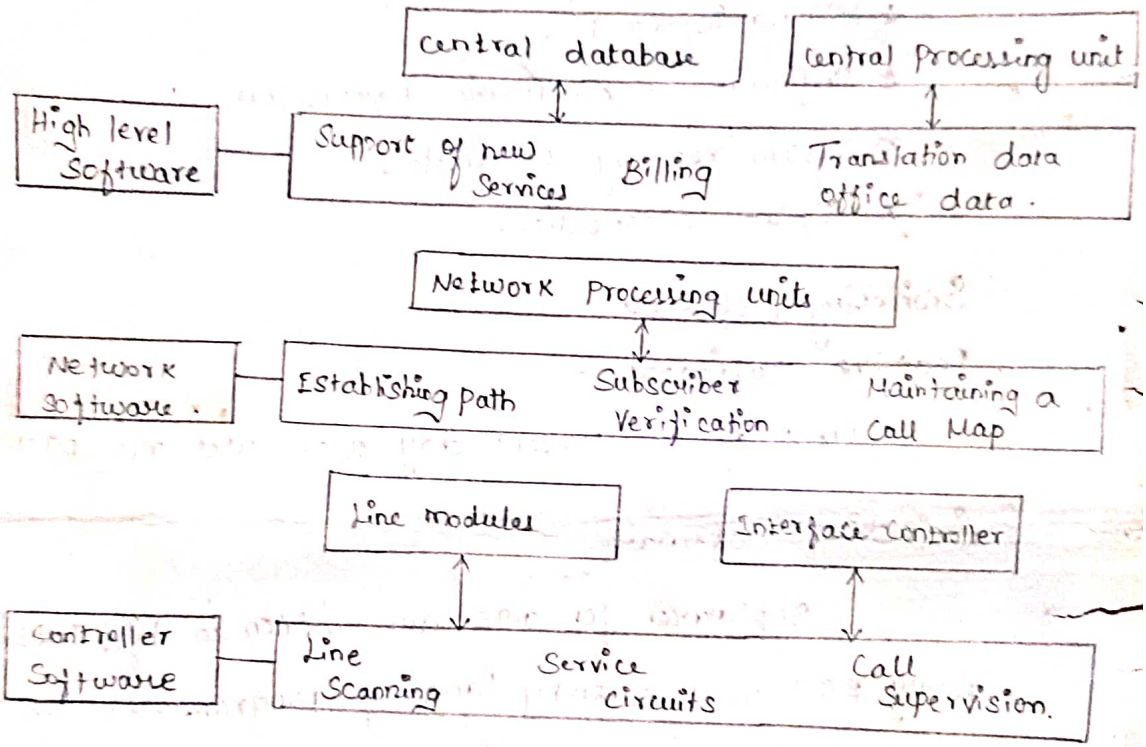
and linked list and translation tables.

An interpreter programs is written to access the lists and tables and to process the call by interpreting the data within them.



3. Database / Administration Software :-

For administration and data base management, large amount of software required. But these tasks are perform infrequently, it uses less than 5% of total processing time.

The administration tasks includes :

* Alarm processing.
* Traffic recording.
* change of numbers or area codes corresponding to the change in subscriber rate and govt. policy.
* changing routing & routing codes (Traffic intensity of a particular exchange).

* Generation of exchange management statistics.

Most digital switching system employ a data base system to :-

* Record office information.
* Billing information.
* Software & hardware parameters.
* System recovery parameters.
* System diagnostics.

~~Switching Software~~ :-

Feature software :-

Most of the present day DSS uses all packages.

Switching software :-

Softwares for DSS are written in high level languages. Early ESS used assembly language programmes. In 1980, CCITT approved the definition of high level language. This language is known as CCITT high level language (CHILL). It has 3 major features as data structure, program structure and action statements.

Software codes for DSS are also written in high level programming languages such as C, C++, PASCAL.

Interfacing :-

The line control programs scan the status of lines and reports the status to the network status program.

The network status programs works with network control programs.

To provide dial tone, ringing, message to caller for invalid number, status of the subscriber and to receive dialled digits and to clear signals from the subscriber, the line control programs interface with network control programs.

The call processing software which is responsible for call processing and in addition interfaces with accounting and maintenance programs for billing, recording and to identify the fault in lines. It also interfaces with feature programs to serve the customers need.

INTRODUCTION TO ISDN :-

The Integrated Services Digital Network (ISDN) is a set of digital transmission standards which are used for end-to-end digital connectivity.

"Integrated services" referring to its ability to sustain numerous applications.

"Digital Network" relating to its end-to-end digital connection.

In general, ISDN networks extend from the local telephone exchange to the remote user and include all the telecommunications and switching equipments in between. ISDN supports voice and data. ISDN integrates video, audio, voice and data services over the same network.

ISDN Services :-

ISDN services generally fall into three categories.

(i) Bearer Services :-

ISDN works on the principle of transport services known as bearer services. The bearer services offers the capability to transport digital voice or non voice services using this standard. The basic operation of the bearer service is the 64 Kbps channel capacity.

Bearer services provide the means to transfer information (voice, data & video) between users. The network does not need to process the information. Bearer service belongs to the first three layers of OSI model. These services can be provided with circuit switched, packet switched, frame switched or cell switched networks.

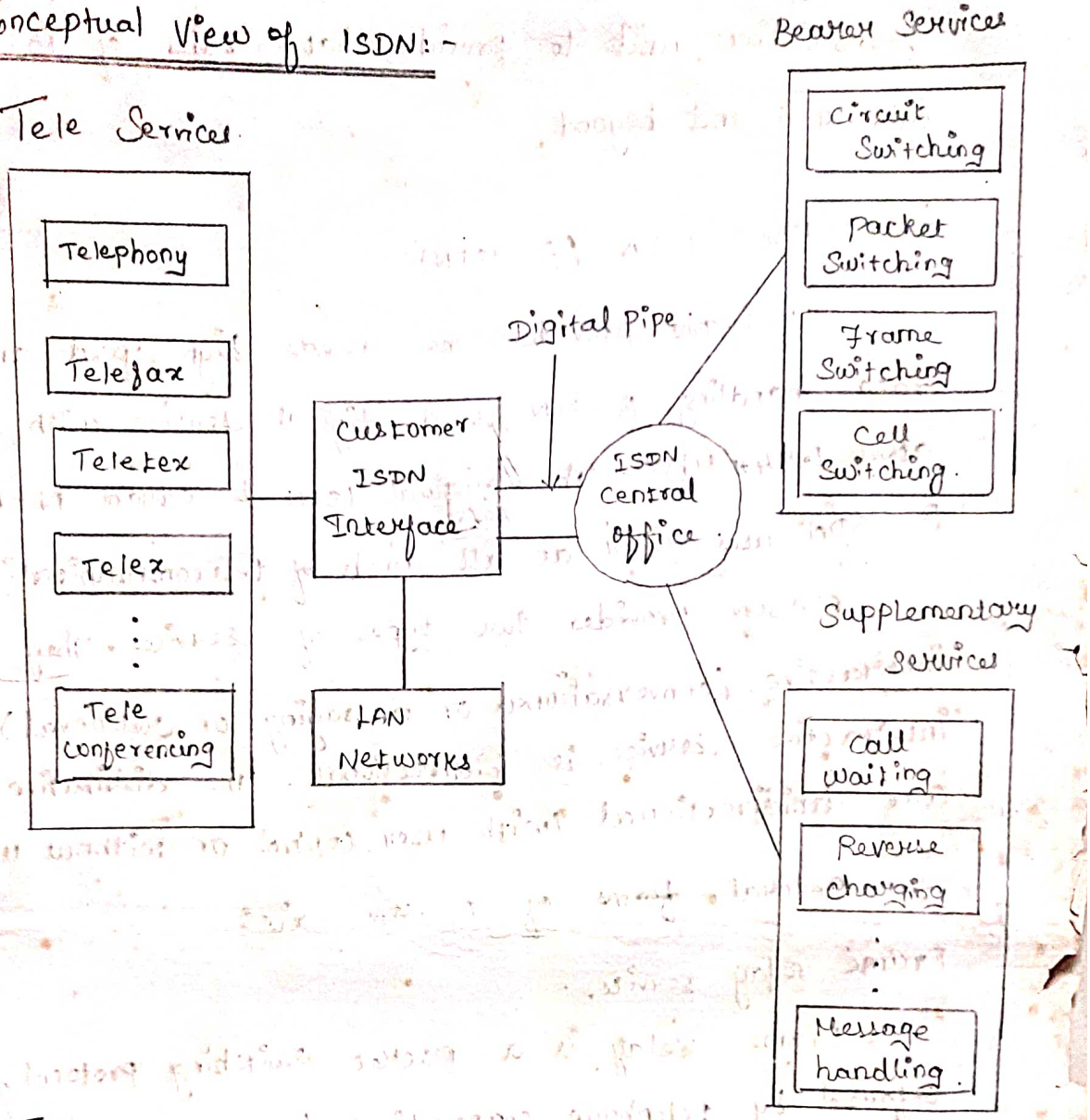
(ii) Tele Services :-

In this service, the network may change or process the contents. This service correspond to layers 4-7 of the OSI model. Tele services include telephony, telefax, videofax, telex and teleconferencing.

(iii) Supplementary Services :-

It provides additional functionality to the bearer service and teleservices. Supplementary services include call waiting, reverse charging, and message handling.

Conceptual View of ISDN:-



Types of ISDN:-

There are two types of ISDN:

(i) Narrow band ISDN (N-ISDN):-

Carry data rating upto 64 Kbps, ranging upto T1 rates. Sometimes used to refer to regular telephone and non video capable systems.

(ii) Broadband ISDN (B-ISDN):-

The communication standards being developed by the ITU to handle the high bandwidth applications such as video. B-ISDN will use ATM technology over SONET based

transmission units to provide data rates of 155 Mbps and 622 Mbps and beyond.

BROADBAND ISDN (B-ISDN):

B-ISDN provides the needs high speed and large data handling. B-ISDN is a digital service with speed above 1.544 Mbps. The original ISDN is called N-ISDN. B-ISDN uses fiber at all levels of telecommunications.

B-ISDN provides two types of services. They are interactive (conversational or messaging or retrieval). The interactive service is bidirectional. The distributive services are unidirectional (with user control or without user control)

Several forms of B-ISDN exists.

Frame relay service:-

Frame relay is a packet switching protocol service offered by telephone corporations to replace the X-25 protocol. It is a WAN network.

Switched Multimegabit Digital Service (SMDS):

SMDS is a digital service that provides a high speed digital path. The transport speed of SMDS is usually 155 Mbps.

ATM:- The transport speed of most ATM applications are 155 Mbps.

Advantages of ISDN:-

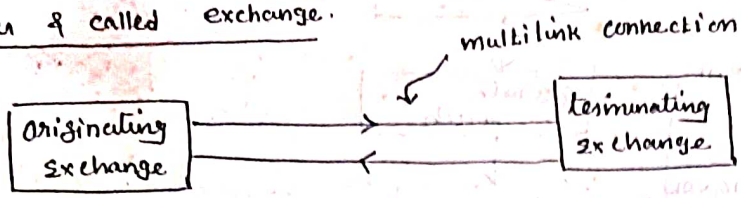
* High speed service.
* Cost advantage.
* High quality transmission
* Simultaneous transmission.
* Multiple device connection.
* Conferencing.
* call Management features.

UNIT-3 III-(1)

SIGNALS & TRAFFIC

Signalling Introduction:- (&) channel associated signaling:-

- In a telecommunications network, signalling systems are as essential as switching system & transmission system
- For a multilink connection, it is necessary to send signals in both direction b/w caller & called exchange.



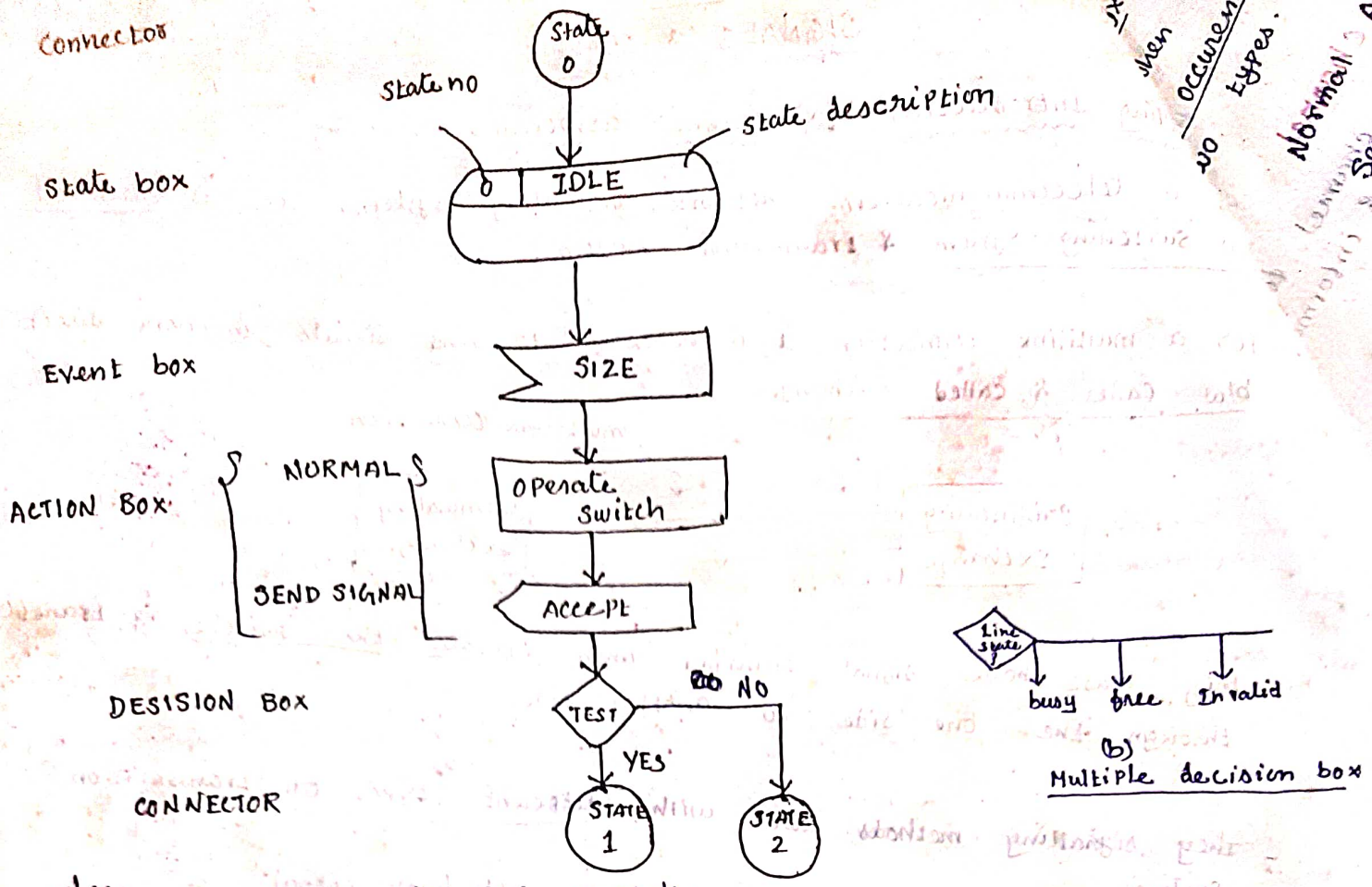
- They must have signal transfer with operate the switches & transfer through the one side to another side
- They signalling methods used with different types of transmission system
  - (i) continuous signals – (Ex) – DC off hook signal
  - (ii) Pulse signals – (Ex) – single pulse (or) coded group of pulses

Transmitted signals may be either unacknowledged signals (or) acknowledged signals

* Traditionally, exchanges have sent signals over the network as the connections this is known as channel-associated signalling
* For a simple telephone call only the following basic signals are required b/w exchange
  - call request (or) size (forward)
  - Address signal (forward)
  - Answer (backward)
  - Clear signals (forward and backward)

- Explain the signal exchange diagram from 1st unit Notes

- Signal State Transition Diagram:-
  - The state transition diagram provides the traditional flow charting feature, to represent sequential and condition computation
  - The state transition diagram has the following boxes
    - (i) state box
    - (ii) event box
    - (iii) action box
    - (iv) decision box



where

→ events from the calling terminal

→ signals to the calling terminal

→ events from the called terminal

→ signals to the called terminal

(1) STATE box :- (lable, title, additional information may also be included).

