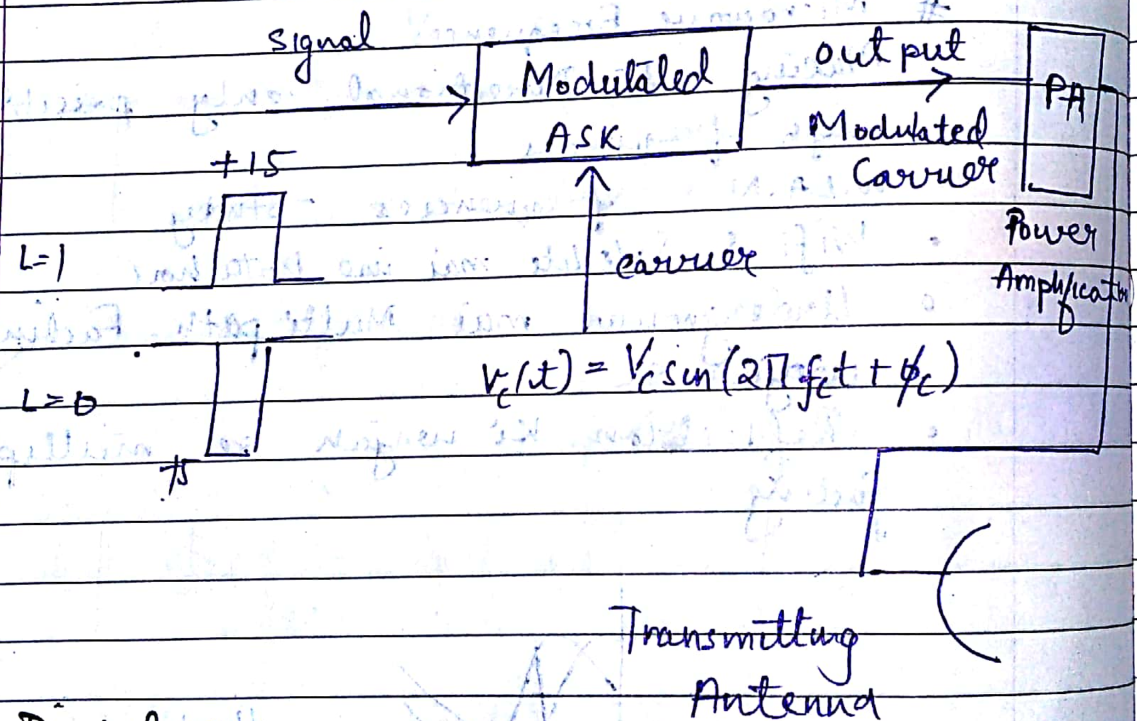
14-3-18

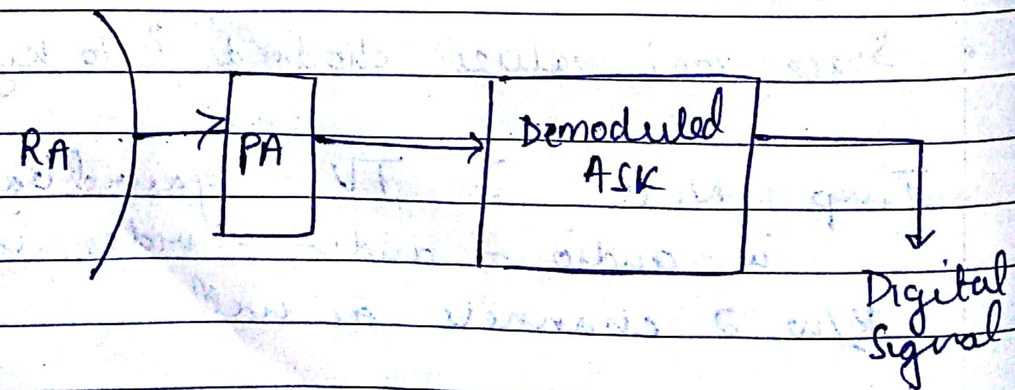
On 13th - 3 - 18 sir discussed multiplexing

