Transmission

↳ b/w transmitter & reciever.

(2) modes → Guided → coaxial, optical
→ Unguided → air, vaccum

- Direct link : → no intermediate device
- Point to Point : → only 2 device.
- Multi Point : → more than 2 device.

(i) Simplex : one dirn eg. TV

(ii) Half duplex : either dirn (but) only one way at a time.
eg. Police radio / walkie-Talkie

(iii) Full duplex : both dirn at same time.
eg. Telephone.

Ryx

Analog signal → varies in smooth (way) over time

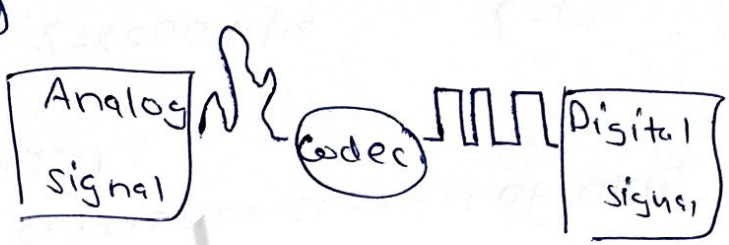
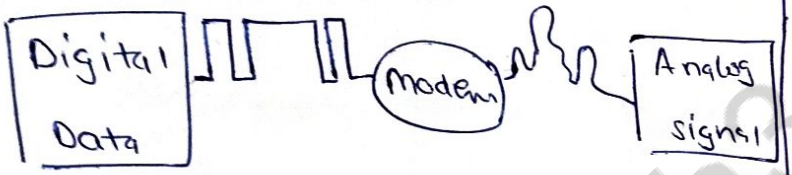
Digital signal → maintain const. level & changes to another const. level

Periodic signal → pattern repeated over time

Aperiodic signal → pattern not repeated over time.

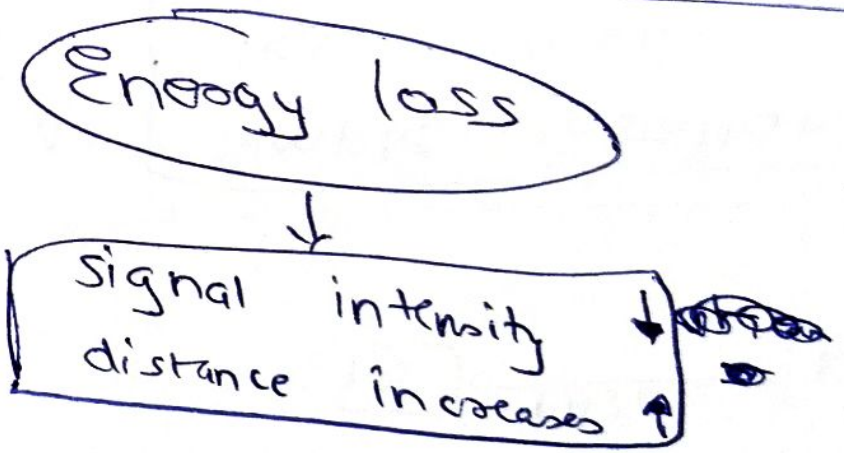
sine wave : Peak Amplitude → max. strength (A)
frequency (f) → cycles per second ($1/T$)
phase (ϕ) → relative posi. in time.

Audio Signal : f : 20Hz - 20kHz
↳ easily converted into electromagnetic signals.

Analog Signals	Digital Signals
(1) Represent data with continuously varying electromagnetic wave	(1) Represent data with sequence of voltage pulses.
(2) 	(2) 
(3) 	(3) 
(4) Denoted by sine wave	(4) Denoted by square waves
(5) Human voice in air, analog electronic devices.	(5) Computers, CD DVD's
(6) Not flexible	(6) Is flexible.
(7) Stored in wave signals	(7) Stored in binary bit
(8) Low cost & portable	(8) High cost & not portable
(9) Can have Errors	(9) No Errors.

Transmission media:

① Attenuation:



② Distortion: Signal form is changed

③ Noise: Unwanted signal produces noise.

Ryx

Nyquist theorem:

For a noiseless channel

$$C = 2B \log_2 L$$

where C = Capacity in bits/second
B = Bandwidth in hertz

lets say, A bandwidth of 3000 Hz is transmitting a signal with 2 signal levels. Max bit rate = ??

B = 3000 Hz
L = 2

$\therefore C = 2B \log_2 L$

$= 2(3000) \times \log_2 2$

$= 2(3000) =$ 6000 bps

Q.2 We send a 256 kbps over a noiseless channel of 20 kHz what/how many signals required.

C = 256 kbps = 256000 bps
B = 20 kHz = 20,000 Hz
L = (??)

$\therefore C = 2B \log_2 L$

$$256000 = 2(20,000) \times \log_2 L$$

$$\log_2 L = \frac{256000}{40,000}$$

$$\log_2 L = 6.4$$

$$L = 2^{6.4} = \boxed{84.448 \text{ Level}}$$

Shannon Theorem:

Shannon Thom gives Capacity of system in presence of noise.

$$C = B \log_2 (1 + SNR)$$

; SNR = signal to Noise Ratio

When extreme noise → SNR = 0

i.e $C = B \log_2 (1+0)$

$\therefore C = B \log_2 (1)$

$\therefore C = B \times 0$

$\therefore C = 0$

The shannon capacity gives us the upper limit whereas the Nyquist formula tells us how many signal levels we need.

Ryx

we have a channel with 1MHz bandwidth. SNR is 63. what is appropriate bit rate & signal level.

$SNR = 63$ $\quad B = 1MHz = 10^6 Hz$

$C = ?$

$$C = B \log_2 (1 + SNR)$$

$$\therefore C = 10^6 \log_2 (1+63)$$

$$\therefore C = 10^6 \log_2 (64)$$

$$\therefore \boxed{C = 6Mbps}$$

Final no. of signals two

$$C = 2B \log_2 L$$

$$6 = 2 \times 1 \log_2 L$$

$$\frac{6}{2} = \log_2 L$$

$$3 = \log_2 L \quad \therefore L = 2^3 = \boxed{8}$$

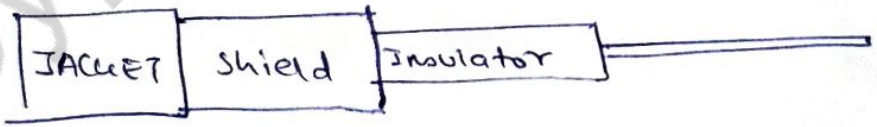
Twisted pair:

- frequency: 0 – 3.5 kHz
- lightweight cable
- easy to mount

A: cheap & easy to install
high speed

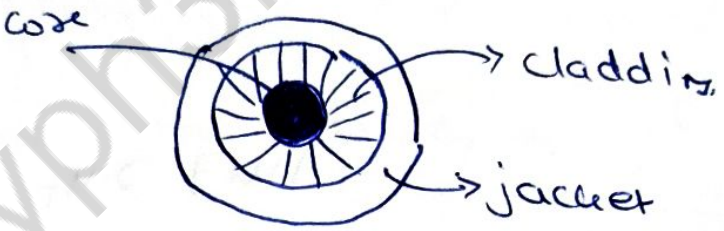
D: only used in short distances

Coaxial:



- frequently used in media.
- higher frequency.
- copper is inner conductor of coaxial cable & a coaxial mesh is the outer conductor.
- middle core is responsible of transmitting the data while copper mesh prevents the EMI

Fibre optic:

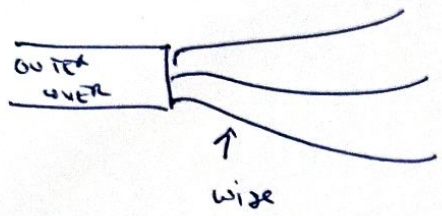


→ Consist of plastic coated fibre that transmits the data through light tubes.

→ provides faster data than wires

→ plastic layer avoids heat, cold, EMI of optical fibres.

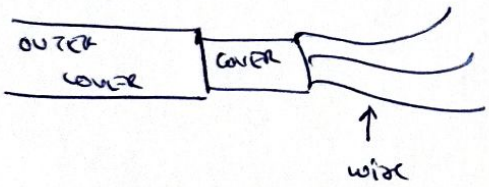
Unshielded Twisted Pair (UTP)



- ordinary wire of telephone
- cheapest
- easy to install

Disad. → suffers from external interference

Shielded Twisted Pair (STP)

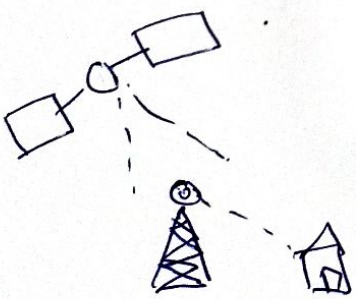


- metal braid
- expensive
- hard to handle.

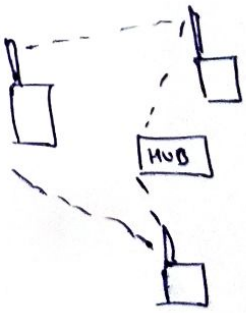
Unguided Media :

(1) Microwave.