The state box indicates the state in which the control unit is present, like that of idle state waiting for routing, waiting for answer. These are eabled with the no/. descriptive title.

(2) Event box :- (arrow, indicating whether the event corresponds to the receipt of a forward (or) backward signal)

The control unit moves from one state to the other due to the arrival of a signal from a terminal or another control unit. They are given in the box

the control unit moves from one state to another due to occurence of the event it performs some action. They are of two types.

Normal Action:- noted by rectangular Box - Operating switch

Send signal : note by arrowed box - Size, accept

This action performed between one stable state to the another is termed as "task"

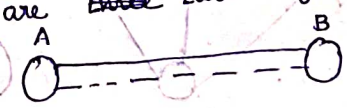
4) Decision box:-

The decision box is used to check while taking a decision. It is usually denoted by a diamond shaped box. It can be a binary decision or multiple decision.

COMMON CHANNEL SIGNALING:-

Signalling involves sending the analog signal from one end and decoding it at the other end. since the control of switching is distributed over many subsystem, the cost involved is more. But "using the computer control involves the direct transmission of the control information from one computer to the other via a data link" & this is termed as the "common channel signalling" & is more economic.

Depending upon the route followed for sending the signalling & speech information there are two types.



____ speech
---- signalling

1) associated mode
2) NON-associated mode → uses one (or) more signal transfer points.

IN CHANNEL
(signals & message in same channel)

① Trunks are held up during signalling
~~signal~~ ~~seperate~~ is ~~Routed~~

② Interference b/w voice & control signals may occure

③ Each trunk group needs signalling equipment. Hence expensive

④ signalling is ∧ slow relatively

⑤ changing (or) adding signal is difficult

⑥ Error rate common channel signalling must be very high.

COMMON CHANNEL SIGNALLING
(seperate channels for signalling & message)

① Trunks are not req for signa-lling more.

② No interference as two channels are physically seperate

③ only one set of signalling equipment is req/. for entire trunk group. Hence less economic significantly

④ Signalling is ∧ fast

⑤ Flexibility to change (or) adding signal is more.

⑥ Error rate common channel signalling must be very low

Signalling

Inchannel

(same channel which carries voice & control signal)

- DC
- Low frequency
- Voice frequency
- PCM

Voice frequency →
- INband (same frequency band as the voice (ie) 300–3400 Hz)
- Outband (The nominal voice channel spacing below the upper limit 4000Hz)

Common channel

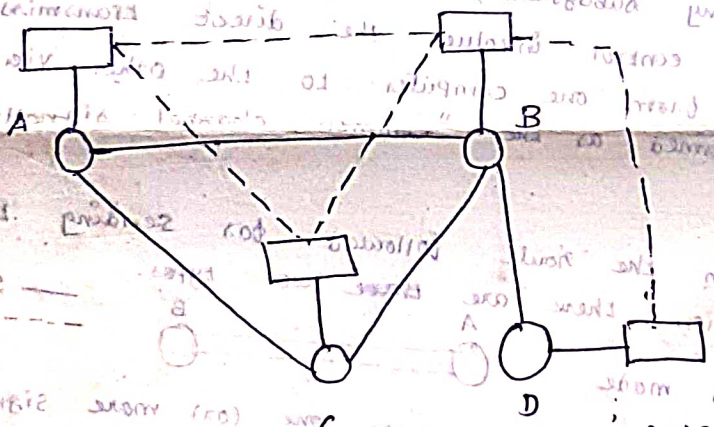
(separate common channel for passing control signal & information signal)

- Associated (signalling path passes through the same set of switch)
- Nonassociated (signalling information may follow a route that different from speech & control signal)

SIGNALLING NETWORK:-

Example

(1)



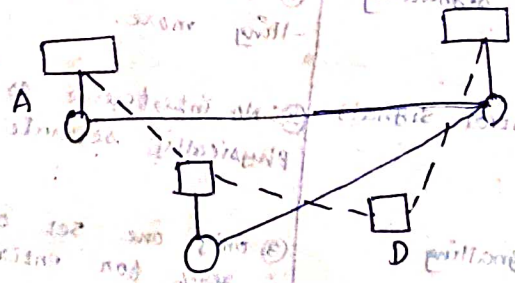
where
- speech signal path
- signalling path
- switching system
- signalling transfer point

(a) channel associated signalling (or) quasi-associated signalling

Signalling path :- AB, ACB, BD

(speech) " (signalling) :- AB, ACB, BD

(2)



where
- speech signal path
- signalling path
- switching system
- signalling transfer point.

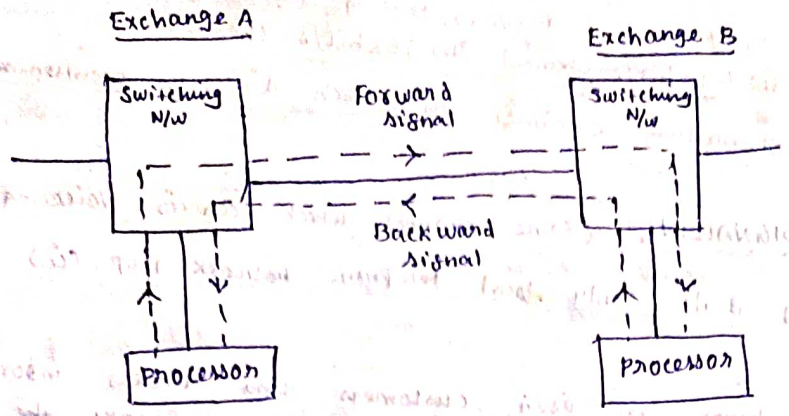
(b) Non channel associated signalling

where
Signalling path :- AC, CD, DB
Speech path :- AB, BC,

Note
- The transmission bearers used for a CCS N/W
- In first generation of CCS system (CCITT 6) used modems to transmit at 2.4 kbit/s / 4.8 kbit/s over analog telephone system
- A 4kbit/s channel could also be provided over a 1.5 mbits in PCM system (CCITT 7)

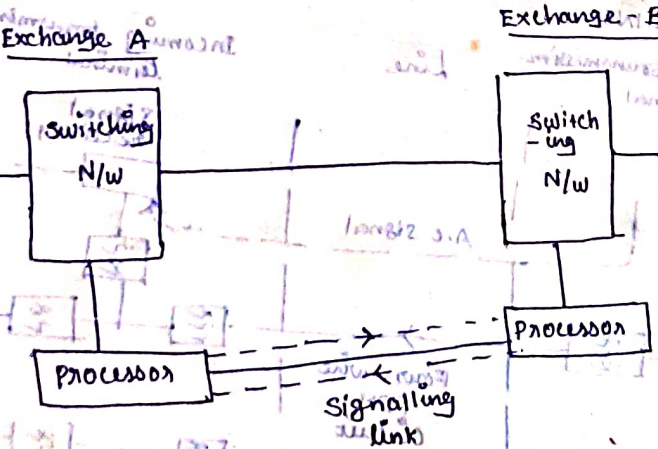
COMMON - CHANNEL SIGNALLING:- III-(3)

A network of SPC exchanges a connection that is made through two exchanges requires call processing by the central processor in each exchange.



(A) channel associated signalling b/w central processor

- If channel associated signalling is used for call from exchange 'A' to exchange 'B' as shown in figure.
- In this case the speech signal (Exchange A) to send its outgoing forward signal transmission to exchange 'B'.
- And then exchange 'B' to detected speech signal and passing through the Back ward signal.
- This is an inefficient arrangement for signalling b/w the two processors.
- But high speed data link it can provide a channel for all signals b/w exchange 'A' & 'B'. This is known as common channel signalling



(b) Common channel signalling b/w central processor.

- channel associated signalling is used, the successful exchange of signals over a circuit proves that the circuit is working
- CCS does not inherently provide this checking facility. (ie) automatic routine testing its can be provides speech circuits.

* A signalling link operating at 64 Kbit/s normally provides signalling for 1000 or 1500 speech circuit

* The use of CCS for inter-exchange signalling has been followed by application to customer's lines in integrated-services digital N/W (ISDN)

- In basic rate ISDN access provides that is signalling link operating at two methode (i) 64 Kbit/s channel (ii) 16 Kbit/s channel
- But common signalling channel in each direction transmission.

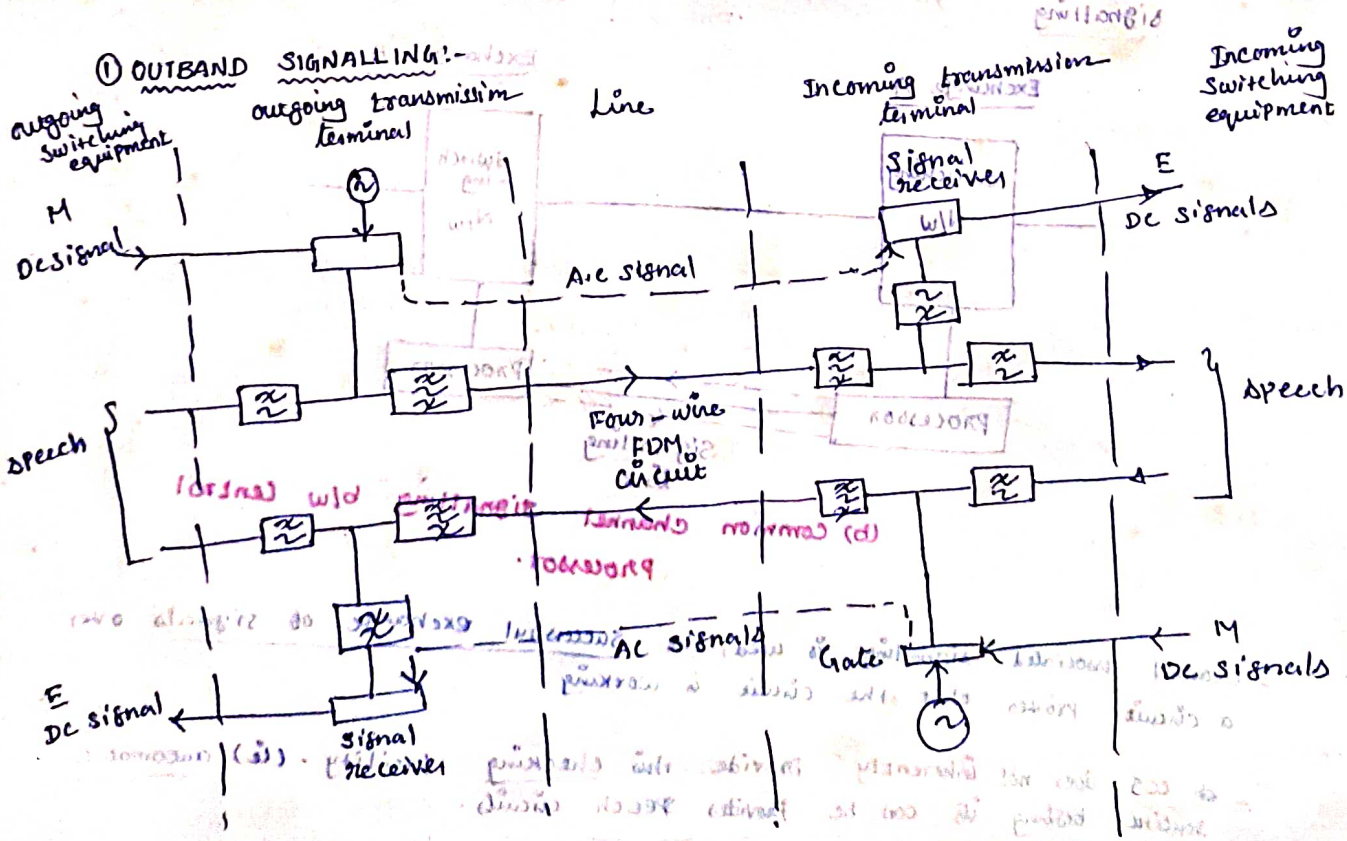
IN CHANNEL SIGNALLING:- (same channel which carries voice & control signal)

- In this channel deals only local telephone network loop. (ie) calling signal, called signal.
- when dial telephones are used, customers send address information by decadic pulsing. For each digit to makes and breaks the circuit.
- In telephone sets frequency coding used by push button

Hz / Hz	1209	1336	1477	1633
697	1	2	3	Spare
770	4	5	6	Spare
852	7	8	9	Spare
941	*	0	#	Spare

- A push button telephone uses dual tone multifrequency signalling (DTMF) so it can access very soon (ie) to make a connection & breaks a connection

① OUTBAND SIGNALLING:-



OUTBAND SIGNALLING SYSTEM

and signal takes place the Frequency-division multiplex (FDM) signal frequency 3.7KHz & 3.85KHz have been used.

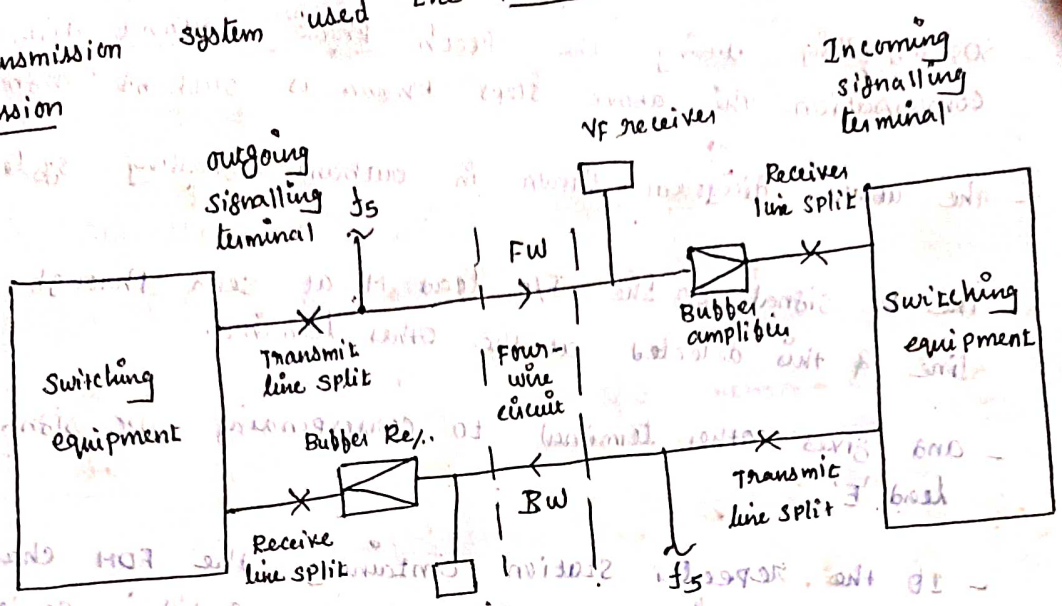
- This is below the voice frequency of 300–3400Hz
- The carriers are spaced at intervals of 4KHz.
- So, signalling during the speech phase without disturbing the conversation. This above steps known as outband signalling.
- The above diagram shwn in outband signalling system.
- The DC signal on the I/P lead M at send through the transmission line & this detected at the other terminal.
- and gives other terminal to corresponding DC signal generates lead 'E'.
- If the repeater station containing the FDM channelling equipment is adjacement to the switching equipment.
- Send & receive the signal separate E & M wires
- The 'E' leads always carries signal frm the signalling apparatus to the switching equipment.
- The 'M' Leads always carries signal frm the switching equipment to signalling apparatus.
- To use outband signalling successfully in a N/w, all routes must use FDM system with built in outband signalling.