# Analog Modulation	Digital Modulation Scheme
AM	ASK
FM	FSK
PM	PSK



Digital Modulation

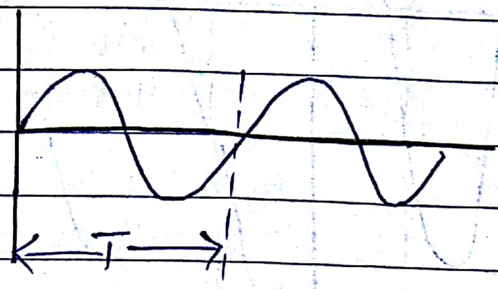
Sender Circuit (Transmitter)



Digital Circuit

~~ANALOG~~ ASK

• signalling element = (1 baud)



$T = \frac{1}{f_c}$

Note: for simplicity now we consider 1 full cycle as signalling element (we can use half)

Baud Rate = f_c

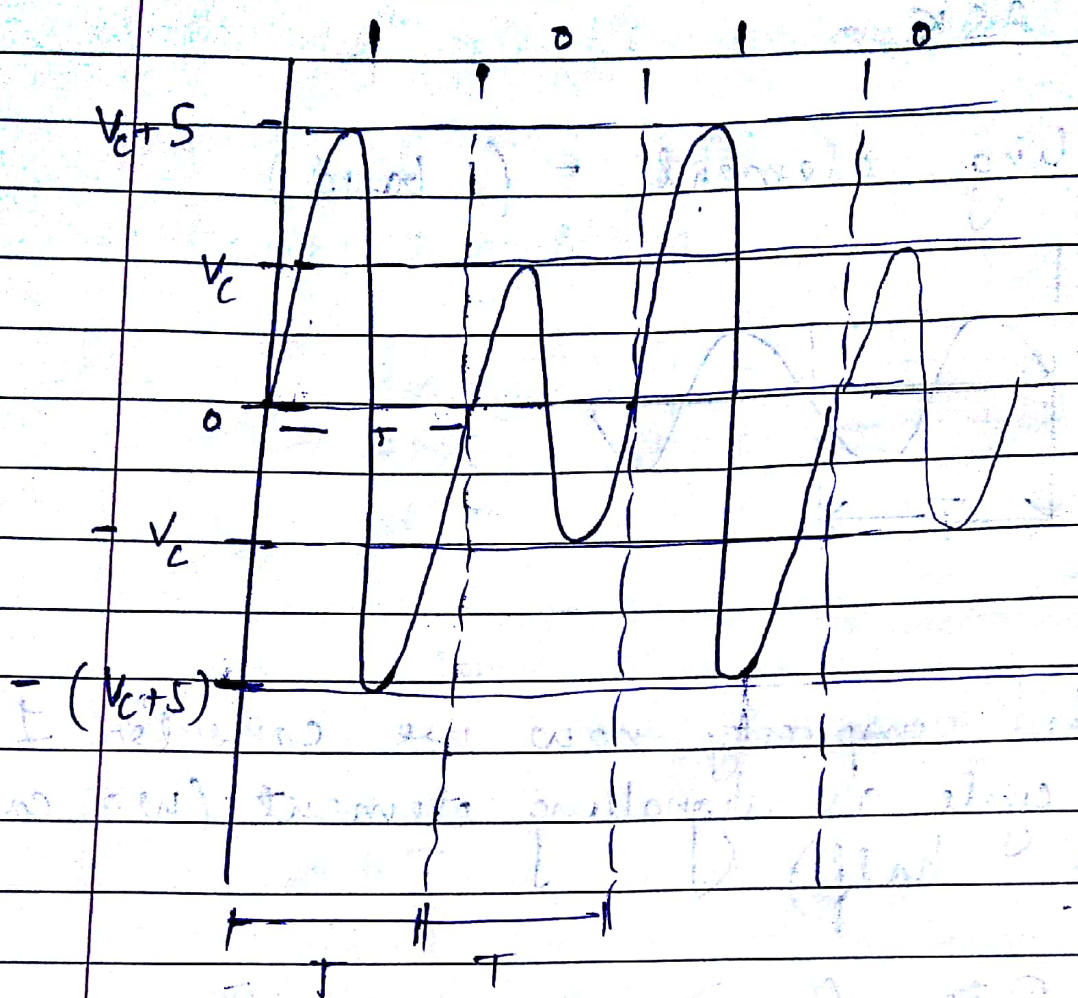
Signalling rate = f_c) =

For simplicity assume $\pm 5V$.