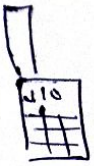
(2) Satellite:



(3) Radio waves:



(4) Infrared:



VLAN : (Virtual LAN)

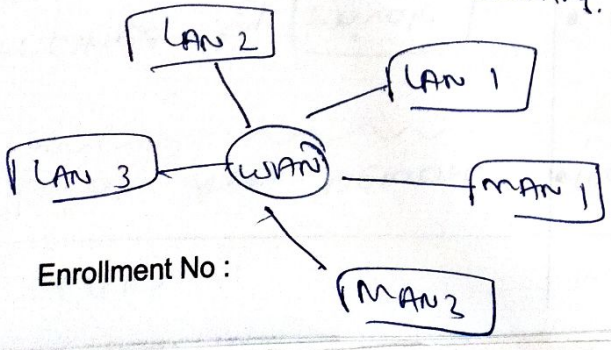
- logical network
- group of host with common set of requirements that communicates regardless of their physical location.
- same as LAN but allows end station for grouping together even if they are not located on same network.
- VLAN can change or add workstation
- mangge load allocation and band allocation.

MAN : (Metropolitan Area Network)

- MAN covers larger area than LAN but smaller than WAN.
- Transmission is moderate.
- interconnection of several local area network (LAN)

WAN : (Wide Area Network)

- Speed lower than LAN
- different LAN and MAN are connected together.
- located in state or country.



LAN : (Local Area Network)

Wired LAN: hardware grouping with physical inter-connection.

Wireless LAN: Communication w/o use of cables or wires but with Infrared, radio & microwave

LAN	MAN	WAN
• Local Area Network	• Metropolitan Area Network	• Wide Area Network
• owned by private organization	• owned by private or public	• owned by private or public
• speed is very high	• speed is average	• speed is lower than LAN.
• Network delay is short	• Network delay is moderate	• Network delay is longer
• maintenance is easy & less costly than WAN	• maintenance is complex & costly than LAN	• maintenance is very complex & very costly than LAN & MAN

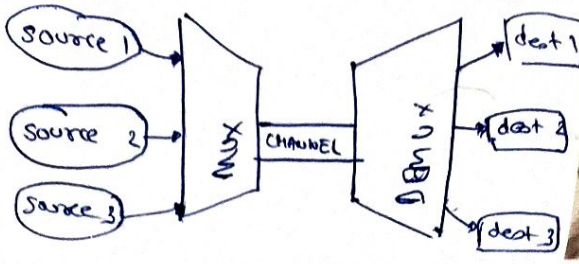
Multiplexing → multiple signals at one time

→ combines multiple signal → one signal

→ Muxing

Coaxial cable or optical fiber

eg.

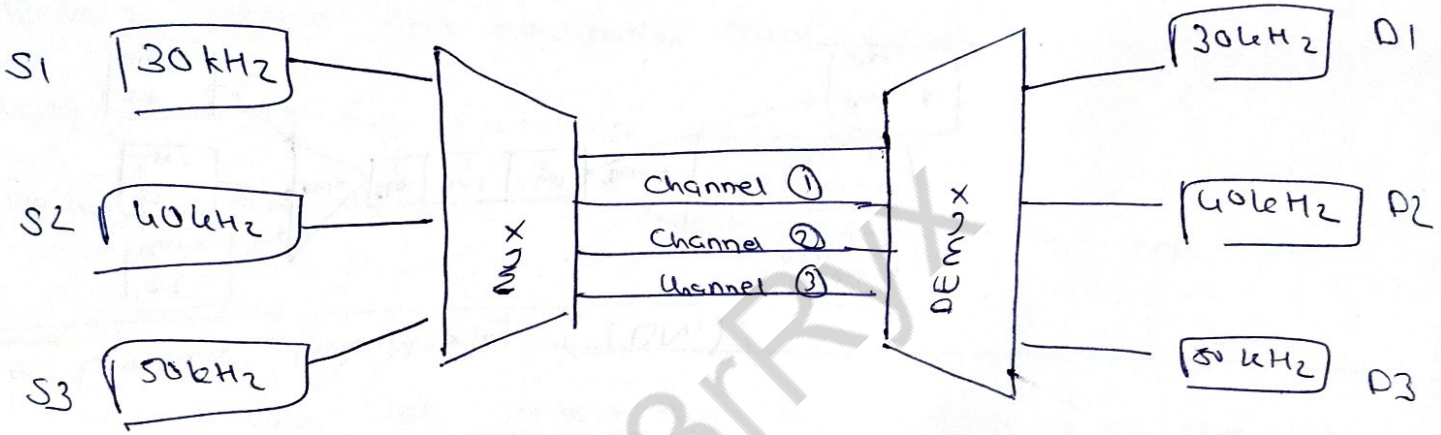


Annexure No :

Faequency divisian multiplexing (FDM):

Signals of different frequencies → Multiplexer → Multiplexed signals are separated by using demultiplexer

Multiplexer ⇓ Send signals over communication channel

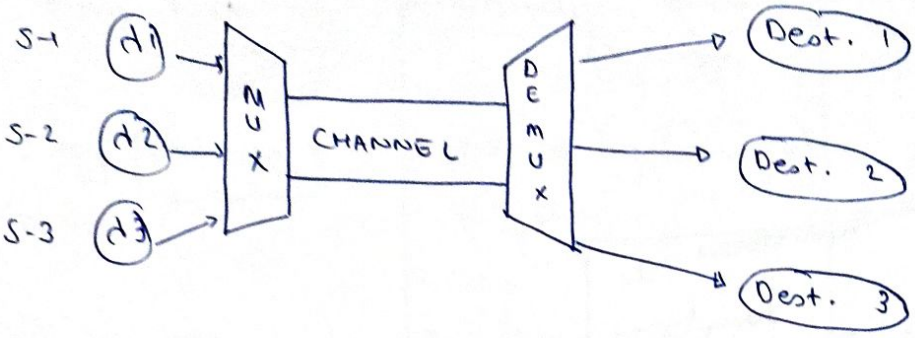


A: Multiple signals at same time.
Demodulation is ez
no need of synchronization

D: needs a large bandwidth communication channel

Application: FM or AM
Telephone
TV broadcasting

Wavelength Division multiplexing (WDM):

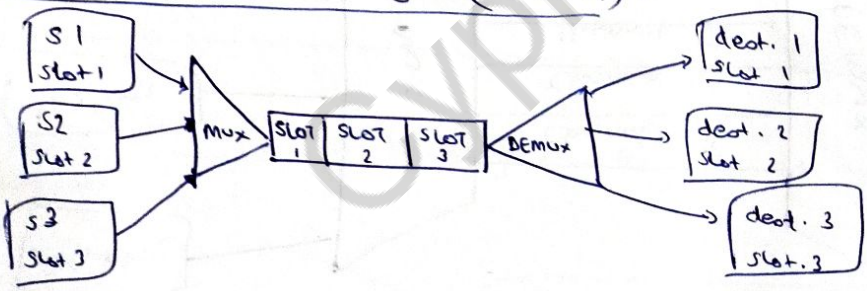


WDM is same as FDM but instead different wavelength are multiplexed into same channel than different frequencies.

A.

- High security,
- Low cost,
- long distance communication,
- Great transmission capacity

Time Division Multiplexing (TDM):



All signals are not transmitted simultaneously, instead they are transmitted one after another.

First we send signal (1) then signal (2) then signal (3) then each user occupies an entire bandwidth for short period of time.

Annexure No :

Switching Techniques:

(1) Circuit switching:
- dedicated path for sender & reciever
- that path remains till connection is terminated

Advantage:
- fixed bandwidth
- communication channel is dedicated

Disadvantage: Expensive & inefficient.

(2) Message switching: it uses nodes to transfer the entire message. message is transferred as a complete unit and routed through intermediate nodes.

Advantage:
- Traffic congestion is reduced
- message priority can be used to manage network.

Disadvantage:
- Long delay
- message switches must have sufficient storage.

(3) PACKET SWITCHING:
- message is split in small pieces and is sent in one go.
- packet travels across the network, taking the shortest path possible.
- one all packets are sent, acknowledgement is recieved.