BLOCK DIAGRAM FOR VOICE-FREQUENCY SIGNALLING SYSTEM

② INBAND (VF) SIGNALLING:-

- system that transmit signals within the baseband of FDM are known as inband signalling system or voice-frequency (VF) signalling system

- The transmission system used the provides satisfactory speech transmission



BLOCK DIAGRAM IN VOICE-FREQUENCY (VF) SIGNALLING SYSTEM

- The above diagram shown in the VF signalling system. It can be ~~axis~~ speech signal on both direction

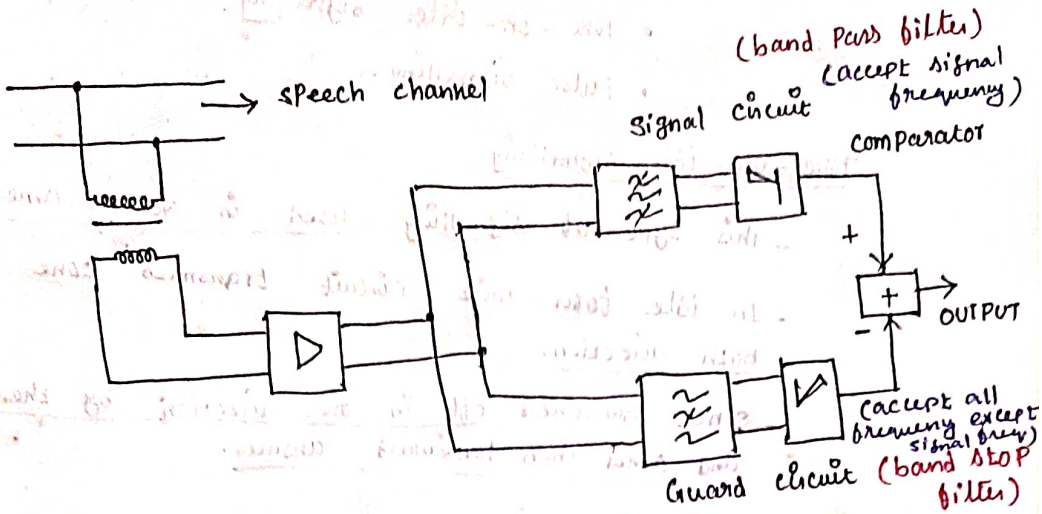
- the line is split when the signal tone is transmitted in order to confine it to the link concerned.

- The unity-gain buffer amplifier at the receiving end (where the signal level may be low) prevents transients produced by electromechanical switching equipment from reaching the VF receiver.

- This takes up a frequency range (speech signal frequency Low) of 500 to 3400Hz
  - * For example 2280Hz is used in the UK (1)
  - * " " 2600Hz in North america (5)

- The duration of signals are made longer than period for which the speech frequency. (control signal)

diagram of voice - frequency receiver:-



- The block diagram of a VF receiver is shown in figure.
- The receiver contains a signal circuit with a band pass filter to accept the signal frequency, & a guard circuit with a band ~~pass~~ STOP filter to accept all other frequency and reject the signal frequency

- The o/p of both circuits are rectified and compared.

condition:-

Step:-1

Signal circuit frequency >> To generate the guard circuit o/p ⇒ The receiver gives o/p signal

↑ this also present in normal signal frequency range.

Step:-2.

guard circuit frequency >> signal frequency ⇒ The receiver gives no o/p signal

↑ this also present in upnormal guard circuit frequency.

11b - (i) (1)

...trol Signaling funt:

- Audible comm/. with subscriber.
- Transmissim of dialed number:
- call can not be completed indication
- Call ended indication
- Signal to ring phone.
- Billing into
- Equipment and trunk status into
- Diagnostic into
- control of specialist equipment.

Control Signal sequence:-

- Both phones on hook
- Subscriber lifts receiver (off hook)
- End Office switch signaled
- Switch responds with dial tone.
- Caller dials number.
- If target not busy, send ringer signal to target subscriber.
- Feedback to caller
  - Ringing tone, engaged tone, unobtainable,
- Target accepts call by lifting receiver.
- switch terminates ringing signal and ringing tone
- switch establishes cnnectim,
- cnnectim release when soure subscriber hangs up

Switch to switch signalling

- Subscribers cnnected to different switches,
- originating switch sizes interswitch trunk
- send off hook signal on trunk
- Terminating switch sends off hook followed by on hook.
- Originating switch sends address,

Location of signaling

- Subscriber to N/w
  - Depends on subscriber device and switch
- Within N/w
  - Management of sub/. calls and N/w
  - Are complex

In channel signaling

- use same channel for signaling and call
  - Requires no additional transmission facilities
- Inband
  - uses same freq as voice signal
- Out of band
  - voice signal do not use full 4KHz B.W

K. Dwarakanath

GRADE OF SERVICE (GOS)

The traffic carried by a network is generally lower than the actual traffic offered to the network by the subscribes The overload traffic is rejected. which indicates the quality of the service offered.

The GOS is defind as the ratio of the traffic lost to that of the traffic offered.

$$GOS = \frac{A - A_0}{A}$$

where

A → traffic offered

A_0 → traffic carried

$A - A_0$ → lost traffic

① Actual traffic < Traffic carried by N/w

⇓

To improved the quality of service ⇐ To offered to the N/w

② Actual traffic > overload traffic carried by N/w

⇓

To rejected

⇓

to improved the quality of service

Subscriber view point:-

GOS = call congestion = loss probability

Network view point:-

Blocking probability = time congection

PROBABILITY OF BLOCKING :-

The probability of blocking is the probability that all services are busy. If the services are busy, no further traffic can be carried by the system and the arriving subscriber traffic is blocked.

The fundamental difference b/w the GOS & P_B is that the grade of service is from the subscriber point of view of the P_B is from the N/w (or) switching system point of view.

probability of number of termination = $(1-\lambda)\,\Delta t$

= $(1-\mu)\,\Delta t$

ERLANG - B FORMULA FOR BLOCKING MODELS :-
(OR)
BLOCKING MODELS AND LOSS ESTIMATES :-

- Telecommunication system may be classied as loss system or delay system
- The behaviour of loss system is studied by using blocking models and that of the delay system by using queuing models
- But we analyse loss system that is blocking models.
- There are three ways in which overblow trabbic may be handled.
  1. The trabbic rejected by one set of resources may be cleared by another set of resources in the N/w (LCC)
  2. The trabbic may return to the same resource after sometime (LCR)
  3. The trabbic may be held by the resource as it being serviced but actually serviced only after the resources become available. (LCH)

The aspect will be explained in more detail later corresponding to the above three types.

1. Lost calls cleared (LCC)
2. Lost calls returned (LCR)
3. Lost calls held (LCH)

} the three models loss systems.

1. LOST CALLS CLEARED (LCC) (Inbinite sources)

whenever the direct trunk route b/w two centre is busy it is possible to divert the trabbic via other switching office using different trunk group. This is termed as clearing a call

The trabbic intensity 'A' is the call, time Procedure

$$A = C \cdot t_h$$

where

A — trabbic intensity

t_h - Holding time of one call

C → No. of calls per min..

and also write $\Rightarrow$ $A = \lambda \cdot t_h$

λ → Poisson arrival rate.

As long as the servers are free, there is no congestion

* let

$C_0 \rightarrow$ The mean of arrival rate

$C_i \rightarrow$ effective arrival rate in state "i"

→ when all the servers are busy no more 'incoming' traffic are accepted this is called as "Erlang (or) pure chance traffic of type 1"

$$C_i = \lambda \quad \text{for } 0 \le i < R, \quad C_R = 0$$

where

R → no/. of servers

→ the mean effective traffic rate C_0 is calculated as

$$C_0 = \sum_{i=0}^{R-1} \lambda P_i \rightarrow (1) \quad \because \begin{cases} \lambda - \text{poission arrival rate} \\ P_i - \text{Probability of system in state } (i) \end{cases}$$

Since the system can be at any one of the state 0, 1 ..... R we have

$$P_0 + P_1 + \ldots\ldots\ldots\ldots + P_R = 1 \rightarrow (2)$$

$$\therefore C_0 = \lambda \sum_{i=0}^{R-1} P_i \quad \text{substituting (2) eqv in (1) eqv}$$

$$C_0 = \lambda (P_0 + P_1 + \ldots\ldots + P_{R-1})$$

This can be written as

$$C_0 = \lambda [1 - P_R]$$

Since $A = C \cdot t_h$ the mean traffic is given by

$$A_0 = C_0 t_h$$

$$A_0 = \lambda (1 - P_R) t_h$$

$$= \lambda t_h - \lambda P_R t_h \quad \text{(sub the value)}$$

$$\therefore \lambda P_R t_h = \lambda \cdot t_h - A_0$$

$$\lambda \cdot P_R t_h = A - A_0 \quad \because \boxed{\lambda \cdot t_h = A}$$

$$P_R = \frac{A - A_0}{\lambda \cdot t_h}$$

$$P_R = \frac{A - A_0}{A}$$

$$\boxed{P_R = \frac{A - A_0}{A}}$$

where

$P_R \rightarrow$ Prob/. that all 'R' servers are busy.

$\therefore$ $\boxed{GOS = P_B}$ for the Lcc model, where the traffic arrival is poission in nature

Now to calculate this value of P_B (or GOS) we perform the steady state analysis of B D process Lcc model. Dealing with the call termination process, if the large no. of servers are busy, there a possibility of termination.

$\therefore$ The termination rate $\propto$ the no. of busy servers

$$\boxed{\mu_K = K \cdot \mu \quad \text{for} \quad 0 \leq K < R} \rightarrow (3)$$

BD → Birth - death Process

where

$\mu \rightarrow$ mean call termination rate $= 1/Th$

$\mu_K \rightarrow$ call termination rate in state 'K'

using the basic eq of B.D Process from the eq

B.D process equation ⇒

$$\boxed{P_{K-1}\,\lambda + P_{K+1}\,\mu(K+1) - (\lambda + K\mu)\,P_K = 0} \rightarrow (4)$$

$$P_{K+1}\,\mu(K+1) = (\lambda + K\mu)P_K - P_{K-1}\cdot\lambda$$

$$P_{K+1} = \frac{(\lambda + K\mu)P_K - P_{(K-1)}\cdot\lambda}{\mu(K+1)}$$

$$= \frac{\lambda P_K + K\cdot\mu\cdot P_K - P_{K-1}\cdot\lambda}{\mu(K+1)}$$

Sub $\therefore$ $\mu = \frac{1}{Th}$ & $\lambda = \frac{A}{Th}$ we have the following Result

$$P_{K+1} = \frac{\left(\frac{A}{Th}\right)P_K + \left(\frac{K}{Th}\right)P_K - P_{K-1}\left(\frac{A}{Th}\right)}{\left(\frac{1}{Th}\right)(K+1)}$$

$$P_{K+1} = \frac{\left(P_K\cdot A + P_K\cdot K - A\cdot P_{K-1}\right)\frac{1}{Th}}{\left(\frac{1}{Th}\right)(K+1)}$$

$$\boxed{P_{K+1} = \frac{P_K\cdot A + P_K\cdot K - A\cdot P_{K-1}}{(K+1)} \quad \text{for } K > 0} \rightarrow (5)$$

sub $k = 0, 1, 2, \ldots$ in (5) eq (6)

$$\boxed{P_1 = \frac{A \cdot P_0}{1}} \quad \text{for } k = 0$$

$$P_2 = \frac{P_1 A + P_1 - A P_0}{2} \quad \text{for } k = 1$$

sub P_1 value in P_2 eq

$$P_2 = \frac{A^2 \cdot P_0 + A P_0 - A P_0}{2}$$

$$\boxed{P_2 = \frac{A^2 P_0}{2}}$$

$$P_3 = \frac{P_2 A + 2P_2 - A P_1}{3}$$

sub P_1 value & P_2 value

$$P_3 = \frac{\frac{A^2 P_0}{2} \cdot A + 2 \cdot \frac{A^2 P_0}{2} - A \cdot \frac{A \cdot P_0}{1}}{3}$$

$$P_3 = \frac{A^3 P_0 - A^2 P_0 + A^2 P_0}{2 \times 3}$$

$$\boxed{P_3 = \frac{A^3 P_0}{6} = \frac{A^3 P_0}{3!}}$$

Hence in general

$$\boxed{P_R = \frac{A^R P_0}{R!}} \rightarrow (6)$$

P_1 & P_2 & P_3 & P_R value sub in (2) eq

$$\Rightarrow P_0 + P_1 + \ldots\ldots + P_R = 1 \rightarrow (2)$$

$$P_0 + A P_0 + \frac{A^2 P_0}{2} + \ldots\ldots + \frac{A^R P_0}{R!} = 1$$

$$P_0 \left(1 + A + \frac{A^2}{2} + \ldots\ldots \frac{A^R}{R!}\right) = 1$$

$$P_0 = \frac{1}{1 + A + \frac{A^2}{2} + \ldots\ldots + \frac{A^R}{R!}} \rightarrow (7)$$

(7) eq sub in (6) eq

$$\boxed{P_R = \frac{A^R / R!}{1 + A + \frac{A^2}{2} + \ldots\ldots + \frac{A^R}{R!}}} \rightarrow (8)$$

This is the famous Erlang 'B' formula or loss formula Prob/. that all the servers are busy in a system or is denoted as blocking Probability "or otherwise the infinite congestion".

II - Lost calls cleared system with finite subscribers :-

Erlang - B applies only if no/. of source > no/. of server. when ever the no of source is comparable to that of the no/. of server the traffic is "Engsets traffic or pure chance traffic of type 2" Here P_B is always less than the infinite source system

Case 1 :-

Let as consider the following parameters

λ_s - arrival rate / subscriber

K - No/. of busy subscriber

N - Total no/. of subscribers

R - No/. of servers.

The offered traffic or the arrival rate when the system is in state 'k' is given as

$$C_K = (N-K) \cdot \lambda_s \quad \text{for } 0 \le K \le R \rightarrow (1)$$

where

(N-K) → The no/. of subscribers who are not busy & those who will have a chance to generate new calls.

λ_s → Arrival Rate / Subscriber

The mean offered traffic rate is given by

$$C = \sum_{k=0}^{R} (N-k)\, \lambda_s \cdot P_K$$

$$= N \cdot \lambda_s \sum_{k=0}^{R} P_K - \lambda_s \sum_{k=0}^{R} k \cdot P_K$$

$$= N \cdot \lambda_s (1) - \lambda_s \sum_{k=0}^{R} k \cdot P_K$$

$$C = \lambda_s \left[N - \sum_{k=0}^{R} k \cdot P_K \right] \rightarrow (I)$$

Here $\sum_{k=0}^{R} k \cdot P_K \Rightarrow$ the average no/. of busy servers. and the average traffic carried through the N/W is the no/. of calls accepted during the mean service time period

Sub the value in (I) eqn. $\sum_{k=0}^{R} k \cdot P_K = A_0$ (carried traffic)

$$C = \lambda_s [N - A_0] \rightarrow (2)$$

The offered traffic is given by $\boxed{A = C \cdot Th} \rightarrow (3)$

$$A = \lambda_s [N - A_0] \, th \rightarrow (4)$$

we know that "R" is the total no/. of servers. If the system is in state "R" (ie) all servers are busy therefore no traffic is accepted & hence rejected (N-R) subscribers do not find the servers Hence the offered traffic rate is $(N-R)\lambda_s$. The lost traffic

$$A - A_0 = (N-R)\lambda_s \cdot P_R \, th \rightarrow (5)$$

where

$(N-R) \rightarrow$ Rejected no/. of subscribers

$\lambda_s \rightarrow$ arrival rate of each subscribers

$P_R \rightarrow$ Blocking prob/.