$L = 0 \quad V_c + K_a(0V) = V_c$ Assume $K=1$ = V_c

$L = 1 \quad = V_c + K_a 5V = V_c + K_a 5V = V_c + 5$

Suppose we want to transmit 10 10 10



In this 1 bit time = 1 signalling element time

$$\boxed{\text{Bit Rate} = \text{Baud Rate} = f_c}$$

Note : Modulated Carrier = Modulated Signal

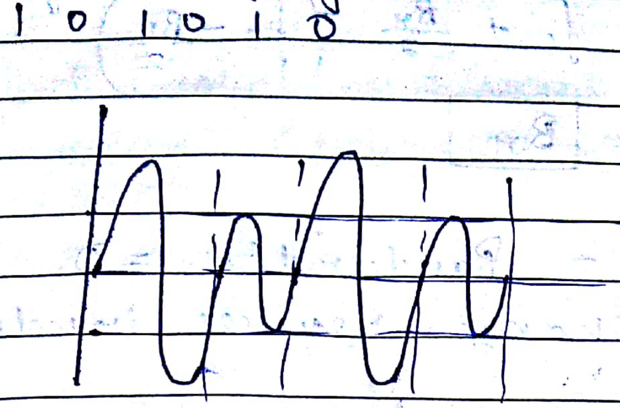
↓ ↓

Note : No longer simple sine wave

⇓

Composite sine wave

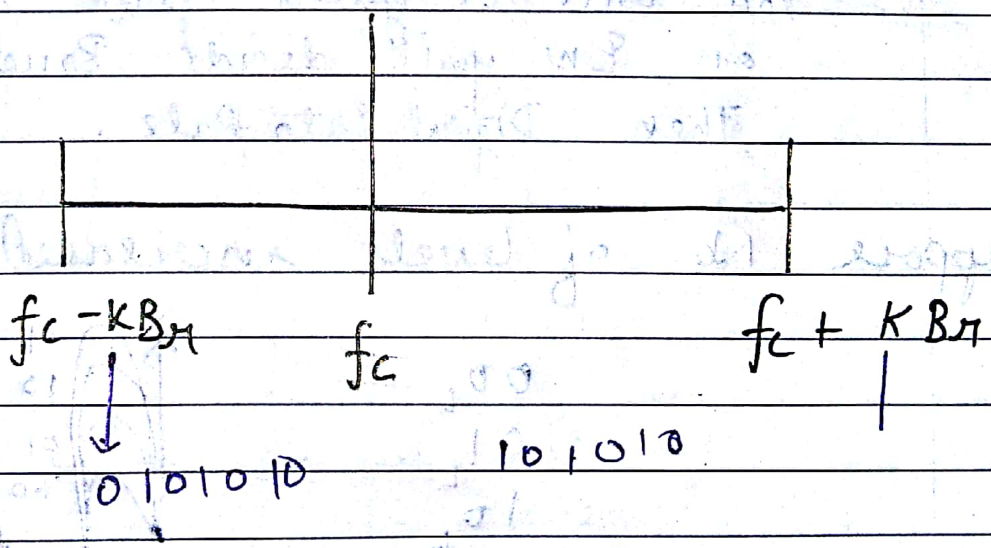
Note - Changing B/W means higher bandwidth