A: Reliable, efficient, cost effective

D: requires low delay & high quality service ⟶ loss of critical information ⟶ highly complex

Ckt switching	Packet switching
(1) has dedicated path.	(1) donot have dedicated path.
(2) fixed bandwidth	(2) dynamic bandwidth
(3) delay is uniform.	(3) delay is not uniform.
(4) wastage of resource	(4) less wastage of resource.
(5) not a store and forward technique.	(5) is a store and forward technique.
(6) not efficient.	(6) efficient.
(7) connection oriented	(7) not connection oriented

Comparison

Circuit Switching	Datagram Packet Switching	Virtual Circuit Packet Switching
Dedicated transmission path	No dedicated path	No dedicated path
Continuous transmission of data	Transmission of packets	Transmission of packets
Fast enough for interactive	Fast enough for interactive	Fast enough for interactive
Messages are not stored	Packets may be stored until delivered	Packets stored until delivered
The path is established for entire conversation	Route established for each packet	Route established for entire conversation
Call setup delay; negligible transmission delay	Packet transmission delay	Call setup delay; packet transmission delay
Busy signal if called party busy	Sender may be notified if packet not delivered	Sender notified of connection denial
Overload may block call setup; no delay for established calls	Overload increases packet delay	Overload may block call setup; increases packet delay
Electromechanical or computerized switching nodes	Small switching nodes	Small switching nodes
User responsible for message loss protection	Network may be responsible for individual packets	Network may be responsible for packet sequences
Usually no speed or code conversion	Speed and code conversion	Speed and code conversion
Fixed bandwidth	Dynamic use of bandwidth	Dynamic use of bandwidth
No overhead bits after call setup	Overhead bits in each packet	Overhead bits in each packet

Image Source: google.com

RYX :-
Ryv

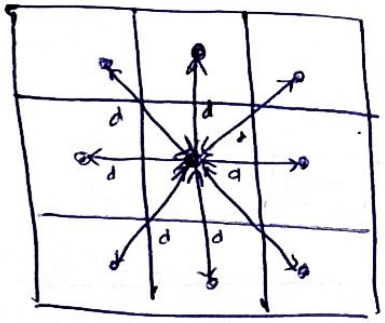
Principles of cellular networks:

Cellular Technology → supports users in location that are not easily served by wired networks.

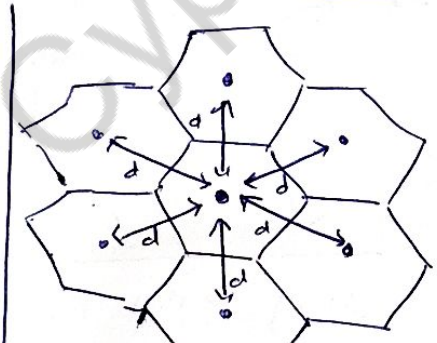
foundation of mobile wireless comms

→ underlying tech for → mobile, wifi, personal comms system.

→ for mobile radio to replace high power Transmitter reciever. Low Power.



square



Hexagon

→ equidistant antennas

→ distant beth centers of cell radius R is "R".

↳ not ideal geometry.

↳ all adjacent antennas equidistant.

↳ each cell has (4) neighbour at distance "d"

Frequency Reuse:

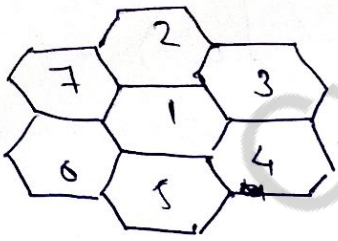
↳ concept of using the same radio frequencies within a given area, separated by considerable distance.

Benifits:

(i) use same frequency for multible convos.

(ii) allows reuse of frequencies in nearby cells.

(iii) limits power escaping.



N = cells all using same no. of frequencies.

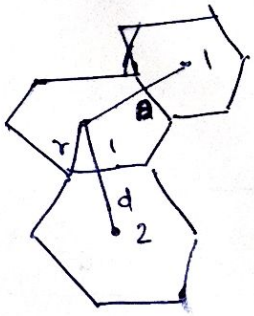
Frequency = ?

here let K = 395 KHz

$f = K/N$

$= \frac{395}{7} = 57 \text{ kHz}.$

K = total no. of frequencies used in systems.



r = radius of cell

d = distance betn adjacent cells

D = Min. distance betn 2 same frequencies.

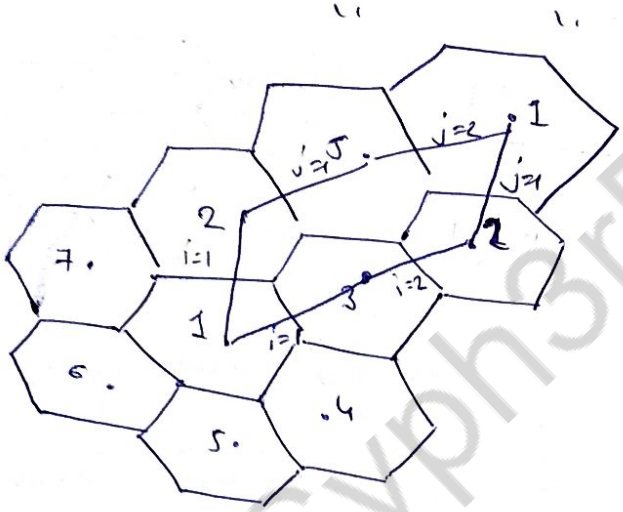
Cluster size:

$$N = I^2 + J^2 + (I \times J)$$

N = no. of cell with repeated frequency

I = no of steps required to move in one dirn in order to reach cells with same frequency

J = ''



'' in other dirn

I = 1 or I = 2

J = 2 J = 1

∴ let I = 1 & J = 2

$N = I^2 + J^2 + (I \times J)$

$= (1)^2 + (2)^2 + (1 \times 2)$

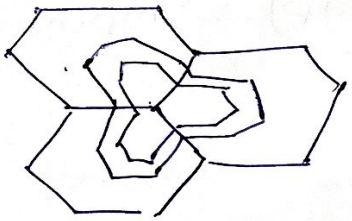
$= (5) + (2) = \boxed{7}$

To maintain the capacity / demand we need to increase the no. of channels.

By. (1) cell splitting
(2) cell sectoring
(3) Coverage zone approaches.

→ ways.

1) Cell splitting



↳ subdividing a congested cell into the smaller cells

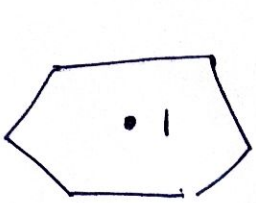
↳ increases the capacity because additional channels per unit area is included.

Eg.

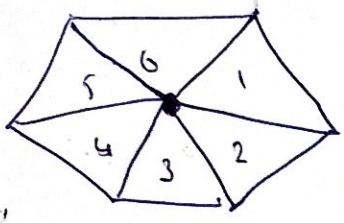
Towers for mobiles are divided into regions

→ reduced power levels from original cell.

Cell sectoring:



Before



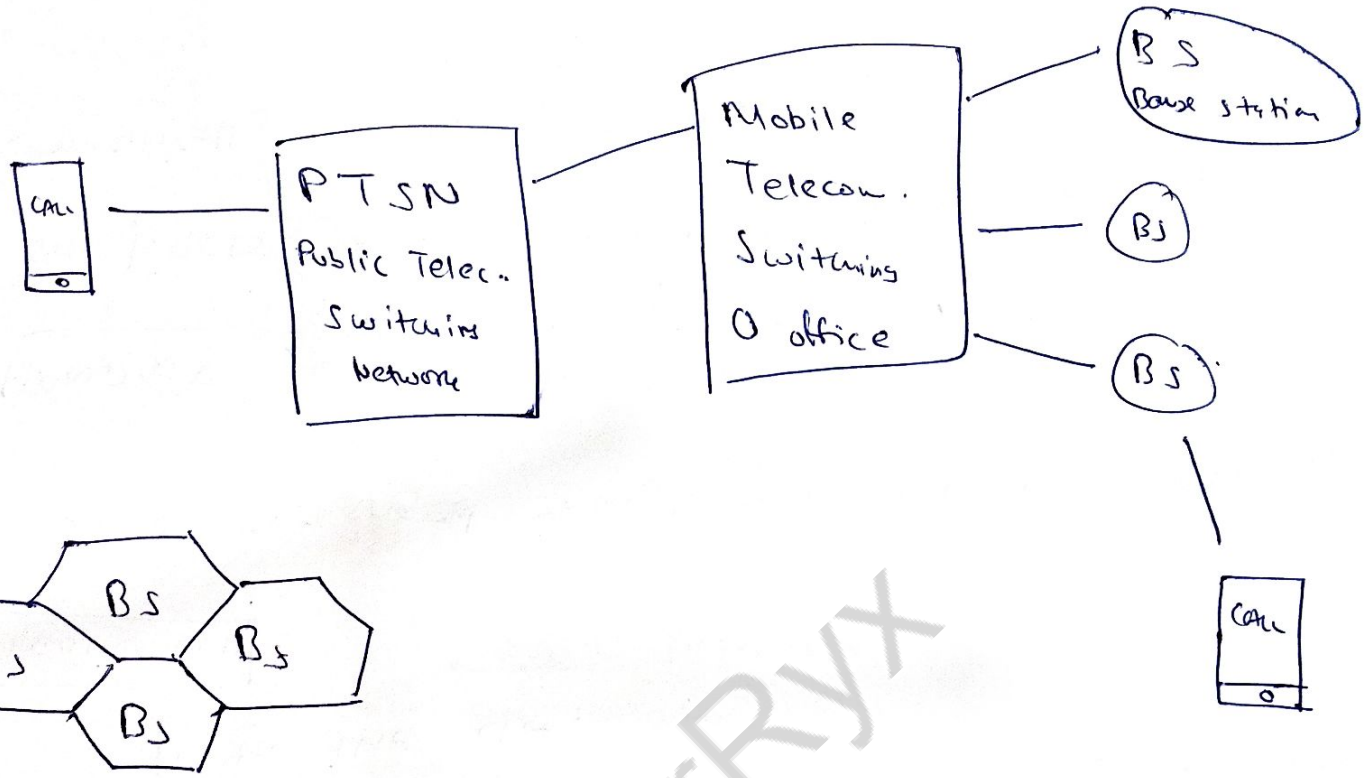
After

Omnidirectional antenna at each 60° opening.