$th \rightarrow$ Holding time of each call

using (4) & (5) the GOS can be found out as

$$GOS = \frac{A - A_0}{A}$$

$$= \frac{(N-R)\,\lambda_s \cdot P_R \cdot th}{\lambda_s (N - A_0)\, th}$$

$$\boxed{GOS = \frac{(N-R)}{(N-A_0)} \cdot P_R}$$

Note

For engsets traffic the GOS and the P_B are not eq/.

for calculating the value of P_B we have

$$P_{K-1}\,\lambda_s (N-K+1) + P_{K+1}\,\mu(K+1) - (\lambda_s (N-K) + K\mu) P_K = 0 \rightarrow (6)$$

(∵ Birth-death processes eq/.)

$$P_{K+1} = \frac{(N-K)\lambda_s \cdot P_K + K\mu P_K - P_{K-1}\lambda_s (N-K+1)}{\mu(K+1)}$$

$$P_{K+1} = \frac{\left(\frac{\lambda_s}{\mu}\right)(N-K) P_K + P_K \cdot K \left(\frac{\mu}{\mu}\right) - P_{K-1}\left(\frac{\lambda_s}{\mu}\right)(N-K+1)}{(K+1)}$$

$$\boxed{P_{K+1} = \frac{\rho(N-K) P_K + K P_K - P_{K-1}\rho(N-K+1)}{(K+1)}} \rightarrow (7)$$

where

$$\rho = \left(\frac{\lambda_s}{\mu}\right)$$

$P_1 = \rho N P_0$ [If K=0]

$P_2 = \dfrac{[(\rho(N-1)+1)]P_1 - \rho(N-1)P_0}{2}$ [for K=1]

$P_2 = \dfrac{[(\rho(N-1)+1)]P_1 - \rho(N)P_0}{2}$

$P_2 = \dfrac{[\rho(N-1)+1]\rho N P_0 - P_0 \rho N}{2}$ $(\because P_1 = \rho N P_0)$

$P_2 = \dfrac{\rho N P_0 [\rho(N-1)+1-1]}{2}$

$$\boxed{P_2 = \frac{\rho^2 N P_0 (N-1)}{2}}$$

we have

$P_3 = \dfrac{\rho^3 N(N-1)(N-2) P_0}{3 \times 2}$ [for K=2]

In generally we get

$$\boxed{P_j = \rho^j \binom{N}{j} P_0} \longrightarrow (8)$$

where

$\binom{N}{j}$ is the binomial co-efficient

$$\binom{N}{j} = \frac{N!}{j!(N-j)!}$$

From equation (8) and the concept

$P_0 + P_1 + \ldots\ldots + P_R = 1$

we have

$$P_0 + \rho\binom{N}{1}P_0 + \rho^2\binom{N}{2}P_0 + \ldots\ldots + \rho^R\binom{N}{R}P_0 = 1$$

finding P_0 from the above eq we get

$$P_0 = \frac{1}{1 + \rho\binom{N}{1} + \rho^2\binom{N}{2} + \ldots\ldots + \rho^K\binom{N}{R}}$$

(or)

$$P_B = \frac{1}{\sum_{K=0}^{R} e^K \binom{N}{K}} \rightarrow (9)$$

Sub/. (9) in (8) eq. Hence the blocking prob/. is given as

$$P_R = P_B = \frac{e^R \binom{N}{K}}{\sum_{K=0}^{R} e^K \binom{N}{K}} \rightarrow (10)$$

Case 2 :-

when the no/. of servers are greater than that of the no/. of sources there is no/. blocking there the probability is given as

$$P_j = \binom{N}{j} \frac{e^j}{\sum_{K=0}^{N} e^K \binom{N}{K}} = \binom{N}{j} \frac{e^j}{(1+e)^N}$$

This is called as bernoulli traffic

If $a = \frac{e}{(1+e)} \Rightarrow e = a(1+e) \Rightarrow 1-a = \frac{1}{(1+e)}$

Rough work

$e = a + ae$

$a = e - ae$

$a = e(1-a)$

$\frac{a}{e} = (1-a)$

Sub/. e value

$\frac{a}{a(1+e)} = (1-a)$

$\frac{1}{(1+e)} = (1-a)$

$$P_j = \binom{N}{j} \frac{a^j (1+e)^j}{(1+e)^N}$$

$$P_j = \binom{N}{j} a^j \frac{1}{(1+e)^{N-j}}$$

$$\boxed{P_j = \binom{N}{j} a^j (1-a)^{N-j}}$$

This is called as binomial formula & it implies that the servers are independent of one another.

(2) LOST CALLS RETURNED SYSTEM :-

- The arrival rate into system is in no way affected by the calls that are rejected. In this technically not used in this case. Particularly subscriber call to busy lines only.

- The rejected calls in such cases do return to the system in the form of retries with the result

offered traffic = new traffic + retry traffic

- we derive the blocking probability relationships taking into account the returning calls. this known as lost calls returned model (LCR)

- The below steps followed with regard to the nature of the returning calls:

① No new call is generated when a blocking call is being retried.

② A number of retry attempts may be involved before a call eventually gets serviced

③ Retries are attempted after a random time and each retry time is statistically independent of the others.

④ Typical waiting time before a retry is longer than the average holding time

- Step ③ retries are not correlated → Because traffic peaks at some intervals → In this method very complicated

- step ④ to maintain its statistical equilibrium even in the presence of retry.

- The effective arrival rate can be expressed as

$$\lambda' = \lambda + P_c\lambda + P_c^2\lambda + P_c^3\lambda + \cdots = \frac{\lambda}{1-P_c} = \frac{\lambda}{1-GOS}$$

where

λ → arrivals rate for new calls

P_c → call congestion.

④ LOST CALLS HELD SYSTEM:-

- In the LCH model, the total time spent in the system is independent of the waiting time and is only determined by the average service time required.

Example :- (TASI) → Time assigned speech interpolation

(ie) [The number of conversations supported is larger than the number of transmission channels or servers in the system]

UNIT - IV

Telephone Networks

communication network in existence today

They are 400 million telephone connections and over 60,000 telephone exchange the worldover.

The length of telephone wire-pairs buried underground exceeds a billion Kilometer

So It's very complexity of the telephone network is managed by using a hierarchical structure, world wide standardisation, and decentralisation of administration, operation and maintenance. but only

Telecommunication N/w may be viewed

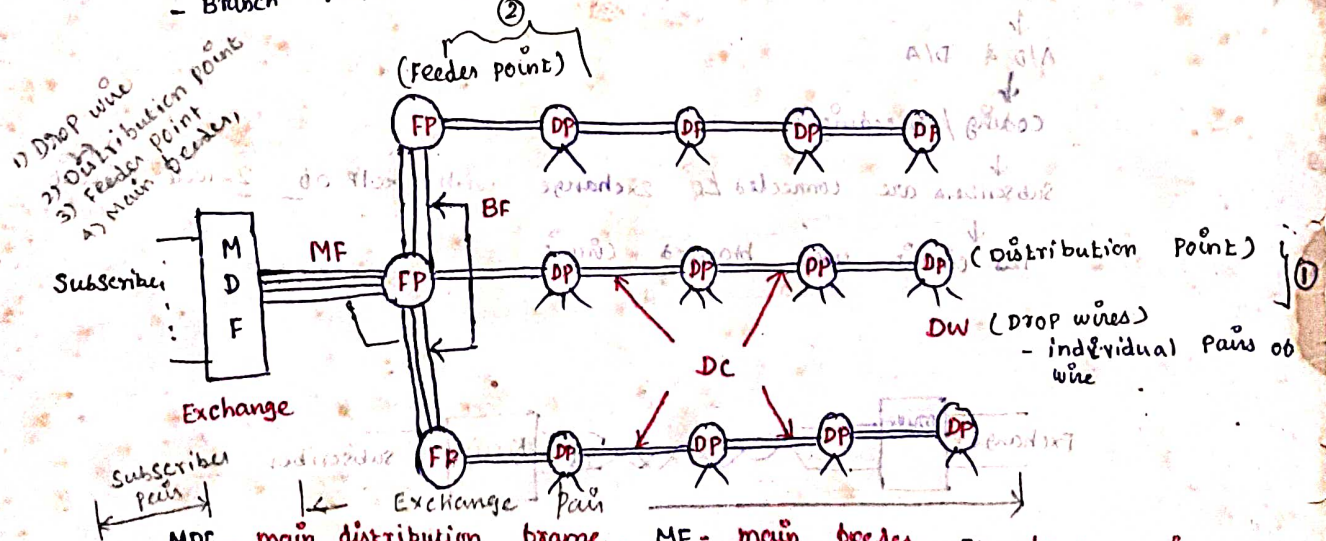
1. Subscribes end instruments or equipments
2. subscriber loop system
3. switching system
4. Transmission System
5. signalling System

Discuss unit ①

Discuss only

Subscribes Loop Systems:-

- Every subscriber in a telephone network is connected generally to the nearest switching office by means of a dedicated pair of wires
- Subscriber loop to this pair of wires.
- Generally, four levels of cabling are used as shown in figure
- At the subscribes end, the drop wires are taken to a distribution point The drop wires are the individual pairs that run into subscriber
- Many distribution cables from nearby geographical locations are terminated on a feeder Point (Branch feeder Point)
- Branch feeder Point connected to the main feeder cable (MDF)



MDF - main distribution frame, MF - main feeder, FP - feeder Point BF - branch feeder, DP - Distribution point, DC - Distribution cable, DW - Drop wires.

Cable hierarchy for subscriber loop

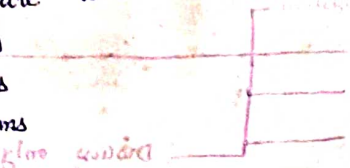
* Subscribers pairs and exchange pairs are interconnected by means of jumpers.

* This arrangement permits efficient utilisation of the cable as well as helps in cable management during faults.

* The Length of the pair wire ↑
↓
But two factors limits their length
(i) Signalling limits
(ii) Attenuation limits
↓
Exchanges are designed to accept a maximum loop resistance 1300 Ω

* In rural areas, subscribers are generally dispersed. It is both unnecessary and expensive to provide a dedicated pair for every subscriber

* Three techniques are used to gain on the number pairs



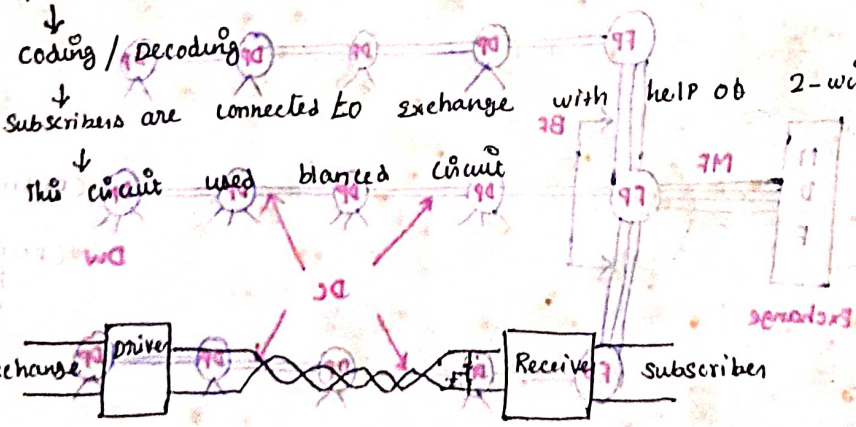
① Party lines
② Concentrators
③ Carrier systems

- Party lines :-
This is a first techniques, two or more subscribers are connected to one line which is termed party line.
(Disadvantages)
① only one subscriber at a time can use the line
② Privacy is not maintained

- concentrator :-
* This is a second techniques, It is used near the cluster of users and another one at the exchange end.

- carrier system :- Analog FDM (or) Digital TDM systems are used.
It involved Multiplexing techniques

* Signals
↓
A/D & D/A
↓
Coding / Decoding
↓
Subscribers are connected to exchange with help of 2-wire circuit
↓
This circuit used biased circuit



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ADDITIONAL BOOK

* The transmission lines have equal impedances to ground and hence do not act as an antenna
* Digital exchanges require receiver & transmit signals on separate two-wire circuits. This is called two-wire circuit to 4 wire circuit with help of HYBRID
* Main func. of Hybrid circuit there is no coupling of signal from the I/P to the O/P
* Now a day's using all electronic telephone used VLSI technology.

Two wire to 4-wire transformer hybrid

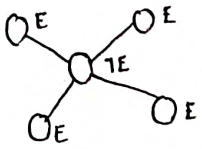
DIAGRAM :-

SWITCHING HIERARCHY AND ROUTING:-

* Telephone networks require some form of interconnection of switching exchange to route traffic effectively and economically.
* Exchange are interconnected by group of trunk lines usually known as trunk groups that carry traffic in one direction
* Three basic topologies are adopted for interconnecting exchanges Mesh, Star and hierarchy,

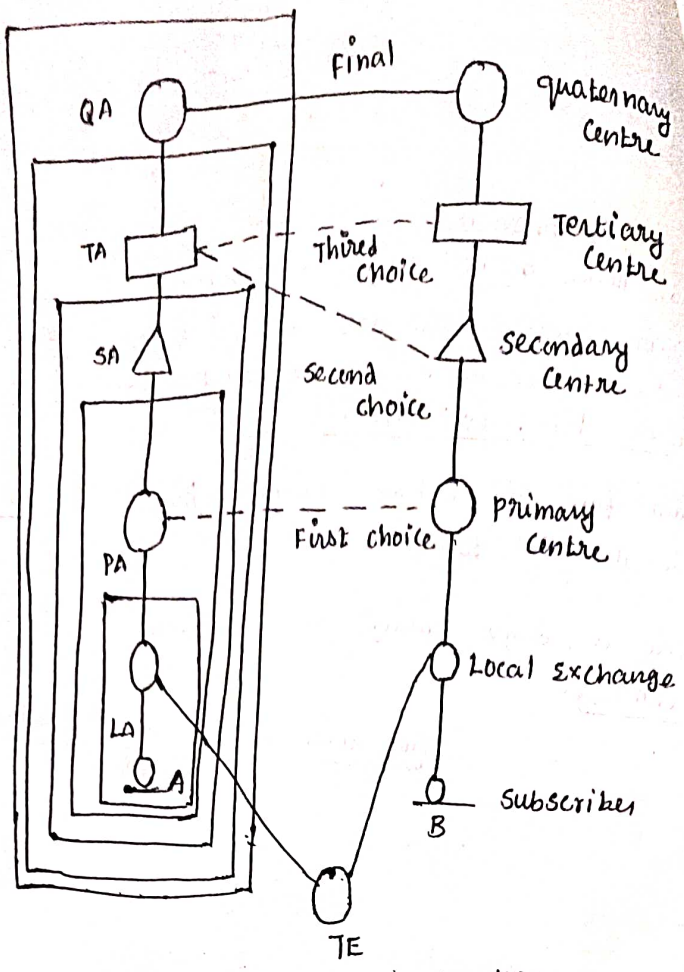
⇒ Mesh → fully connected N/w → No. of trunk α sqn of the exchange being interconnected. → Mesh connections are used only when there is heavy traffic among exchange

⇒ STAR CONNECTION
↓
Intermediate exchange called a tandem exchange



↓
Star connection used when the traffic levels are comparatively low

⇒ Multilevel star network leads to hierarchical N/w
↓
It's handling heavy traffic
↓
The 5-level switching hierarchy is recommended by CCITT



(c) CCITT Hierarchical structure

where

LA, PA, SA, TA, QA = Local, Primary, Secondary, Tertiary and quaternary.

TELECOMMUNICATION N/W TOPOLOGIES

⇒ In a strictly hierarchical N/w

↓

Traffic from 'A' to 'B'

↓

Traffic flows through the highest level of hierarchy (quaternary centre)

↓

Highest level of hierarchy is known as the final route

↓

No overflow is permitted from the final route because to reduced to choice b/w primary centres into Tertiary centre.

⇒ Three methods are commonly used for deciding on the route for a particular connection.

① Right - through routing

② own - exchange routing

③ computer - controlled routing.

① Right - through routing :-

- The originating exchange determines the complete route from source to destination

- NO routing decisions are taken at the intermediate routes

② Own - Exchange routing :-

- Own - Exchange routing (or) distributed routing allows alternative routes to be chosen at the intermediate nodes.

- To change over the traffic load combinations

- Advantage of distributed routing → when the new exchanges added, modifications required.

③ computer controlled - routing :-

- computer are used in N/w with common channel signalling (CCS) features.