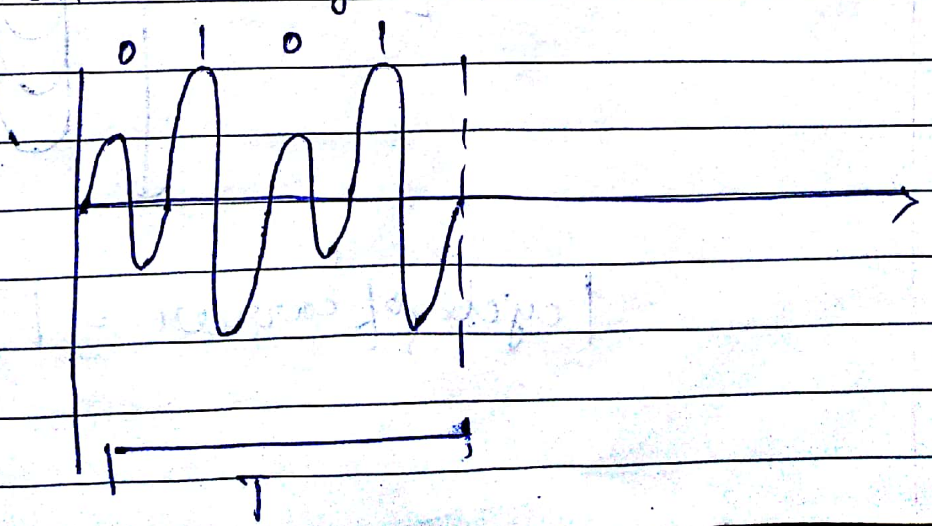
Carrier amplitude is changing at Baud Rate

Suppose 400 KHz → 400 Kbps

800 Kbps → 800 KHz



Explanation : My Doubt



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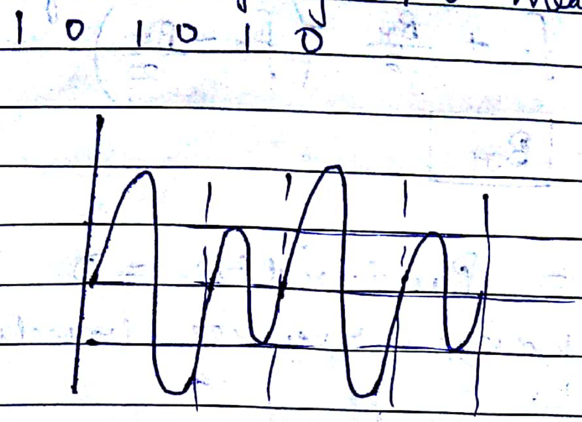

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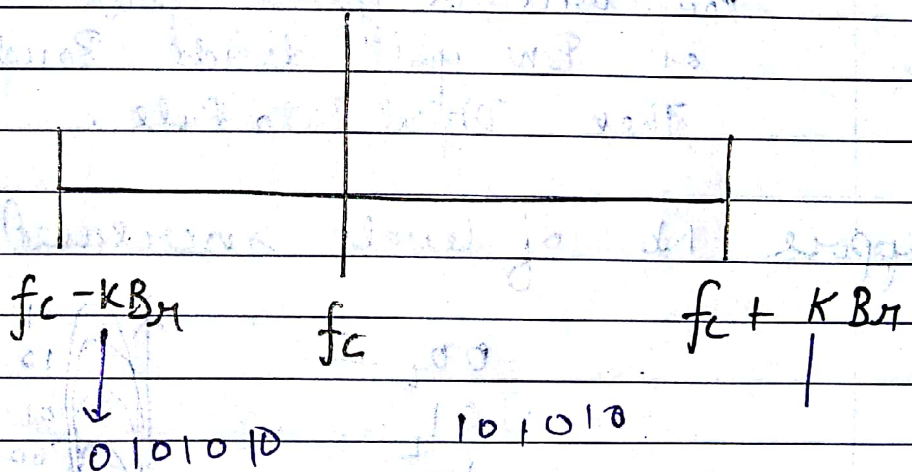
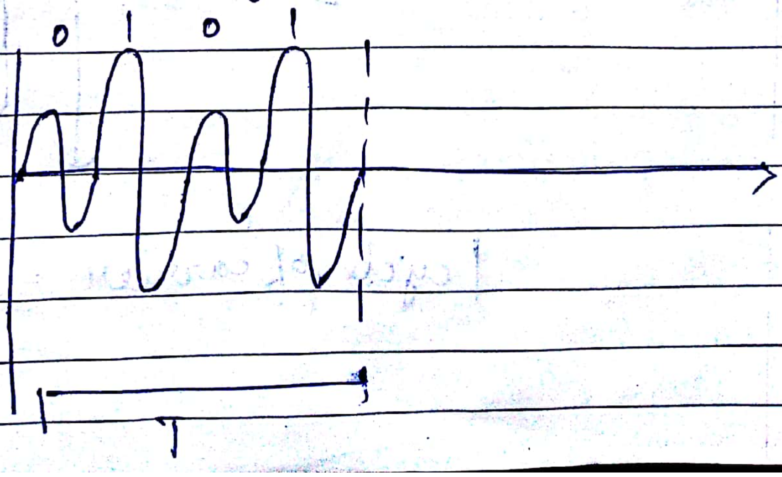