↳ less expensive than cell splitting

cell splitting	cell sectoring
(1) Divided into smaller base.	(1) sectored at 60° angle
(2) has co-channel interference	(2) No cochannel interference
(3) Radius = decreased	(3) Radius = same
(4) large cell dedicated for high speed traffic	(4) sectors are all of same size
(5) No. of handoff reduced.	(5) No. of handoff increased

Annexure No :



(1) Mobile ⟶ ON

(2) SCAN & SELECT ⟶ STRONG BS

(3) HAndshake betn MTSO & Mobile via BS

Call Process:

(S-1) CALL Initialized.

(i) Check ⟶ Channel free or not.

(ii) Send no. to BS

(iii) BS will send req. to MTSO.

② PAGING :

(i) MTSO connects to mobile

(ii) Paging sms sent to BS

(iii) Paging signal transmitted to setup channel

③ Call Accepted

(i) Mobile recognize the no.

(ii) Responds to BS ⟶ sends response ⟶ MTSO

(iii) MTSO sets up ckt. betn 2 BS.

(iv) MTSO select the traffic channel & allocate it to the ckt.

④ Ongoing Call:

↳ voice exchanged through respective BS & MTSO.

HANDOFF

if one party goes out of range of selected BS then automatically new BS is selected,

Generations:

(1G) → 1st Gen.

- **Analog** radio signal ~~~~~
- **Basic** voice service.
- Speed → **1 - 2 kBps**
- 32 bit serial no. & 10 digit phone no.

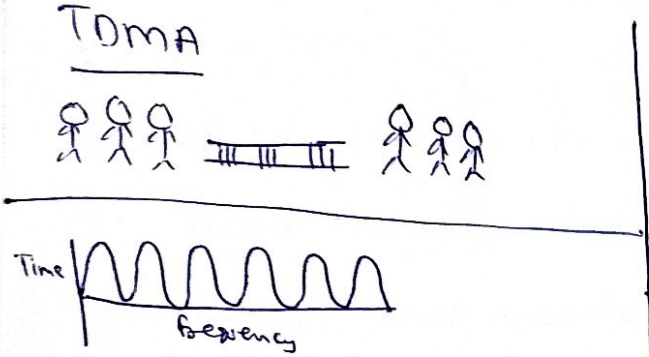
Disad.	Advs.
→ no encryption	→ ckt switching
→ poor sound	→ FM (frequency modulation)
→ no internet	→ cell radius → 2-20km.

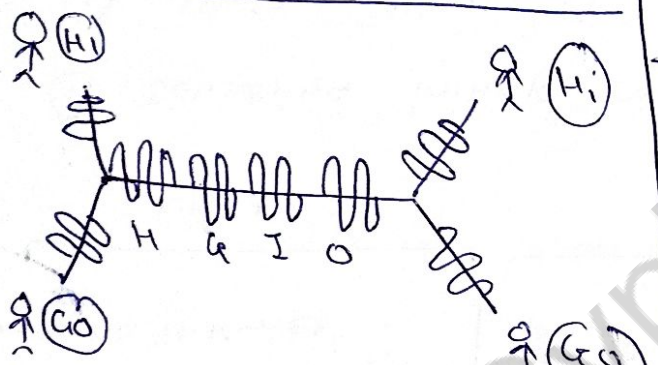
(1) Subscriber initiate call
(2) MTSO validates it
(3) MTSO issues message → traffic channel
(4) MTSO sends ringing → other party
(5) MTSO establish ckt & initiate comms.
(6) One party dc → release ckt → makes bill.

— CALL Process for 1G.

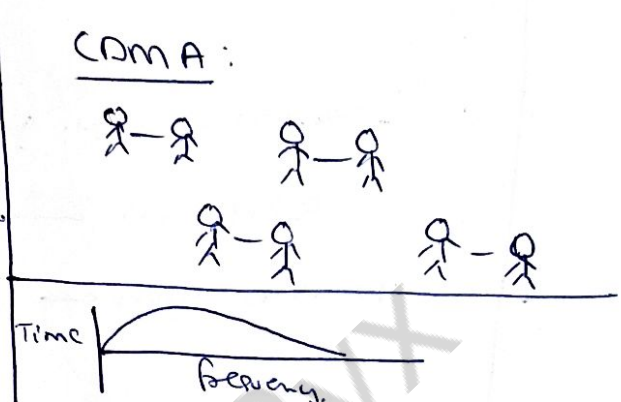
2G :→ TDMA
→ CDMA

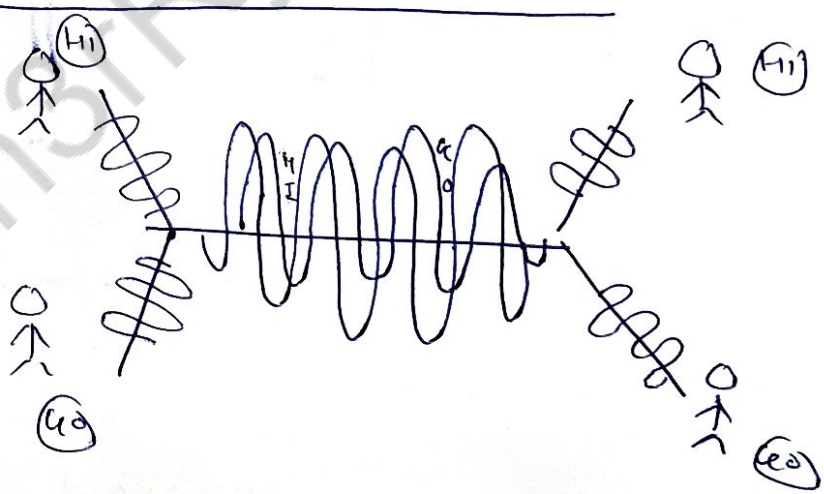
TDMA





CDMA:



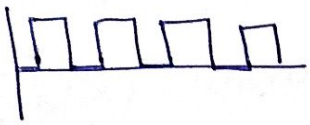


2nd gen TDMA:

Time Division Multible Access.

TDMA :

- Users have to share same frequency without interference.



- Digital mobile radio system.
- Divides signals into timeslots & increases the data carrying capacity.

Adv.

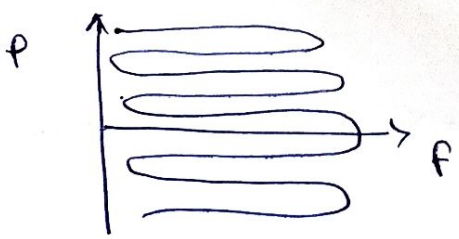
1. Flexible rates
2. variable traffic
3. frame by frame
4. no. of slots can be changed

Disadv.

1. complex
2. energy consumption = high
3. inaccuracies
4. synchronization required

CDMA :

- Shared code
- every channel uses full available spectrum.
- better voice
- digital data
- encrypted data



Adv.

1. high quality
2. Flexible
3. not decodable
4. no synchronization req.
5. low power level

Disad.

1. no international roaming
2. stored in phone memory
3. performace degrades with increase users.

3rd Gen:

- 2000 year
- ckt & packet switching
- high speed
- low investment

- 5 -10 mbps
- 15 -25 GHz
- high security

- cost = high
- cost of 3G licence = high

GSM → Global System for mobile comm.

GSM	CDMA
(1) Global system for mobile comms.	(1) Code division multible Access
(2) TDMA & FDMA	(2) only CDMA
(3) High speed = (42mBPS)	(3) High speed = 3.6MBPS
(4) (3G)	(4) (2G)
(5) Stored in (SIM)	(5) stored in (Phone)
(6) Global market share = 75%	(6) Global share = 25%.
(7) Support international roaming.	(7) Donot support international roaming.

Antenna

- electrical conductor

Transmission : (i) radiates electromagnetic energy into space.

radio frequency → convert → electromagnetic energy → via Antenna → air

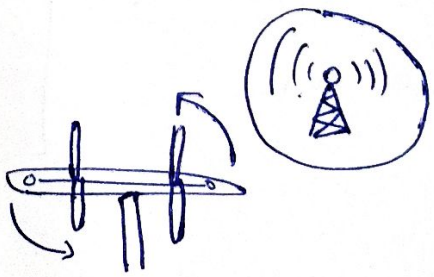
Reception : (i) collects electromagnetic energy from space

" vice versa of above "

2 type of Antenna:

1. isotropic → radiate power equally in all dirs.
2. dipole → used to calculate the gain of antennas.