- computer based routing is a standard feature in data network

Drawback :-

Hierarchical network suffers its poor fault tolerence feature

DIGITAL SUBSCRIBER LINE (DSL) (4)

- The DSL is a newer technology that uses the existing telecommunication N/w such as the local loop telephone line

- To accomplish high speed delivery of data, voice, video, and multimedia

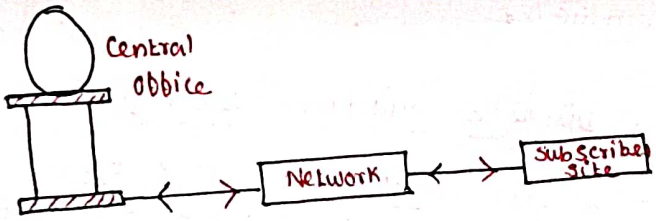
- DSL is a family of technologies

where

(i) ADSL - Asymmetric digital subscriber Line
(ii) RADSL - Rate Adaptive Asymmetrical Digital subscriber line
(iii) HDSL - High bit rate Digital subscriber line
(iv) VDSL - very high bit rate digital subscriber line
(v) SDSL - Symmetric (or single-line) digital subscriber line

ADSL

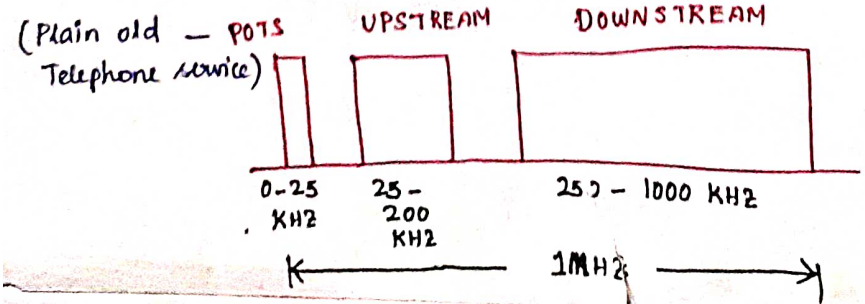
- Asymmetric digital subscriber line (ADSL) is asymmetrical which means it provides highes bit rate in the downstream direction & upstream direction



- Down stream (from the telephone central office to the subscriber site)

- up stream (from the subscriber site to the telephone central office)

- The subscribers want to receive high volume files quickly from the Internet but they usually have small files (Ex) (i) short e-mail message



- ADSL divides the bandwidth (1 MHz) into three

- The first band, normally b/w 0 to 25 KHz is used for POTS
  * This services uses only 4KHz of this band, the rest is used as the guard band to seperate the voice channel from the data channels.

- The second band, normally b/w 25 KHz to 200 KHz is used for upstream communication.

- The third band, normally b/w 250 KHz to 1 MHz is used for downstream communication.

Modulation techniques:-

* ADSL originally used a modulation technique called
  (i) Carrier less amplitude / Phase (CAP)
  (ii) Discrete multitone (DMT)

ASK
1 0
00 01

PCM
K ⇒ no. of bits
M = 2^K ∴ K = 1
M = 2 (Binary)
0 & 1

K=2
M = 4 (quater)
00
01
10
11
4 diff.

K=3, m=8 octal
000
111

K=M
2^m = M any System
PSK
BPSK
QPSK

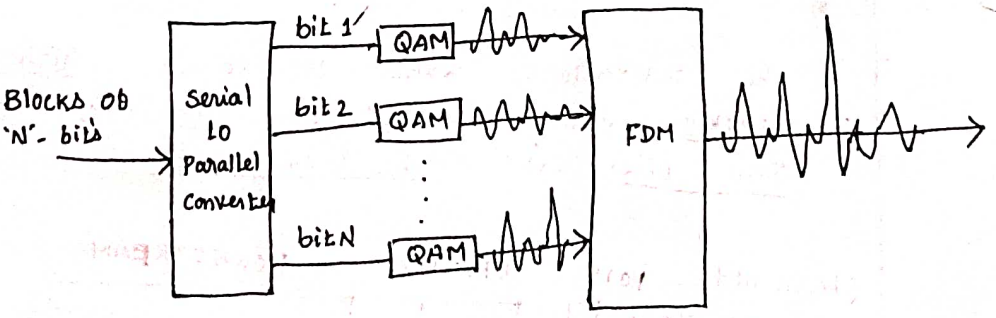
(i) Carrier less amplitude / phase (CAP)

* CAP is a modulation technique that is similar to QAM
* But only one difference number of the carrier signal is eliminated

(ii) Discrete Multitone technique:- (DMT)

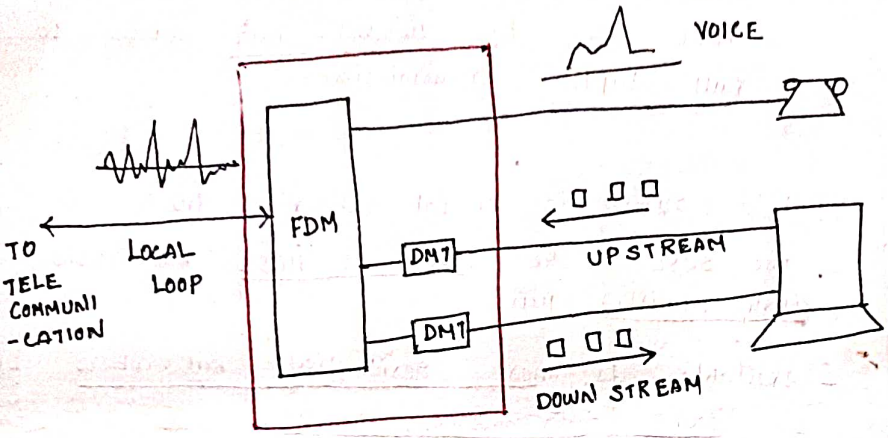
- * DMT combines QAM & FDM
  * Available band width for each direction 4KHz channels
  * Each having own carrier frequency.

- Figure shows the concept of DMT with 'N' channels



- The bits created by the source are passed through a serial - to - Parallel converter
- serial N bits divided into 'N' Parallel Paths each consisting of 1 bit
- The QAM modulated with input bit signal & multiplexed together and the result is sent to the line.

ADSL MODEM :-



* The ANSI Standard defines a rate of 60K bPS for each 4KHz channel which means QAM modulation with 15 bits per second.

* The upstream channel usually occupies 25 channels which means a bit rate of 25 x 60 KbPS (or) 1-5 MbPS

* The Down stream channel usually occupies 200 channels which means a bit rate of 200 x 60 kbPS (or) 12 MbPS

RADSL :- (Rate adaptive Asymmetical Digital Subscriber line)

- RADSL is a technology based on ADSL
- It allows dibberent data rates depending on the type of communication
- RADSL is provided to the customers required. and. the cost is based on the data rate .

⇒ HDSL :- (High bit rate digital subscriber line)

- HDSL was designed by Bellcore company (Telcordia) as an alternative to T-1 line
- The T-1 line uses AMI encoding which is very susceptible to attenuation of high frequency. This limits the length of 1km

Alternative Marking inversion

- Long distances a repeater (amplifier) is necessary.
- The data rate of almost 2 MbPS can be achieved without repeaters upto a distance of 3.6 km
- HDSL uses two twisted-pair wires to achieve full duplex transmission.

⇒ SDSL :- (Symmetric digital subscriber line)

- The SDSL is the same as HDSL but uses one single twisted pair
- Available to most residential subscribers to achieve the same data rate as HDSL
- This technique called echo cancellation is employed to create a full-duplex transmission.

⇒ VDSL :- (Very high bit rate digital subscriber line)

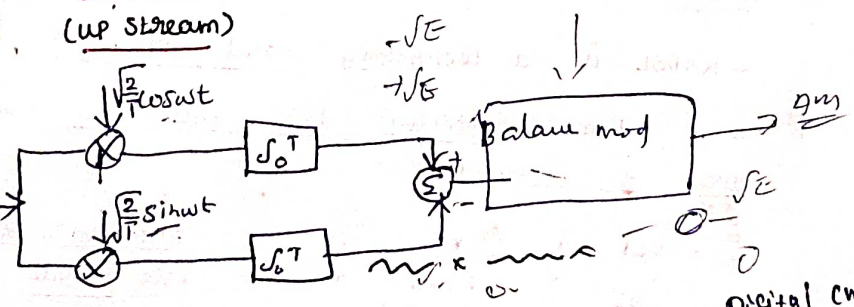
- VDSL an alternative approach that is similar to ADSL
- which is used to co-axial, fiber-optic (or) twisted pair cable for short distance (300 - 1800) meters
- The modulation technique is DMT with bit rate of 50 to 55 MbPS (down stream) & 1.5 to 2.5 MbPS (up stream)

QPSK

$S_1(t)$ & $S_2(t)$

$\sqrt{\frac{2E}{T}}\cos\omega t$

$-\sqrt{\frac{2E}{T}}\cos\omega t$



$= \int_0^T \sqrt{\frac{2E}{T}}\cos\omega t \times \sqrt{\frac{2}{T}}\cos\omega t \, dt$

$= \sqrt{E}$

Digital Comm

Bipolar
VRZ
NRZ
Base Band.

Pass band (or) Band pass

- co-axial
- PSK
- QPSK
- QAM,

(6)

Transmission system:-

Modern long distance transmission system can be placed under three broad categories.

(1) Radio system
(2) coaxial system
(3) Optical system.

(1) Radio system:-

(*) - Radio communication deals with electronic radiation of electromagnetic energy from one point another through the atmosphere (or) free space

- presently frequency range from 9KHz to 100GHz
- International allocation of radio spectrum up to 275 GHz
- Commercial uses takes place b/w 100KHz and 20GHz
- Few experimental system have be operated beyond 100GHz

(*) Different layers of the atmosphere play a role in propagation radio waves.

- when electromagnetic waves travel within the earth's atmosphere is known as terrestrial waves.

- The terrestrial radio communication with respect to earth atmosphere mainly three wave of propogation.

where

(1) Space wave propagation (Tropospheric) } (30 - 300MHz)

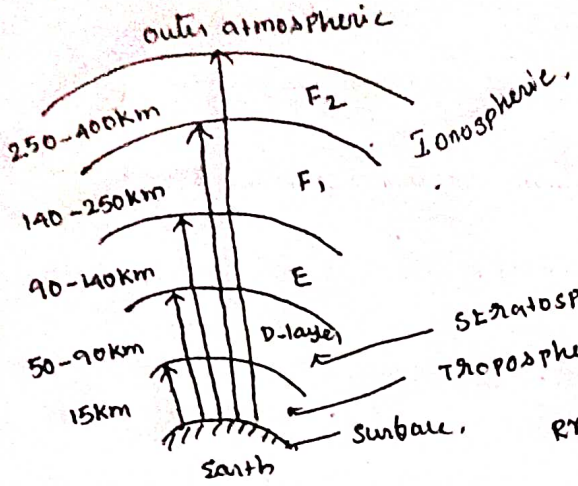
(2) Surface wave propagation (upto 2MHz)

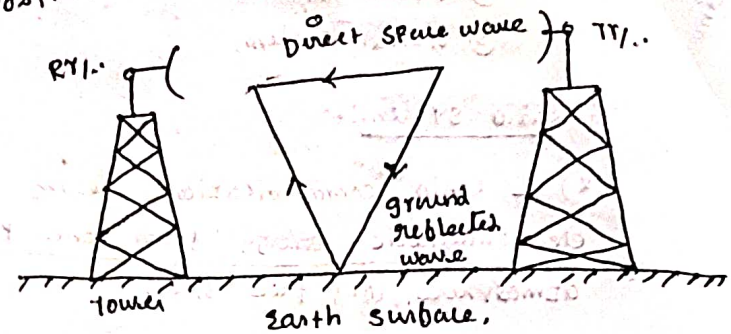
(3) Sky wave propagation (3MHz to 40MHz) (Ionospheric)

(1) Space wave Propagation:-

- The space wave propagation is mainly the energy radiated into space that travels a longer distance in terms of miles of the earth atmosphere.

- The space wave also include direct waves and ground reflected waves.





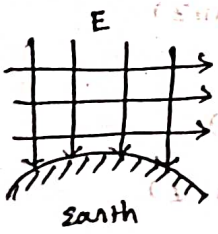
- For example the direct wave in space travels straight where some waves hit the earth surface and subjected to reflection.

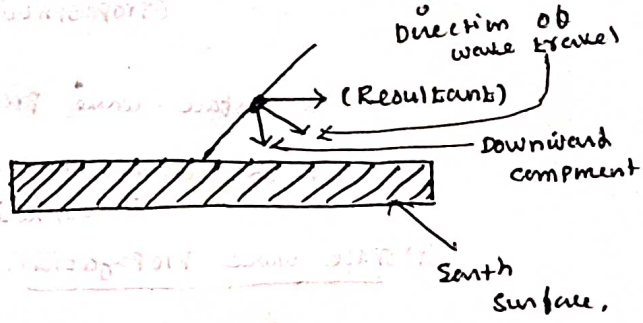
- The ground reflection wave travels towards receiving antenna.

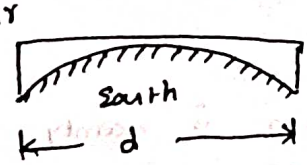
(ii) Surface wave propagation:-

- Surface wave is one which is guided by the earth surface, and travels near the earth surface it also accompanies the charges induced by the earth surface.

- Earth surface has resistivity components so the charges are dissipated in several directions. Hence surface waves resemble a transmission line in this aspect.

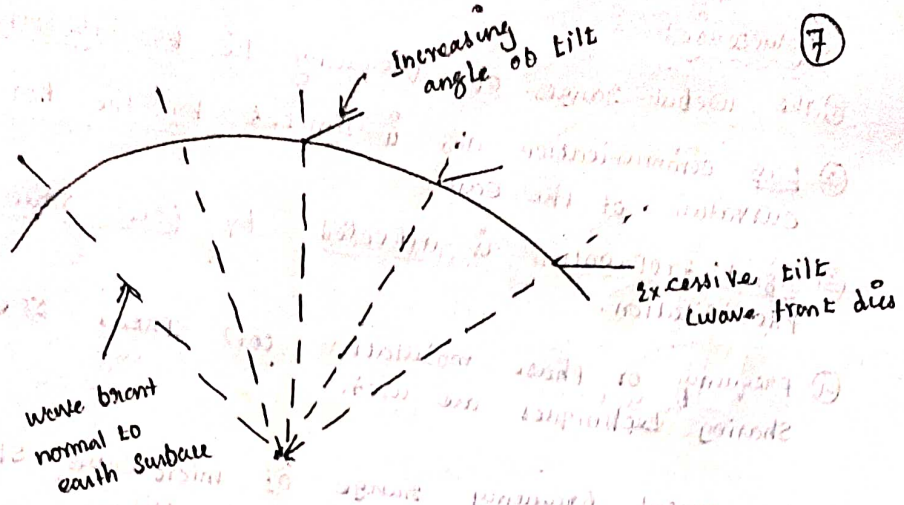






- The main application of these waves are in ship related communication.

- Frequency range :- 15KHz



(Examples of surface wave)

- The earth density decreases as the distance from earth surface increases.

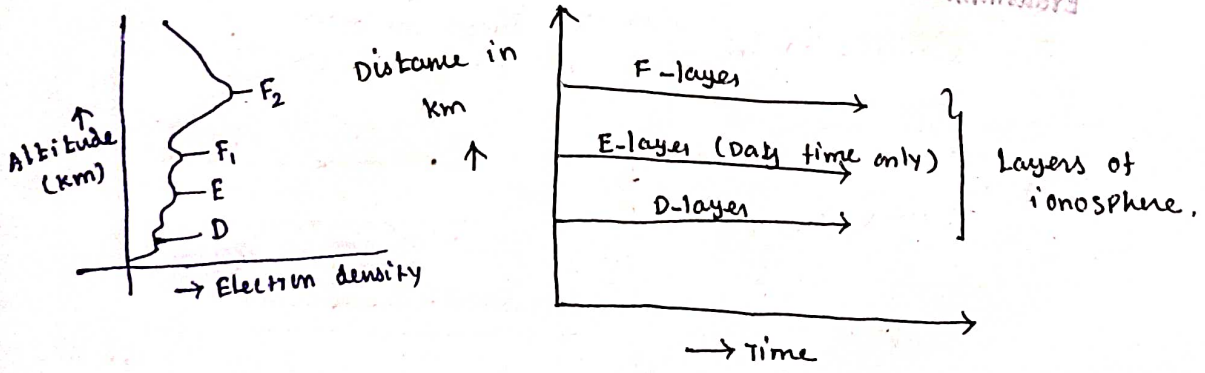
(iii) Sky wave Propagation:-

- The electromagnetic waves are directed above the horizon level then it is termed as sky wave.

- Generally a large angle will be provided sky waves propagati

- Sky wave radiate usually reflected (or) refracted to the earth due to ionosphere

- The three layers D, E and F layers of ionosphere region



- ionosphere region occupies 50 to 400 km above from the earth surface.

- Propagates according to the density of ionosphere which depends on availability of sunlight.