Explaination : My Doubt



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$$BW_{ASK} = f_c + \frac{B_r}{2} - \left(f_c - \frac{B_r}{2}\right) \quad \text{for } k = \frac{1}{2}$$

$$= \boxed{B_r}$$

Imp: No Info = Bandwidth = 0
Note: change requires bandwidth

For ASK

$\boxed{\text{Bandwidth} = \text{Baud Rate}}$

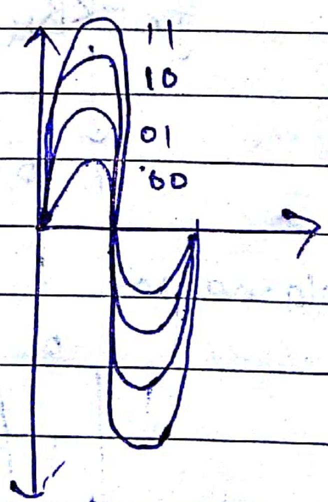
$$BW_{ASK} = Br_{AK}$$

$\forall$ $\boxed{Dr = Br}$

You will be given Bw then based on Bw you'll decide Baud Rate. Then Digital Data Rate.

Suppose No. of levels increased

00 L
01 L
10 L
11 L



1 cycle of carrier = 1 baud

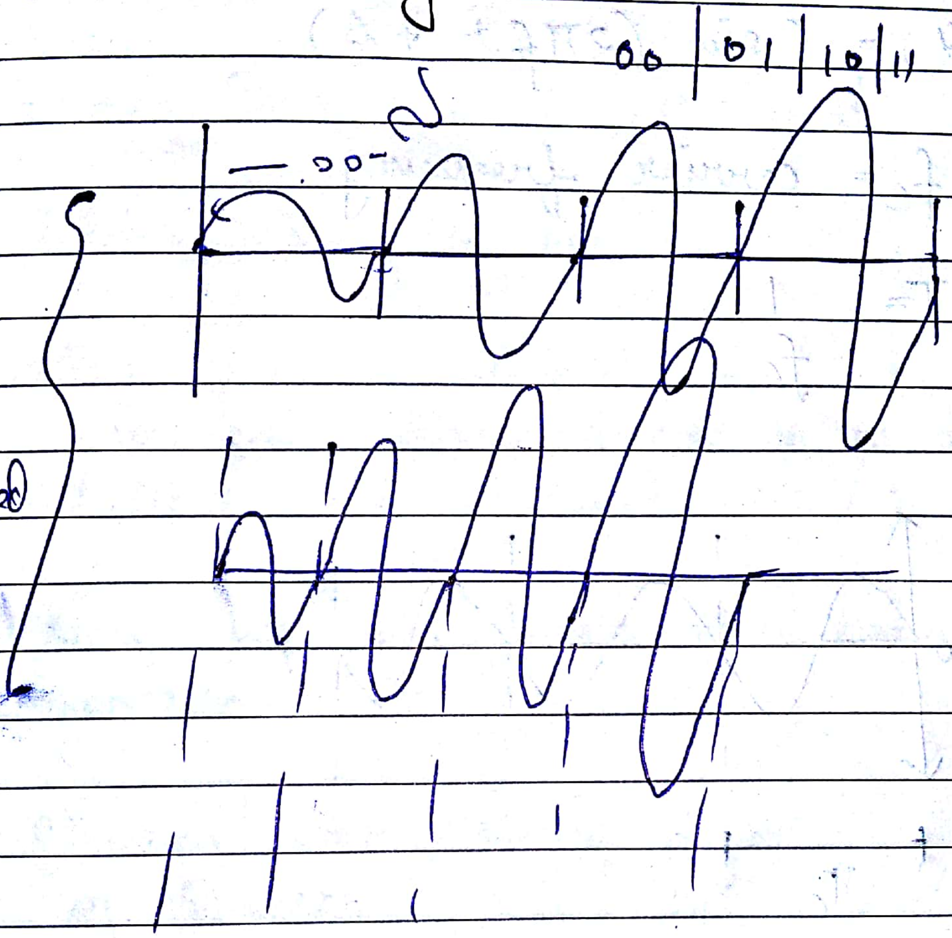
Carrier Frequency

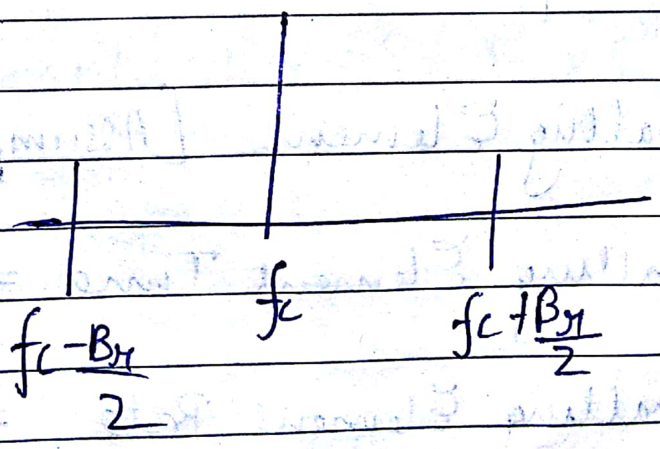
Baud = 1 Signalling Element = 1 cycle of carrier
(Assumption

= T

Understanding

To be improved





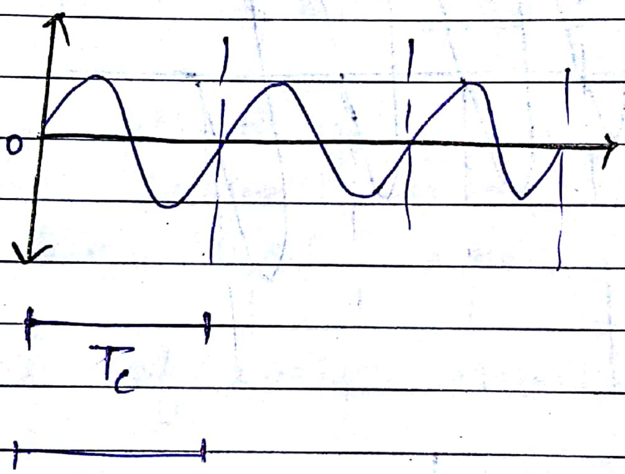
Date

\# $\boxed{dr = Br \log_2 (\text{No of levels})}$

\# $s(t) = C \sin (2\pi f_c t + \phi)$

f_c = carrier frequency

$T = \dfrac{1}{f_c}$



⇓

Signalling Element [Assumption]

\# Signalling Element Time $= T_c$

Signalling Element Rate $= \dfrac{1}{T_c} = f_c$

→ Baud is also called signalling element.