Hertz
Marconi
} Antennas



Hertz : length = $\lambda/2$

Antenna gain — Effective area

Ae

(G)

$$\therefore \boxed{G = \frac{4\pi A_e}{\lambda^2}} \quad \text{or} \quad \boxed{G = \frac{4\pi A_e f^2}{c^2}}$$

i.e $\lambda = c/f$

Isotropic : G = (1)

Dipole : G = (1.5)

Propagation mode: Propagation in form of electromagnetic waves

1. Ground wave
2. Sky wave
3. Line of sight

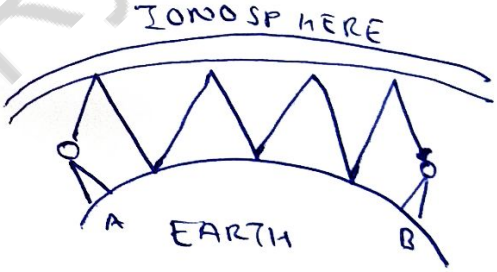
(1) Ground wave :

- EM wave remains close to earth.
- follows curvature.
- 30kHz and 3MHz : Range
- while passing, ground waves induces current to it : looses some energy

(2) Sky wave :

- signals reflected from ionosphere.
- travels a no. of hops - back & forth
- reflection is caused by refraction.

eg. Car radio → range is high.



(3) Line of sight wave :

- min. distance b/w A & B
- travels till the vision of naked eye
- signal >30MHz is not reflected back
- Antenna within effective LOS works.
- need amplifier.

eg. Microwave & infrared.

Ryx

1. Attenuation : Strength falls off with distance.
2. free space loss : loss of signal w/ distance
3. Noise : unwanted signals
4. Refraction : bending signal away from reciever
5. multipath : multiple interfering signals
6. Absorption : oxygen, vapour & water absorbs signals

Modulation :

↳ Shifting of [baseband signal] — [pass band signal] range.

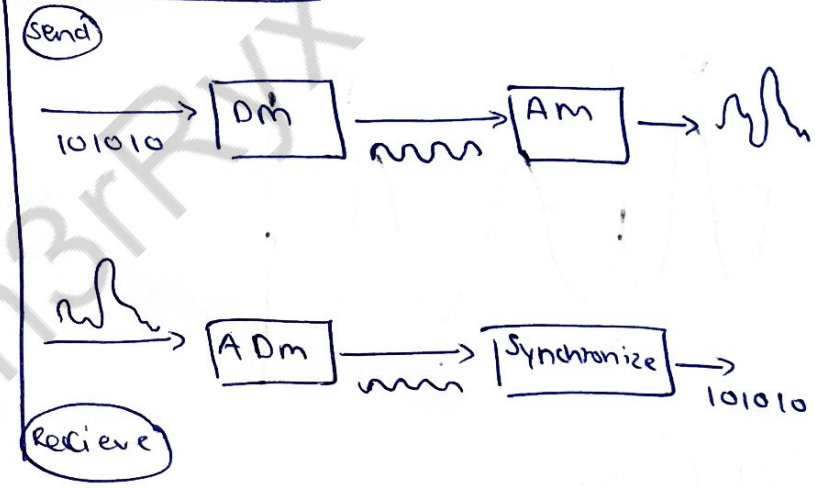
Demodulation :

↳ shifting of [pass band signal] — [baseband freq.] range.

Encoding :

1. Analog – Analog
2. Analog – Digital
3. Digital – Analog
4. Digital – Digital

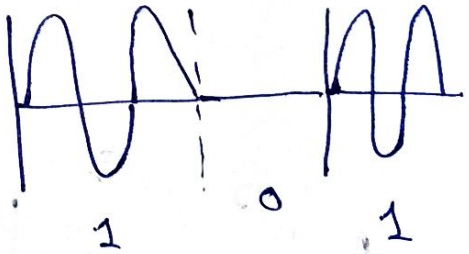
Modulation : (Radio wave)



Digital – Analog Modulation :

Amplitude Shift keying (ASK)

↳ 2 binary value ⟶ 2 amplitudes



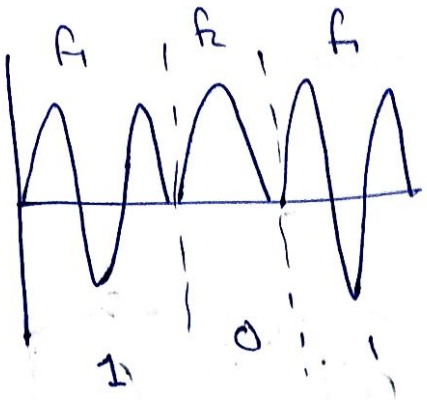
↳ susceptible to interference.

↳ (low bandwidth) requirement.

↳ Not used for wireless radio ⟶ used in wired network (Optical)

Ryx

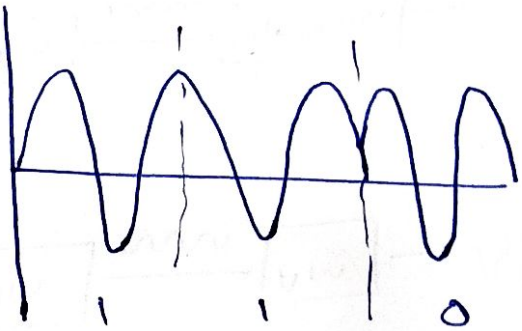
FSK: frequency shift keying



- 2 binary value ⟶ 2 diff. frequency
  - f1 → 0 & f2 → 1
- need (larger) bandwidth.
- less susceptible to errors.

implementation by: switching b/w 2 oscillators, one w/ f1 & other w/ f2.

PSK: Phase shift keying



- more (complex)
- just opposite phases / freeform signals for 2 values
- robust against interfesence

ANALOG — ANALOG

Modulation is needed iff bandpass in nature or iff bandpass channel is available.

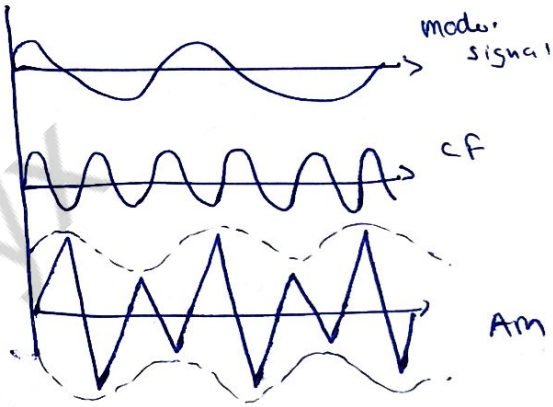
Types :

(1) Amplitude modulation :

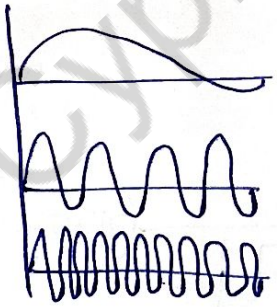
↳ carrier signal modulated → Amplitude value.

↳ modulating signal → envelope of carrier.

Required bandwidth = $2B_k$ ← bandwidth of modulating signal



(2) Frequency modulation :

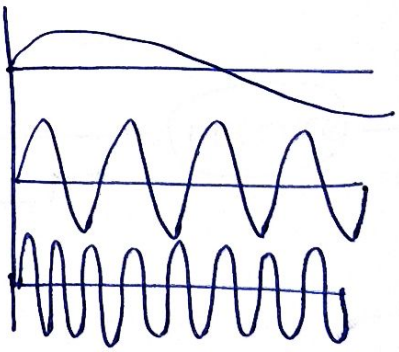


↳ Bandwidth is (high).

↳ 10x of signal frequency.

↳ modulating signal ↓ (change) fc of carrier signal

(3) Phase modulation :



↳ modulating signal → change → Phase of CS

↳ bandwidth is higher than for (Am).

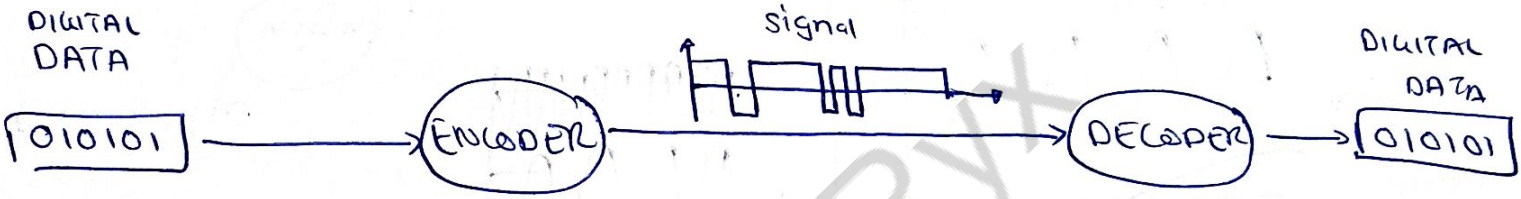
Digital – Digital conversion:

① Line coding:

↳ converting 1's & 0's into **sequence of signals.**

High voltage = +V or 1

low voltage = −V or 0

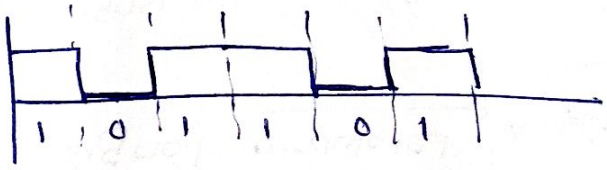


DATA SIGNAL Mapping:

1 ⟶ +V

0 ⟶ −V

UNIPOLAR: All signals are either above or below.