MICROWAVE Communication:-

Characterised

(1) The useful ranges of frequency lie b/w 150MHz and 1500

(2) LOS communication and is limited by the horizon due to curvature of the earth

(3) Signal Propagation is affected by free space attenuation & Precipitation.

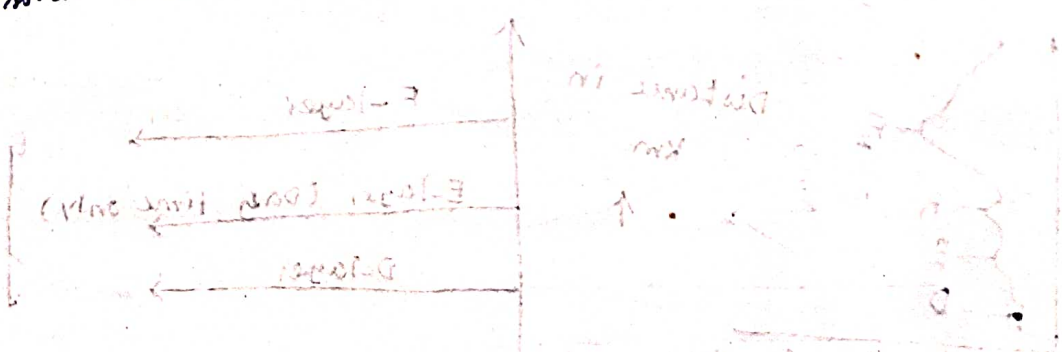
(4) Frequency or Phase modulation (or) spread spectrum and time Sharing techniques are used.

The useful frequency range of microwave spectrum is divided into a number of bands designed by litters

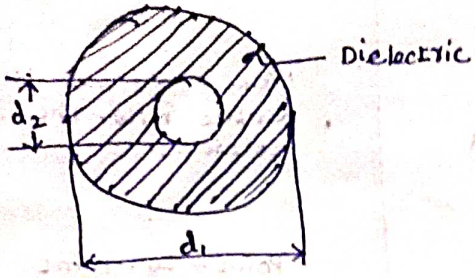
MICROWAVE BANDS

Frequency range (GHz)	Band
0.25 – 0.39	P
0.39 – 1.55	L
1.55 – 3.90	S
3.90 – 6.20	C
6.30 – 10.90	X
10.90 – 36.00	K
36.00 – 46.00	Q
46.00 – 56.00	V

- Commercial microwave telecommunications, frequency range S, C, K bands
- Three comm bands 4, 6, 11 GHz are used widely.
- Height of the antenna above the earth to determining the transmission distance in LOS communication.



Coaxial Cable Transmission:-



where
d_1 → inner diameter of the outer conductor.
d_2 → outer diameter of the inner conductor.

- almost eliminating the pick up of unwanted interference and reducing the signal loss due to electromagnetic radiation

- Full duplex transmission, generally a pair of coaxial line is used. For long-haul systems, 4, 6 & 8, (or) more lines

- Standard co-axil cables:-

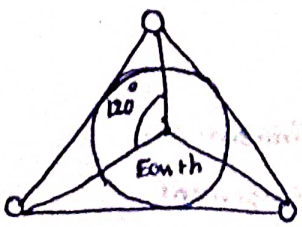
	d_2(mm)	d_1(mm)	a	b	c	v_p (m/s)
size (1)	1.2	4.4	0.066	5.15	0.0047	1.8×10^8
size (2)	2.6	9.5	0.013	2.305	0.003	1.8×10^8

where
a, b, c → constants dependent upon the physical parameters of the cable.
v_p → Phase velocity.

- The design of a coaxial system involves the following:-

1) Repeater design.
2) Repeater spacing
3) Equalisation
4) Temperature considerations
5) Supervision and fault location.
6) Power feed
7) Right of way.

Satellite communication:-



Satellite positioning for 100% earth coverage.

Comparison of satellite & terrestrial communication

Satellite communication	Terrestrial communication
1) Star topology	Mesh topology
2) Satellite is a critical component (i) failure results in total failure of the N/w	Node failures do not affect the entire N/w. The N/w is fault tolerant.
3) Broadcast in nature	Point-to-Point in nature.
4) Large distance communication	Distances are relatively small
5) Time delay 270ms for one way communication	Time delay 40ms for one way communication.
6) Nw communication	Nw. Cable (or) Optical fibes communication.
7) Stellite life span is typically '7' YEARS	Life span is large, typically '30' years or more.

Network management:-

- The management of both public & private telecomm/. N/w is carried out at a number of levels follows.

① Business level:-
- This is the mangement of the N/w as a business
- It includes sales, customer administration, billing, accounting and investment planning.

② Service level:-
- Service provided to the customers
- It includes both basic services (eg - telephony) & value added services.

③ N/w level:-
- It includes.
  1) Route optimization.
  2) Traffic Mangement.
  3) planning of changes and extensions to the N/w

④ N/w element level:-
- It include
  1) installation of equipment
  2) Diagnosis of fault
  3) Management maintenance, repair and alterations

PLAN:-

Transmission quality & efficiency of operation of signalling it is desirable to limit the number of circuit connected in tandem.

- Tandem chain, the apportionment of links b/w national and international circuit is necessary to increasing quality of telecommunications.

① The maximum number of circuit to be used in an international call

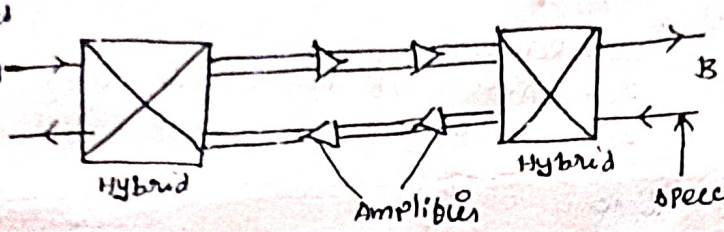
- Transmission loss budget should provide for two factors other than the line and switch losses:-

② No more than four international circuit be used in tandem b/w the originating and the terminating international switching centres.

* Keeping echo levels with limits.
* Control singing.

- Hybrid is required to convert a 2 wire circuit into 4 wire circuit b/w the subscriber and a digital exchange.

③ In exceptional cases and for a low number of calls, the total number of circuits may be 10, but even in this case, the international circuits are limited to a maximum of four.

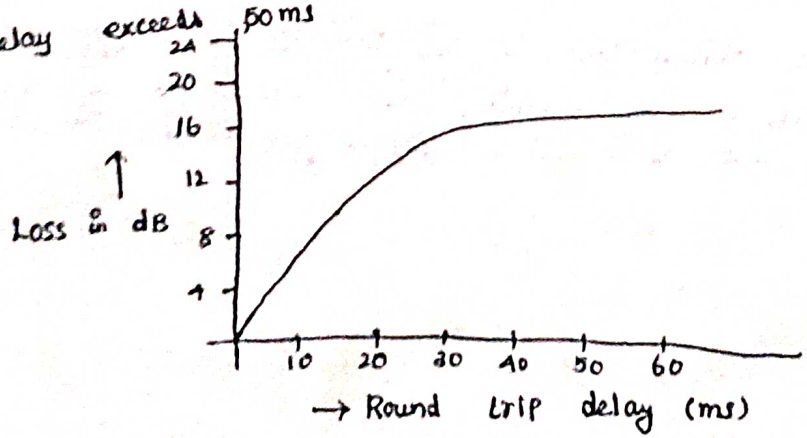


- In analog exchanges, local calls are established on 2-wire circuit But long distance calls require 2-wire to 4-wire conversion at the subscriber line trunk interface.

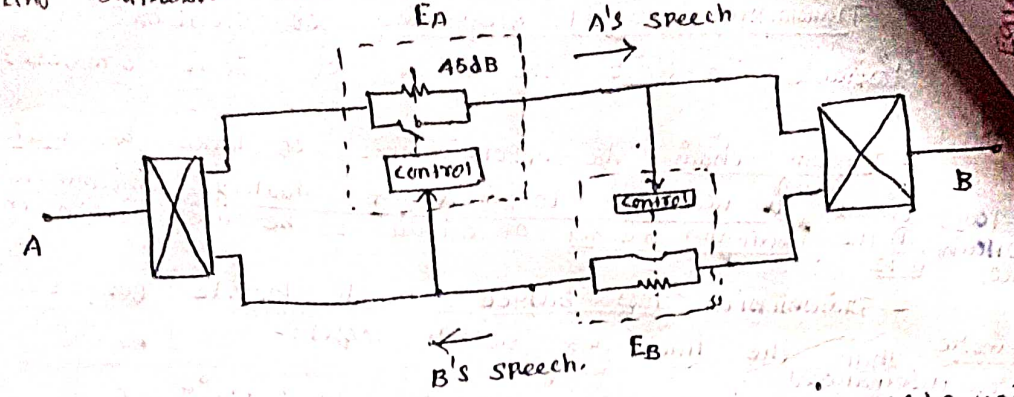
- Long distance
  ↓
  need amplifiers
  ↓
  The amplifiers are almost invariably one-way devices and can't handle bidirectional signals
  ↓
  Hence the need for 2' wire to 4 wire conversion in long distance connections.
  ↓
  there is no coupling loss.

- short distance echo controlled by using attenuators
- Long distance echo controlled by echo suppressors (or) echo cancellers.

- The use of echo suppressors & cancellors if the round trip delay exceeds 50 ms



- Echo suppressor's are voice activated attenuators



- The amount by which the reflected signal is attenuated is known as return loss. This is given by

$$R_L = 20 \log \frac{Z_1 + Z_2}{Z_1 - Z_2} \text{ dB}$$

where

R_L - Return loss
Z_1 - impedance of the 4-wire circuit
Z_2 - impedance " " 2-wire circuit

(or) in terms of Power

$$R_L = 10 \log \frac{P_1}{P_1 - P_2} \text{ dB}$$

where

P_1 - incoming power on the 4-wire circuit
P_2 - power reaching the 2-wire circuit
$P_1 - P_2$ - power reflected on to the return path

(or) in terms of signal voltages

$$R_L = 20 \log \frac{V_1}{V_1 - V_2} \text{ dB}$$

$$= 20 \log 1/r_c$$

where $r_c = \frac{\text{reflected signal}}{\text{incident signal}}$ $\quad \frac{Z_1}{Z_1 - Z_1}$

the two networks are perfectly balanced then $Z_1 = Z_2$

therefore from

$$R_L(\text{balanced}) = 20 \log \frac{2Z_2}{0} = \infty$$

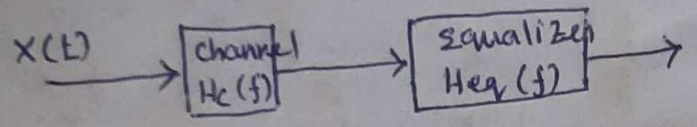
The return loss is infinite (ie) the return signal experiences an infinite attenuation and hence there is no reflected signal

Equalization Techniques :-

- when the signal is passed through the channel, distortion is introduced in terms of
  1. Amplitude
  2. Delay

(Inter symbol Interference)

- This distortion creates the problems of ISI
- This distortion can be compensated with the help of equalizers
- equalizers are basically filters, which correct the channel distortion
- shows channel and equalizer for correction of distortion



Aliasing effect:

- we have derived a condition for distortionless transmission

∴ The transfer function

$$H(f) = Ke^{-j2\pi f t_0}$$

- The cascade connection of channel + equalizer

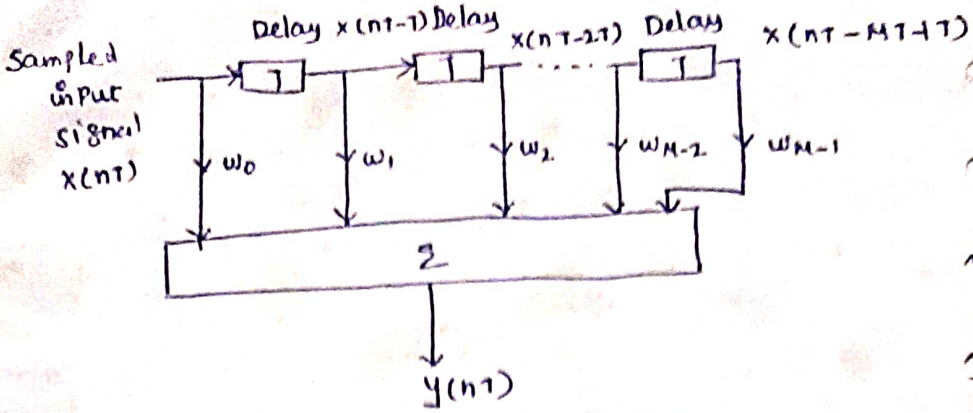
$$H_c(f) \cdot H_{eq}(f) = Ke^{-j2\pi f t_0}$$

- Hence transfer function of the equalizer will be

$$H_{eq}(f) = \frac{Ke^{-j2\pi f t_0}}{H_c(f)}$$

The above equation is difficult to realize directly, but approximations are available with can be implemented with the help of tapped ~~day~~ delay ~~line~~ line filters

① Tapped Delay Line filter:-



- The o/p of above filter is given as

$$y(nT) = \sum_{i=0}^{M-1} w_i x(nT-iT)$$

where

w_i is the weight of i^{th} tap

M is the total number of tap

T is the symbol duration of the signal

$$y(nT) = \sum_{i=0}^{M} w_i x(nT-iT)$$

- The weights are basically filter coefficients
- Hence this is fixed filter.

② Adaptive equalization:-

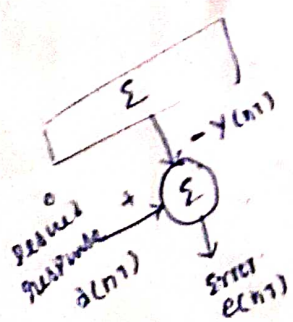
- Most of the channels are made up of individual links

For example

The switched telephone N/w the distortion induced depends upon

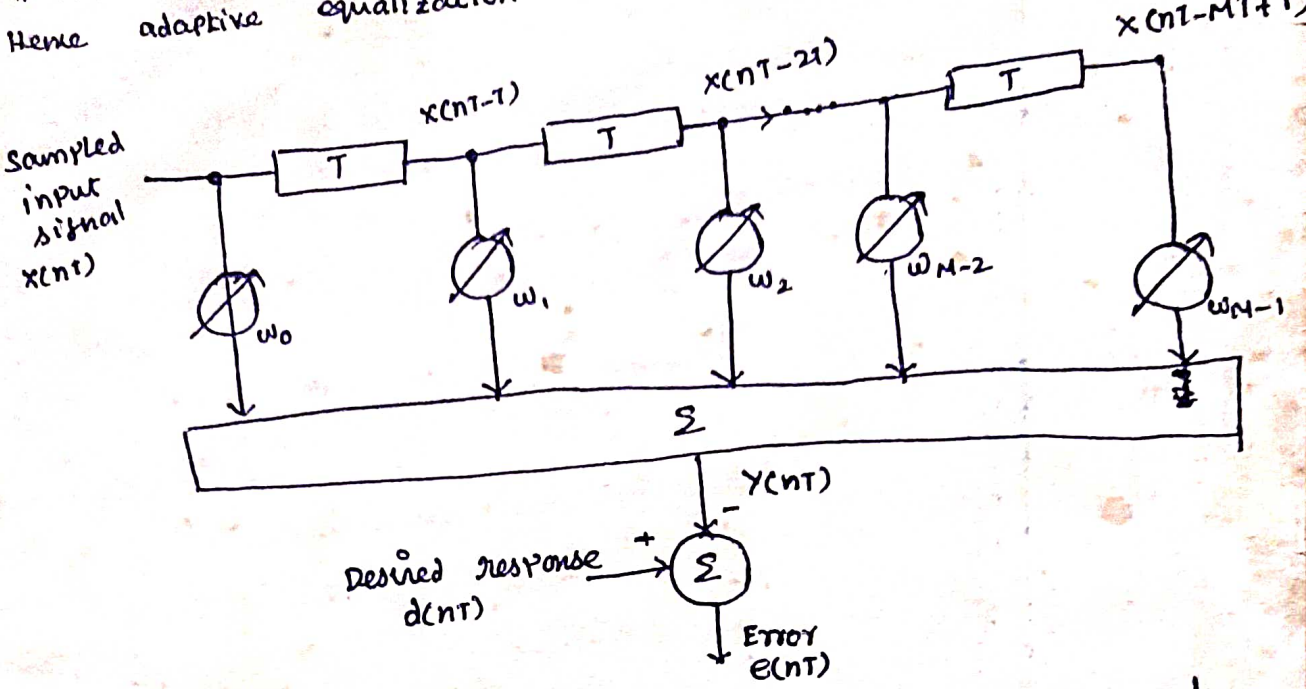
① Transmission char/. of individual links

② Number of links in connection



* The fixed pair of transmit and receive filters will no serve the equalization problem completely.