NRZ

↓ ↓ ↘

non return to zero

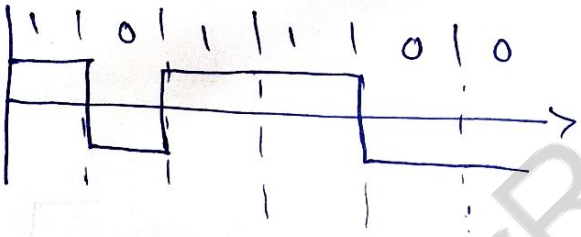
POLAR NRZ : voltages are on both sides of the time axis.

+V → 1

−V → 0

2 version: **NRZ-L (NRZ-level)** : +ve voltage → one signal

−ve voltage → one signal



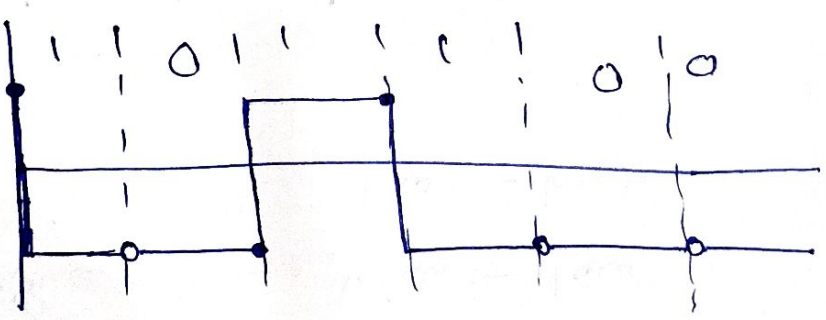
NRZ-I (NRZ-inversion) : "1" inverts the polarity

"0" dont " " "

means jya jya one ave ethe signal change kari deyase.

eg. 1011000 : Upar NRZ-L no reference.

NRZ-(I)



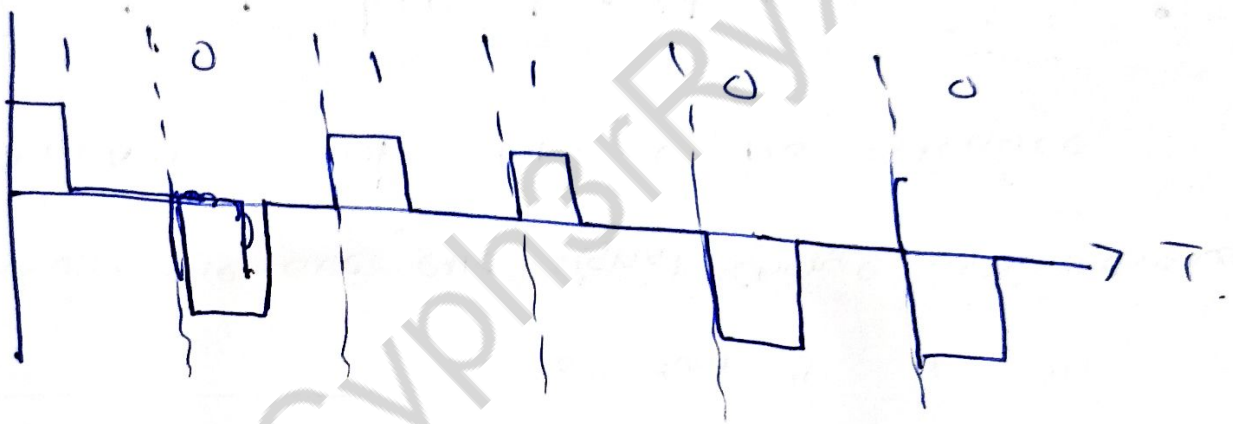
• → Change the phase

0 → dont change the phase.

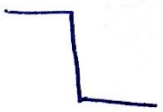
jya "one" ave ethe phase change baki chalya do

Polar RZ : Return to Zero

- 3 value +, 0, −
- each symbol has transition in middle
  - (1) either from high → low
  - (2) " " low → high
- complex.



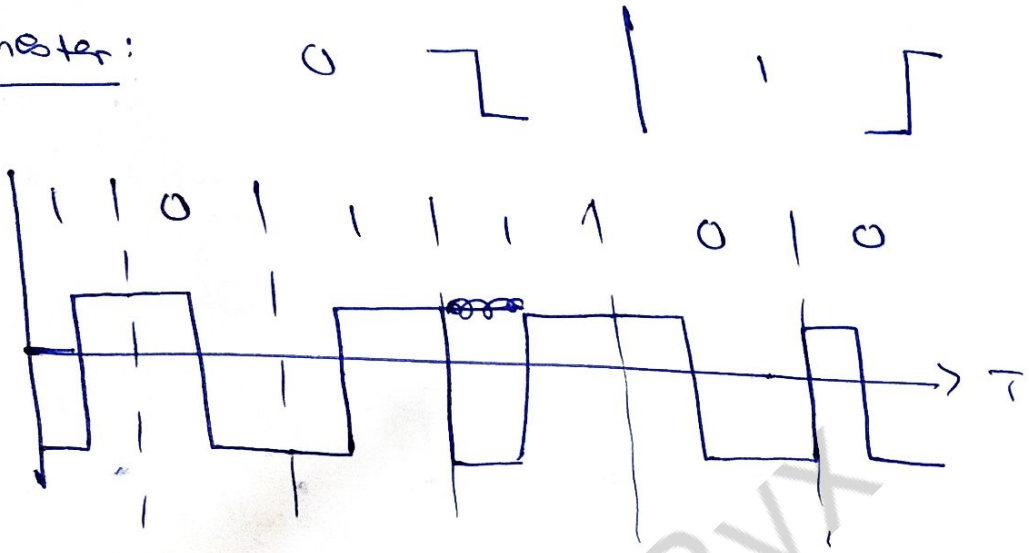
for 1



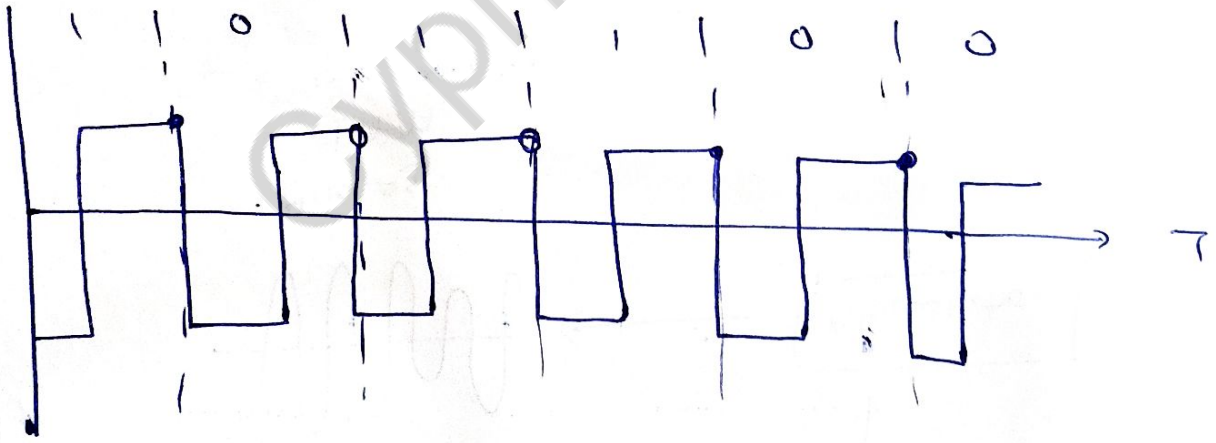
for 0

Polar Biphase:

Manchester:



Differential: 0 ⟶ next bit is 1 ●⟶ next bit is 0



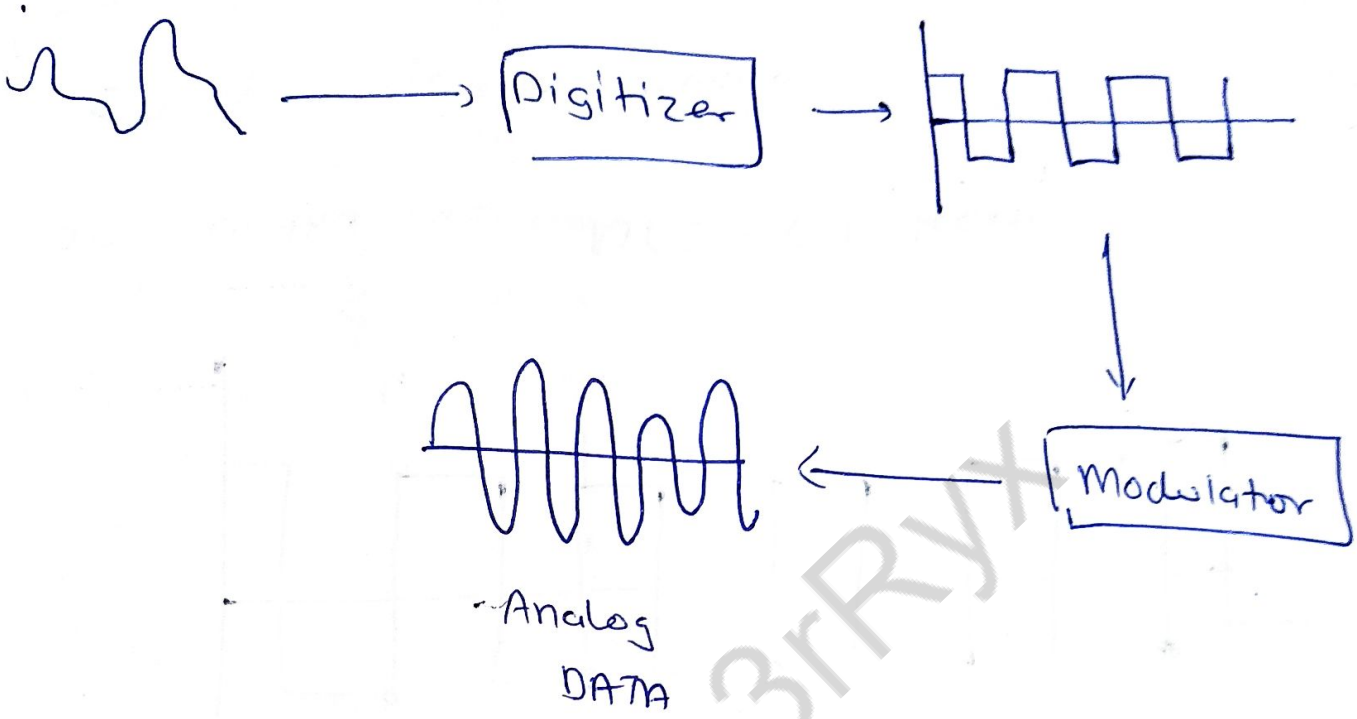
aa undhu che NRZ-(I) karta.

"1" ma change nai levano

"0" ma change lavano.

Ryx

Analog to Digital



Annexure No :

SPREAD SPECTRUM :

In wireless conventional communication,

"A fixed frequency is used & this frequency doesn't change over time"

eg. 93.5 FM & 98.3 FM will always transmit the radio wave on those selected frequencies only.

Problem:

(i) **interference** :

When another signal → transmitted → on very near frequency

eg. 98.3 FM & 99.1 FM can collide.

(ii) **interception** :

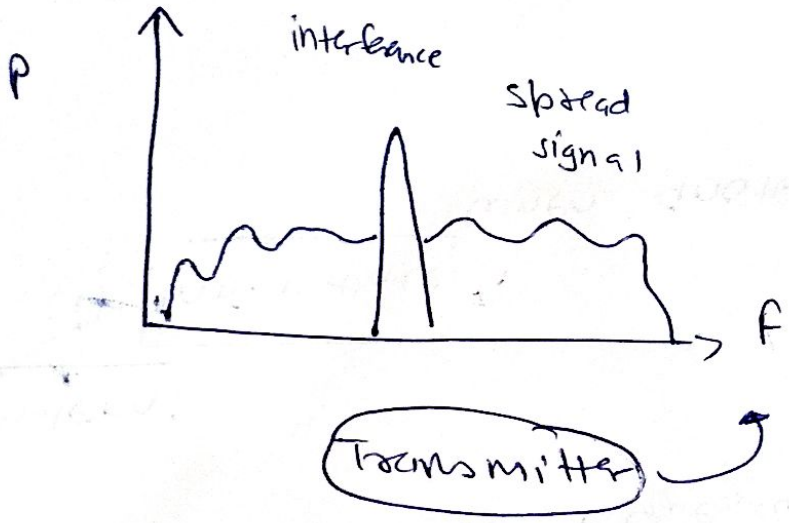
A middleman listening to the frequency

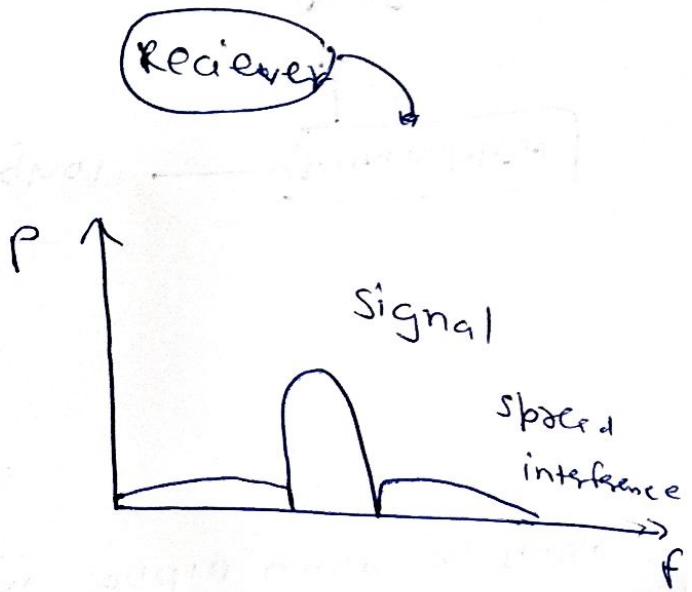
Soln is **SPREAD SPECTRUM TECH**

↳ Spread [narrow band] → [broad band] using special code.

↳ expansion

↳ spread data signal on frequency spectrum.





Annexure No :

Type :

① FHSS : frequency hoping Spread spectrum

eg. WLAN

SPACE Application.

↳ multiple frequency ⟶ transmit data

↳ freq. periodically modified following a special sequence

↓

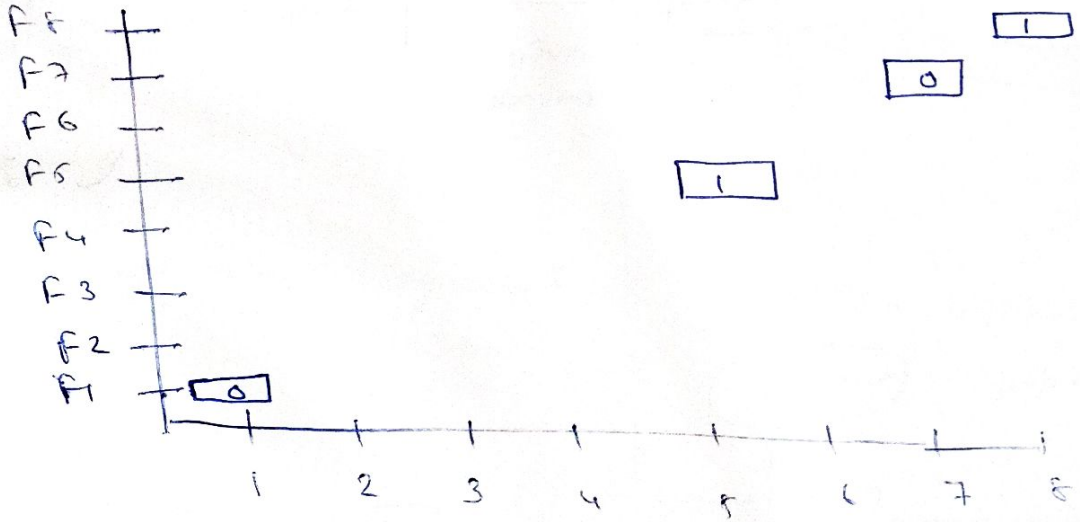
hoping sequence

Amount of time spent on each frequency

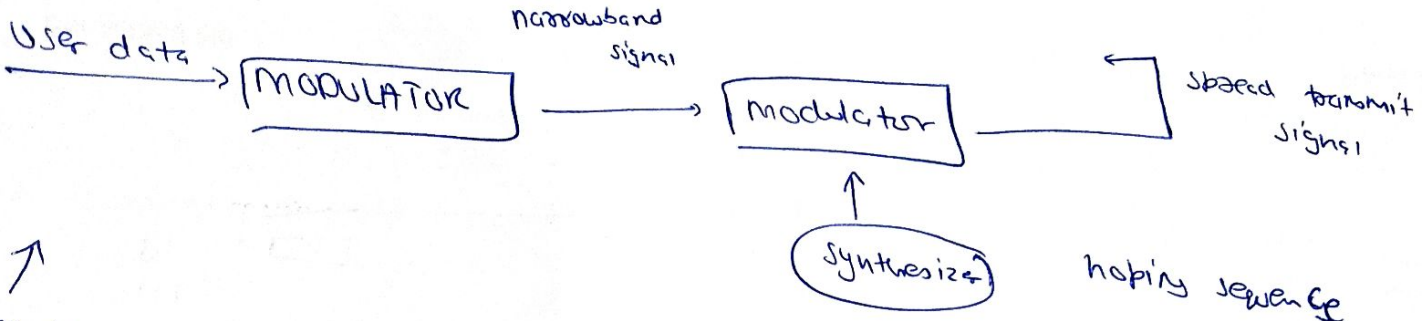
↳ "dwell time"