* The transmission chy. of the channel keep on changing Hence adaptive equalization is used.



*The coefficients of the filters are changed continuously according to the received data.

* Filter coefficient changed
↓
Distortion in the data is reduced.

* when an equalization is done at the transmitting side it is called prechannel equalization.

* receiver side it is called postchannel equalization.

* The o/p y(nT) of the adaptive filter will be

$$y(nT) = \sum_{i=0}^{M} w_i\, x(nT - iT)$$

where
x(nT) → input
w → weight,

SONET / SDH:- (Synchronous Optical Network) / (Synchronous Digital Hierarchy)

INTRODUCTION:-

* Synchronous Optical Network (SONET) is a high speed optical carries using fibes optic cable.

* SONET was originally proposed by bellcore and standardised by ANSI.

* The ITU has set of standard for SONET called Synchronous Digital Hierarchy (SDH)

* The international and U.S versions of SDH and SONET are very close, they are not exactly identical.

* The existing digital Hierarchy which carries digitized voice over twisted wire is asynchronous at DS3 / (digital stream) and lower levels

The most significant characteristics (OR) advantages of SONET are:-

① SONET uses byte multiplexing at all levels.

② As SONET is a synchronous network, a single clock handles the timing of transmission and equipment across the entire N/w.

③ Establishes a standard multiplexing format using some number of STS-1 signals as building blocks.

④ SONET / SDH contains recommendations for the standardization of fiber optic Txn system (FOTS) equipment.

⑤ It defines multiplexing formats for carrying existing digital signals of the asynchronous multiplexing hierarchy (DS1, DS2, DS3)

⑥ SONET / SDH supports [CCITT (ITU-T)] digital signal hierarchy (E_1, E_2, E_3, E_4)

⑦ The flexibility of SONET accomodates applications such as ISDN with variety of transmission rates

⑧ SONET provides extensive operation, administrations, maintainance and provisioning functions.

⑨ It has enchanced network relaiability, availability and universal connectivity.

SONET Signal Hierarchy:-

- SONET defines a hierarchy of signalling levels called synchronous transport signals (STS)
- The lower level, referred to as STS-1 (or) OC-1

where,
OC1 → optical carrier level 1

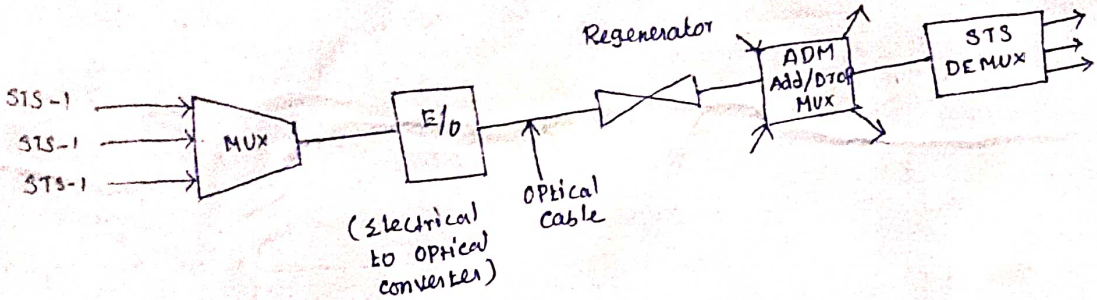
- Multiple STS-1 signals can be combined to form as STS-N (or) OC-N
- The STS is
  - ↓ electrical signal
  - ↓ physical links defined to carry each level
  - ↓ that is called optical carriers (OC)
  - ↓ The most popular implementations are OC-1, OC-3, OC-12 and OC-48

- The ITU-T recommendation of SDM defines the hierarchy of signalling levels called synchronous transport module (STM)
- The lowest level is STM-1 has a lowest rate 155.52 Mbps. This is exactly equal to STS-3 rate

- The following table shows the SONET & SDM signal rates

STS for SONET	OC	STM for SDH	Data rate (MbPS)
STS-1	OC-1		51.84
STS-3	OC-3	STM-1	155.52
STS-9	OC-9	STM-3	466.56
STS-12	OC-12	STM-4	622.08
STS-18	OC-18	STM-6	933.12
STS-24	OC-24	STM-8	1244.16
STS-36	OC-36	STM-12	1866.23
STS-48	OC-48	STM-16	2488.32
STS-96	OC-96	STM-32	4976.64
STS-192	OC-192	STM-64	9953.28

SONET COMPONENTS:-



- SONET transmission having three basic devices

① STS Multiplexer / demultiplexer.

② Add Drop multiplexer (ADM).

③ Regenerator.

① STS Multiplexer / demultiplexer:-

* The function of an STS MUX is to multiplex electrical input signals (higher Data rate)

* The STS DEMUX convert and demultiplex optical signals to electrical signals for the users.

② ADD/ DROP MULTIPLEXER (ADM):-

* It adds or removes the lower rate signals from or into high rate multiplexed signals.

③ Regenerator:-

* The regenerator performs the functions of a repeater

* Long distance optical communication we need repeaters to increasing signal level.

ANNAMALAI UNIVERSITY

ADDITIONAL BOOK

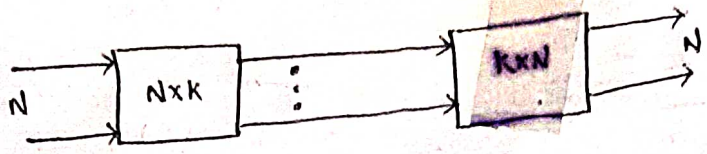
NAME-SAROJ KUMAR SINGH

Roll No- (15)

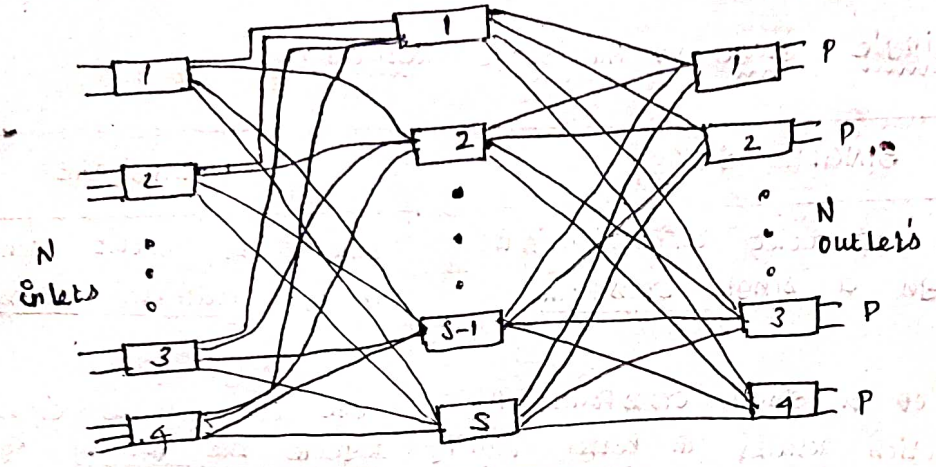
Single Stage Vs Multistage Networks:-

SINGLE STAGE	MULTISTAGE
(1) Inlet to outlet connection is through a single cross point	Inlet to outlet connection is through multiple cross point.
(2) Use of a single cross point per connection results in better quality link	Use of multiple cross points may degrade the quality of a connection
(3) Each individual cross point can be used for only one inlet / outlet pair connection.	Same cross point can be used to establish connection b/w a number of inlet / outlet pairs.
(4) A specific crosspoint is needed for each specific connection	A specific connection may be established by using different set of crosspoints.
(5) If a crosspoint fails, associated connection cannot be established. There is no redundancy.	Alternative cross-points and Paths are available.
(6) cross points are inefficiently used	cross points are used efficiently
(7) A large number of cross points in each inlet / outlet leads to capacitive loading	There is no capacitive loading problem.
(8) The network is non blocking in character.	The network is blocking in character.
(9) Time for establishing a call is less	Time for establishing a call is more.
(10). Number of cross points is prohibitive	Number of crosspoint is reduced significantly.

TWO STAGE REPRESENTATION:- (N:N network)



3rd stage N/w



NXN

Planning

objective of the Planning is to provide the subscribers needs.

UNIT-5 (Tele Communication)

(i) Amplitude
(ii) Frequency,
(iii) Depending upon the transmission system
(iv) Data links

TYPES:-

(i) Frequency Planning (or) Frequency Reuse
(ii) Las Microwave relay links
(iii) Satellite links
(iv) Cellular Mobile communication links.

Communication:-

which is realiability.

1837 - telegraph
1876 - tele phone
1910 - US govt → regulations
1915 - Transcontinental phone services
1951 - Direct dialed long distance services,
1960 - Data communication over telephone
1970 - online are the real time system
~~1980 - Personal computers~~
1984 - Cell Phone,
1990 - LAN (Local area Network)
1993 - Internet,

Classification:-

Based on signal < Analog / Digital

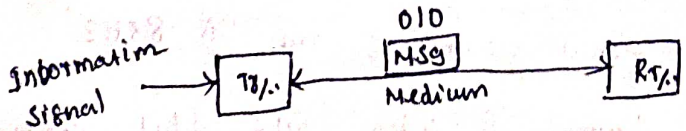
Based on modulation usage < Base band / Broad band,

Based on Medium < Guided - (Σx) wire, Optical communication / unguided - (Σx) Air, Mobile communication

Based on frequency - VLF, LF, MF, VHF, UHF, SHF,

Data communication:-

- Sub set of digital communication,



- Based on clock < Syn/r (common clock used T/r & R/r)
Asyn/r (separate clock " " ")

- Based on transmitted mode { Serial / parallel

- Based on transmission mode,
  - simplex
  - Duplex { Half duplex / full duplex

- unit for data communication
  - Bits / second
  - Baud rate,

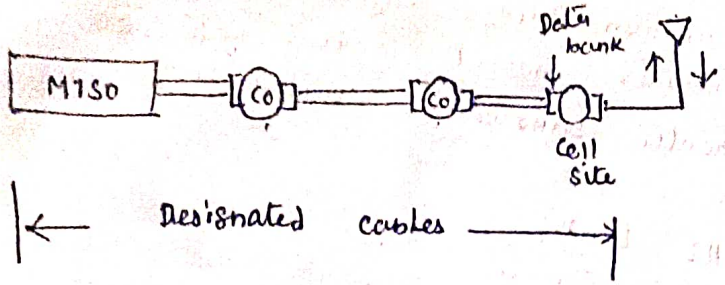
Data links (W.C.Y. Lee) 363-376

- Implementation of data links is an integral part of cellular mobile system design, and the performance of data links significantly affects overall cellular system performance.
- The main func.. of data links depending upon the MTSO
- MTSO (it's performance to control the call process of mobile units)
- Data links are classified into three types
  (i) wire line
  ~~(2) 800-MHZ radio frequency~~
  (3) Micro wave frequency.

(1) wire line:-

- wire line connection used telephone company's (T1 carrier) In regular telephone wire can transmit only at a low rate (2.4KBPS)
- Carrier frequency used wide band transmission (1.5MbPS)
- wide band transmission consists of 24 channels & each channel transmit at rate of 64KbPS [(24 * 64K) = 1.5M]
- Message signal (voice signal) converted into digital signal. and many number of digital terminals are multiplexed to form a single digital line called a digital channel bank
- the signal sampling rate is 8KHz
- Each channel is coded into 7 bit words.
- The total number of bits per frame is

one sample (7 x 1) signaling bit x 24 samples/channel + 1 frame bit. = 193 bits / frame



Disadvantages:-

* Route may be rearranged by the telephone company
* It is not totally under the user's control.

i) 800-MHz radios:-

- The Data Send frequency range 800-MHz
- Signaling Data rate 10kbps
- Additional 666 channels handle this data link.

ii. Micro wave:-

* Micro wave system is used to cover a large area
* Before designing it, we must consider,
  1. System reliability
  2. Economical design,
  3. Present & furture frequency selectim,
  4. Minimization of the number of new new sites
  5. Flexible and Multilevel system,

* Microwave frequency can be Grouped as follows,

(i) 2GHz band

- Minimum path Length of 5km
- limited frequency range 3.5GHz bandwidth
- limited path length & limited traffic capacity,
- large antenna Cell side.

(ii) 4GHz to 6GHz band:-

- Minimum path Length of 17km
- The minimum channel load of 900 channels for 6GHz along with 4GHz frequency present a restriction.

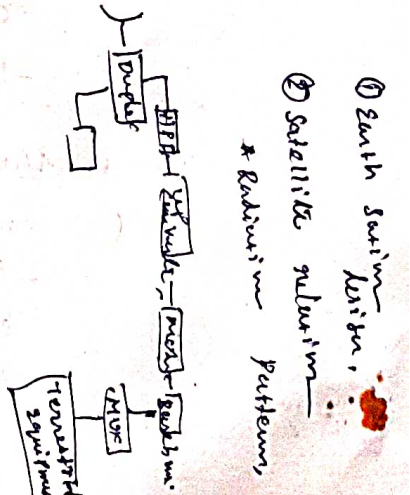
(iii) 11 GHz band

- The minimum Path Length of 5km
- The minimum channel loading of 900 Voice
- The greater bandwidth availability.

(iv) 18 and 23 GHz bands:-

- None minimum Path Length,
- minimum Channel loading would appear to make these two frequency.
- To calculate a microwave link we need,
  ① link gain - Power, antenna size, Antenna height and receiver sensitivity.
  ② Free-Space loss,
  ③ Attenuation,
  ④ Given availability,
- The transmission rate of a signal over a microwave link is limited to the time delay spread.
- Time delay spread depending upon the distance

① Earth station design,
② Satellite antenna Patterns,
* Radiation Patterns,



Transmission control Protocol Internet protocol are not used to creat the Lans but they Internet working multilan N/w.

- The Lan is used for data sharing & broad casting common purpose.
- The N/w connects to the internal gateway in turn to the external gateway on the internet.

- Connectionless Service :-
  - It is unreliable.
  - Packet may be duplicated
- Reliable transport service :-
  - with the environment
- Application services :-
  - Interface with most services of other architecture.

- TCP/IP Reference Model Diagram
- Application level
  - SNMP
  - SMTP
  - FTP
  - TELNET
  - HTTP
  - DNS
- Transport level :-
  - TCP & UDP
- TCP Header :-
- Types of Services

① Header ② current used IPV4 ③ Flag 3 bits

Connection oriented & connection-less Prot

- Routing control.
  (i) Virtual circuit
  (ii) Datagram

Datagram

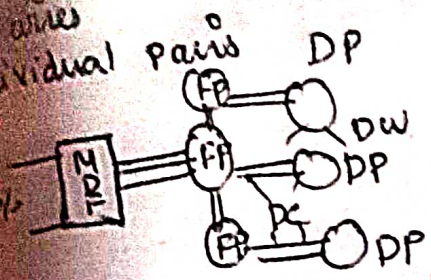
- independently
- routes estimate, (Diagram)

Virtual circuit

- fixed
- identified (Diagram

...riber loop system:-

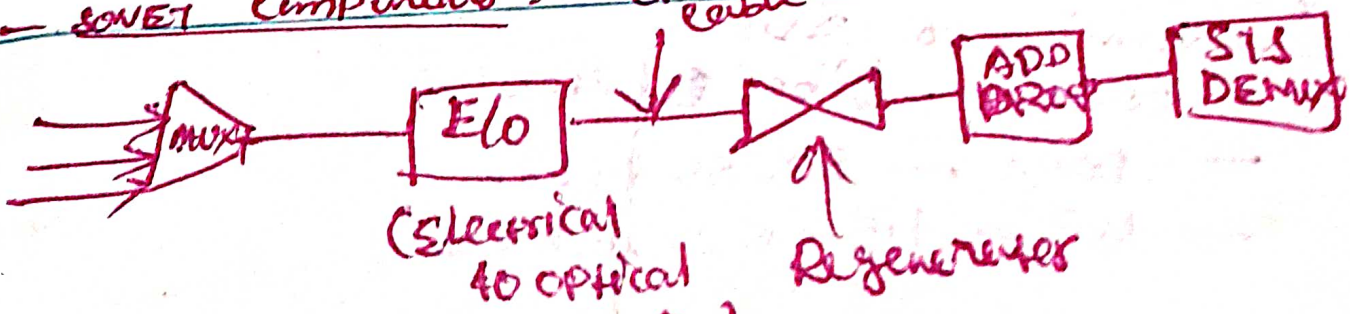
- ... subscriber connected ... switching office.
- ... wires
- individual pairs



- ... interconnected at the jumpers
- efficient utilisation
- Disadvantages:
  - (i) signalling limits.
  - (ii) Attenuation limits
- Max. loop resistance 1300 Ω
- Three technique to improve gain
  - (i) party lines – two or more sub. interconnected
  - (ii) concentrators – near the cluster
  - (iii) Carrier system – Multiplexing techniques
- Signal – A/D – coding/decoding – medium – balanced circuit
- Balanced circuit
- no coupling loss
- equal impedance,
- 2 to 4 wire with help of hybrid transformer, (Diagram)

SONET

- high speed communication
- STS-1 (or) OC-1
- STS – Electrical signal – carrier signal → OC 1 (or) OCN
- ANSI (SONET)
- ITU (SDH)
- Advantages,
- SONET components :- optical cable



DSL

- Newer technology.
- with speed delivery,

ADSL
RADSL
HDSL
VDSL
SDSL

⇒ ADSL

Down Stream, 250 – 1000 KHz
Up Stream 25 – 200 KHz

Modulation
① Carrii less amplitude / phase. (CAP)
② Discrete multitone (DMT)

ADSL MODEM.
Diagram

⇒ RADSL
- based ADSL
- Different Data rate
- customer requirement cost on the data rate.

⇒ HDSL
- Bellcore.
- AMI encoding
- 2 MBPS
- Distance ⇒ 3.6 KM.
- Full duplex.

⇒ SDSL
- based HDSL
- Residential Subscriber.
- echo cancellation

VDSL
- similar to ADSL
- Coaxial, fiber optic used
- Down — 50–55 MbPS
- UP — 1.5 to 2.5 MbPS

INCIPLE OF ATM N/W

1. Introduction
2. ATM Addressing
3. ATM concepts.

ATM Addressing:-

(i) Virtual Channel (VC)

Transport of ATM cells - same unique identifier called virtual channel identification

(ii) Virtual path (VP)

ATM Concepts:-

- Channel based transport layer,
- In the concepts of VP & VC
- ATM cell has 8 or 12 bit VPI and 16 bit VCI pair,
- Switching is achieved by changing the VCI / VPI values.

Four basic types:-

1. CBR - constant bit rate
2. VBR - variable " "
3. ABR - Available bit rate
4. UBR - unspecified bit rate,

Numbering plan:-

- ITU Recommendation

(i) Recommendation E.164

(ii) 3 types of International public telecommunication

1) National telephone Services:-

NSN → CC + NDC + SN

2) Global telephone Services:-

8xx or 9xx range,

3) International N/w

CC + N/W : ID CODE + SN

4) Recommendation E.123

-, *, @ #.

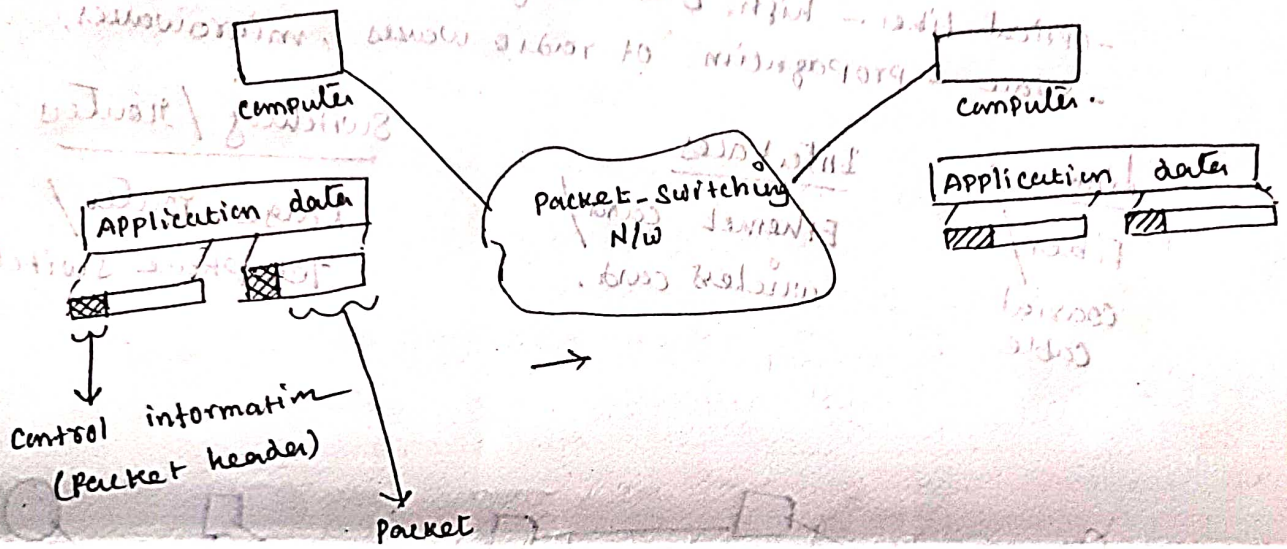
Basic operation:-

- Data transmitted in small packets
  - * Longer message split into series of Packets
  - * Each packet contains a portion of user data plus some control info

- Control info
  - * Routing (addressing) info

- Packets are received, stored briefly (buffered) and past on to the next node.
  - * Store and forward.

USE OF PACKETS



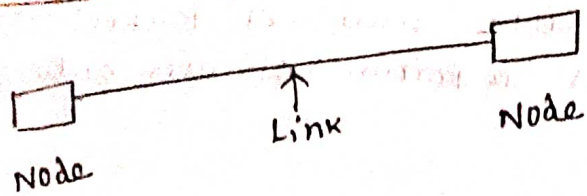
Advantages

(i) Line efficiency
(ii) Data rate conversion.
(iii) Packets are accepted even when n/w is busy
(iv) priorities can be used.

Switching technique

Packets handled in two ways.
- Datagram → independently,
- virtual circuit. — dependently (handshake)

Simple N/w :- Nodes and a Link.



- Node : computer

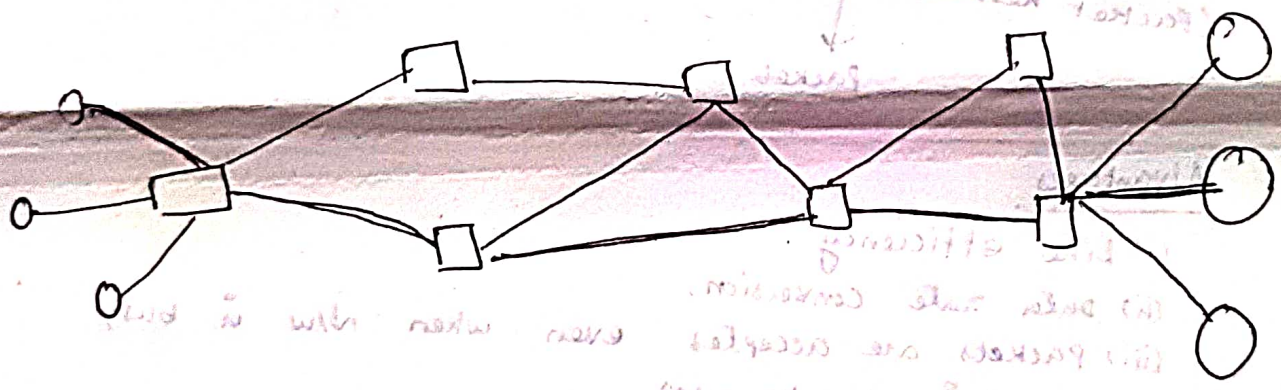
Example
- Switch (or) router

- Link : physical medium connecting nodes
  - Twisted pair : The wire that connects to telephones.
  - coaxil cable :- The wire that connects to TV sets
  - Optical fiber – high B.w long. – distance links.
  - Space – propagation of radio waves, microwaves.

Link
Fiber / coaxial cable

Interfaces
Ethernet card / wireless card.

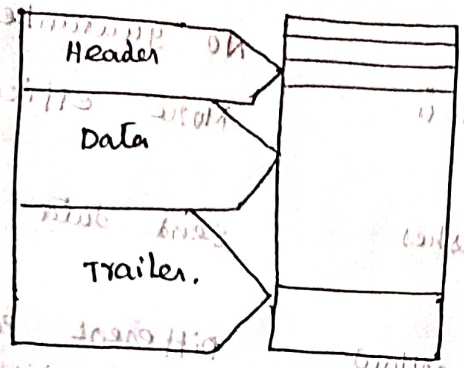
Switching / routers
Large router / Telephone switch.



PACKETS

- Fixed piece of information sent across a N/w consists of three elements.
  - Header (addressing info and alert signal)
  - Data (initial request of server response)
  - Trailer (CRC & information)

(15)



- CRC (cyclical redundancy check)
  - CRC is a mathematical calculation that allows the receiving computer to verify whether the packet is valid.
  - Receiving host calculates its own CRC and compares it with the CRC stored in the trailer.
  - If they match, the receiving host processes the packet, if they don't it discards the packet.

Packet creation process:-

(b)

- Begins in the application layer and continues through the physical layer.

Application
↓
Presentation
↓
Session
↓
Transport
↓
Network
↓
Data link
↓
Physical → Bits (1's and 0's)

Application Data	AH
APP Data + AH	PH
APP Data + AH + PH	SH

April. Both C&D batch.

5 – 9 → Record correction & Repetition.

12 – 16 → Lab Test

AU NOTES

(7)

Circuit switching	Packet switching (Asynchronous)
① Guaranteed capacity	No guarantees (best effort)
② capacity is wasted if data is bursty	More efficient
③ Before sending data establishes a path	Send data immediately
④ All data in a single flow follow one path	Different packets might follow different paths.
⑤ No reordering; constant delay; no pkt drops	Packets may be reordered delayed, or dropped.

Chap. 00 the Internet

(4)

- Each packet is individually routed
- No time guarantee for delivery.
- No guarantee of delivery of sequence.
- No guarantee of delivery at all
  - * Things get lost
  - * Acknowledgements
  - * Retransmission
- If packet is re transmitted too soon → duplicate.

Connection oriented & Connectionless Protocol:-

- Routing control decides the route to be attempted while sending the packets of message through the N/w to the destination. It is of two ways

  (a) Virtual circuit

  (b) Datagram.

- Data gram:-
  * Packets are send independently.
  * Routers estimate about the path.

{ Explanation & Diagram }

- Virtual circuit:-
  * The path is fixed for all the packets in the data stream.
  * Virtual circuit identifier is established it is easier than sources & distination address.

{ Explanation & Diagram }

Principle of ATM N/w

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- which is used communication purpose.
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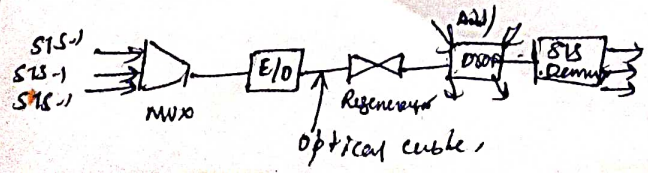
  - SMTP (e-mail)
  - FTP (File transfer protocol)
  - TELNET (Trivial file transfer protocol)
  - HTTP (world wide web)
  - DNS
- Transport level
  - TCP & UDP Diagram
- TCP Header
- Types of Services
  - (1) Header (2) current used IPV4 (3) Flag 3 bits

SONET/SDH

* high speed optical carrier
* Bellcore and std.. by ANSI
* ITU → SDH
* Advantages
  - byte multiplexing
  - sync. network
  - support digital signal hierarchy
  - flexibility
  - provides extensive operation, administrations, maintainance & provisioning func..
  - reliability, availability, universal connectivity,
  - STS-9 equal to STM 1

(1) STS multiplexer / demultiplexer
(2) Add DROP multiplexer (ADM)
(3) Regenerator,



Transmission control protocol → Reliability, complexity.

IP → No Reliability, less complexity, Speed of Communication.

Connection Oriented & connectionless protocol:-

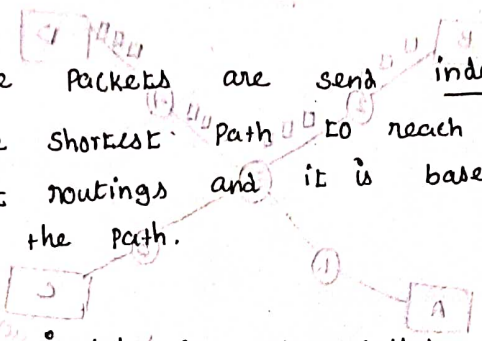
Routing control decides the route to be attempted while sending the packets, of message through the network to the destination. It is two ways:-

a) Virtual circuit

b) Datagram.

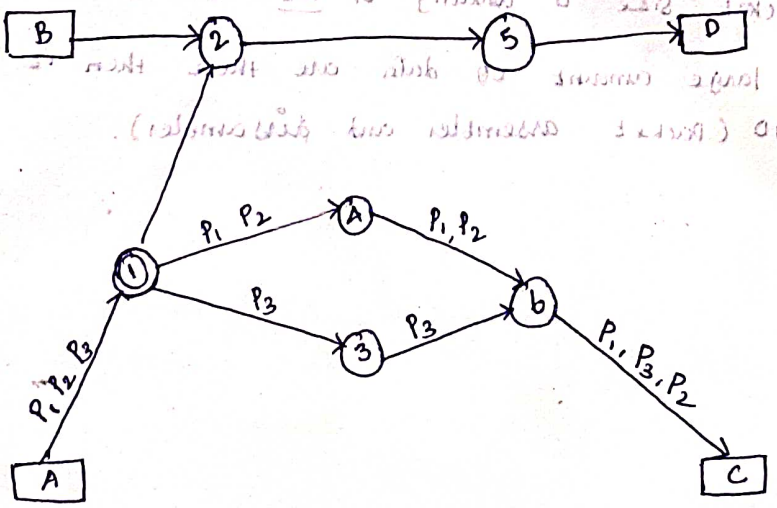
Datagram:-

* In this the packets are send independently. Then, it depends on the shortest path to reach the destination. So it has different routings and it is based on the routers estimate about the path.



* Here in this circuled one are called switching nodes which purpose is to switch from one node to another node

* The squared one are stations, it may computer terminal etc.

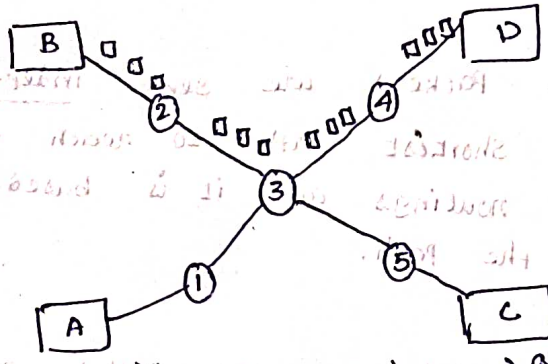


* The 3 packets of messages are send from A to C. 'A' send to node ①. Node ① finds ④ as shortest compared to 3 and send P_1 & P_2 but it is not accessible so send P_3 to node ③. Then node ③ & ④ send received packets to 'C' through Node ⑥

* Due to the different links, the packets may get reorder and 'c' is responsible for it & also it is responsible if any packet are lost during transmission.

Virtual circuit

* fixed route before the transmission.



* 'B' intended (planned) for 'D' traverses (travel (or) extend across (or) through) which the arrangement of the nodes are 2, 3, 4

* 'D' intended for 'B' traverses in which the arrangement of the nodes are 4, 3, 2

* packet size is usually of 128 bytes some times 512 bytes

* If large amount of data are there then it passes to PAD (Packet assembler and disassembler).