User "A" wanna sent 0101 to B

so., let say hoping sequence of A is. f1, f5, f7, f8

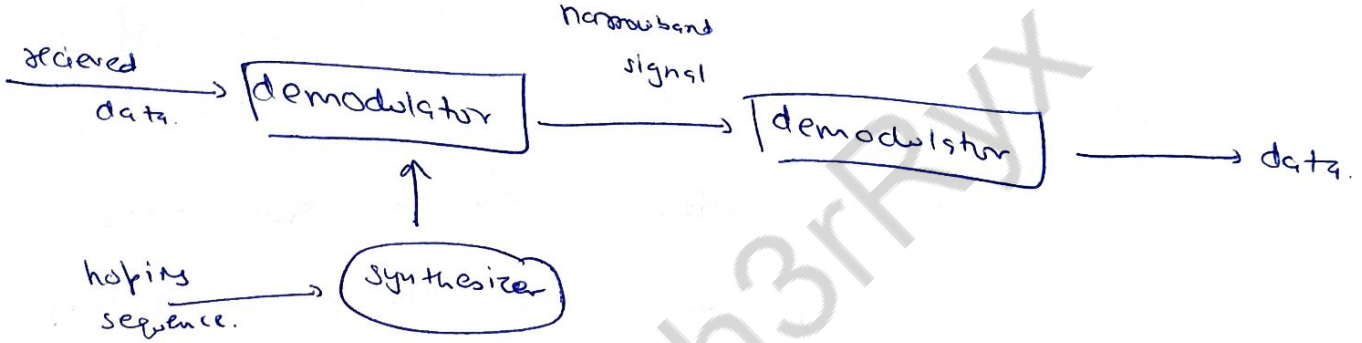


Ryx



Sender

Reciever



Advantage:

(1) Resistance from interference & interception

(2) multipath propagation

Disadvantages:

(1) more difficult to synchronize

(2) High latency.

(2)

Annexure No :

DSSS : Direct sequence spread spectrum.

↳ every user is assigned a **code**

↓

encode → (signal)

Code

↳ multiplied with (M) → [Result] → transmitted

Reciever

↳ use **same code** → decode [M]

Eg. 010111

Here 0 is represented via −1

∴ (−1, 1, −1, 1, 1, 1) ⇒ [spreading code]

Adv.

(1) Resistant from interference & interception

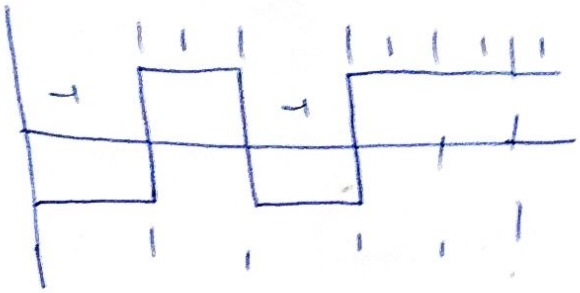
(2) More reliable

Disad.

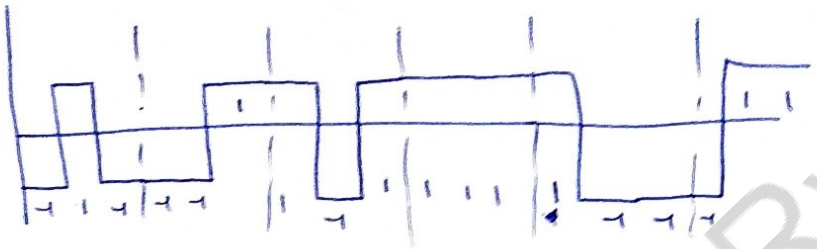
(1) Design is hard.

Ryx

eg. (-1, 1, -1, 1, 1, 1)



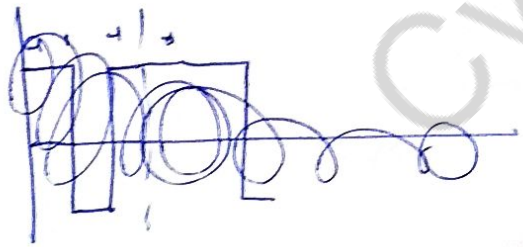
Low bandwidth

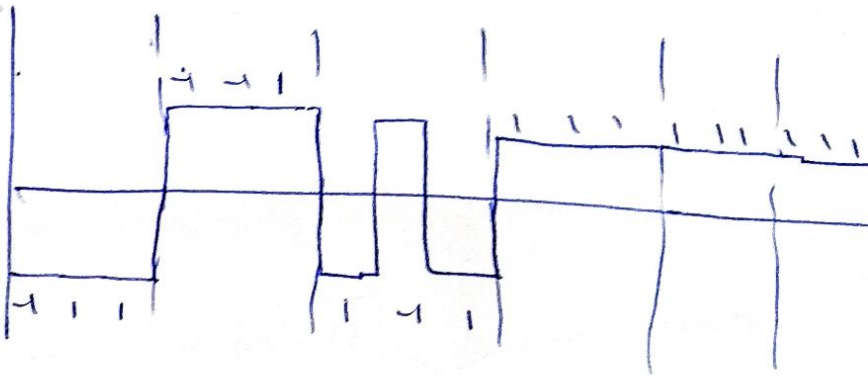


high bandwidth

Now multiply (1 x 1 => same

1 x -1 => Opposite)



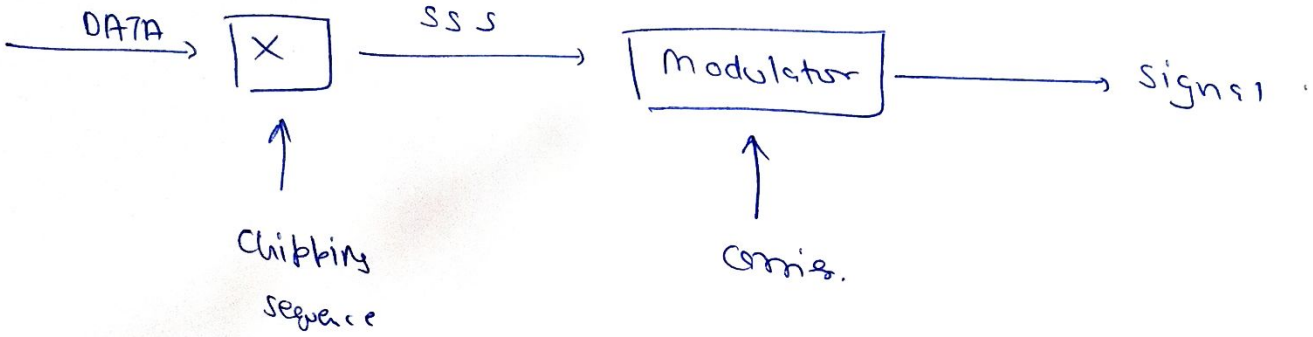


for decoding

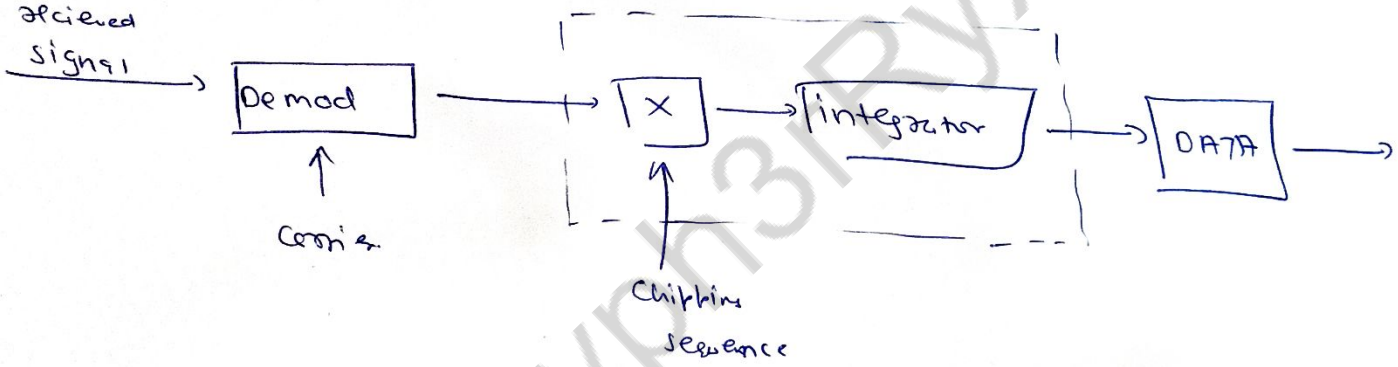
send the result and the high bandwidth &

multiply => Low bandwidth

SENDER:



RECIEVER:



For Part - II... Click Here!

For more study notes:
CYPH3RRYX