Under this assumption $\boxed{\text{Baud Rate} = \dfrac{1}{T_c} = f_c}$

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$dr = Br \log_2 |L|$

Under ASK

$$Br_{ASK} = B.W_{ASK}$$

$= dr = Br \times$ no. of bits sent / baud

$= \text{BitRate} = Br \times \log_2 |V|$ no of levels.

Now for a fixed BW we can't increase Br. So thus to ~~be~~ increase bitrate we increase |V| i.e no. of levels.

\# Now we see how much can we increase |V| ?

Modem can handle fixed amount of Power

We know, $P \propto C^2 \therefore P = KC^2$

Let $K = 1$

$$P_{max} = C^2$$

$$C = \sqrt{Power_{max}}$$

* C = Carrier's Amplitude

Remember :— from basic concepts of Physics

$$R = \frac{1}{\delta \times A}$$

where

δ — conductivity

Date

- Amplitude Gap of Carrier $= \frac{C}{|V|}$
- Amp Gap $\propto$ Noise power
- Noise Pow $\propto \frac{1}{\left(\frac{S}{N}\right)}$
- $\frac{S}{N}$ = Signal to Noise Ratio
- S → Signal ~~Level~~ N → Noise

⇒ • Amp Gap $\propto \frac{N}{S}$

$$V = \frac{C}{\text{Amp Gap}} = \frac{C \times S}{N}$$

$$V = \frac{C}{\text{Amp} \propto N} = \frac{\text{Power}}{N}$$

⇒ N - Noise will limit the value of |V|.

V and |V| are used interchangeably.

Now,

$$dr_{ASK} = BW \times \log_2 \frac{\text{Power}}{N}$$

⇒ Hence Bit rate is also limited by Noise

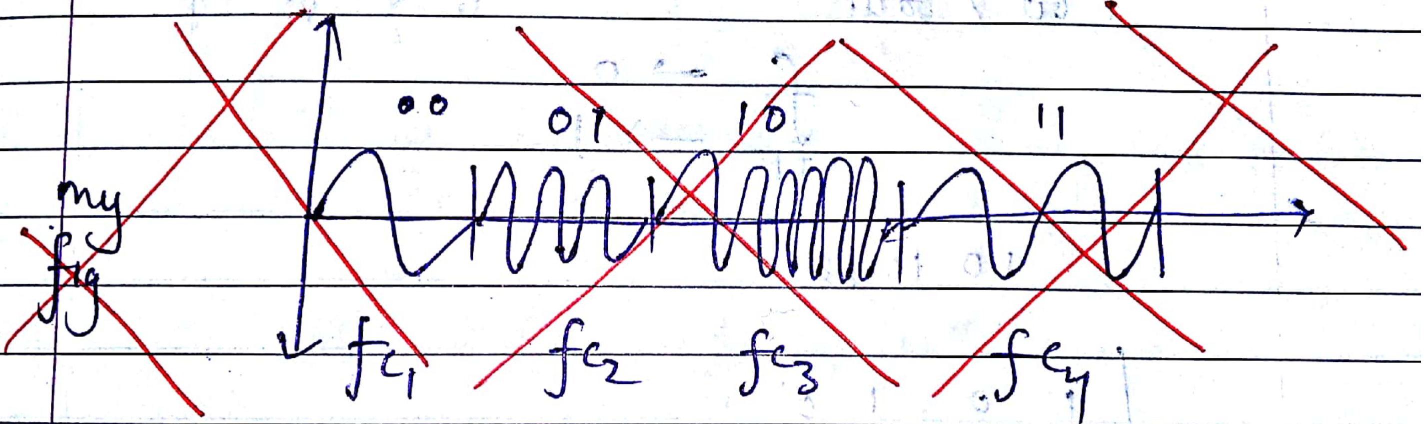
Scanned by CamScanner

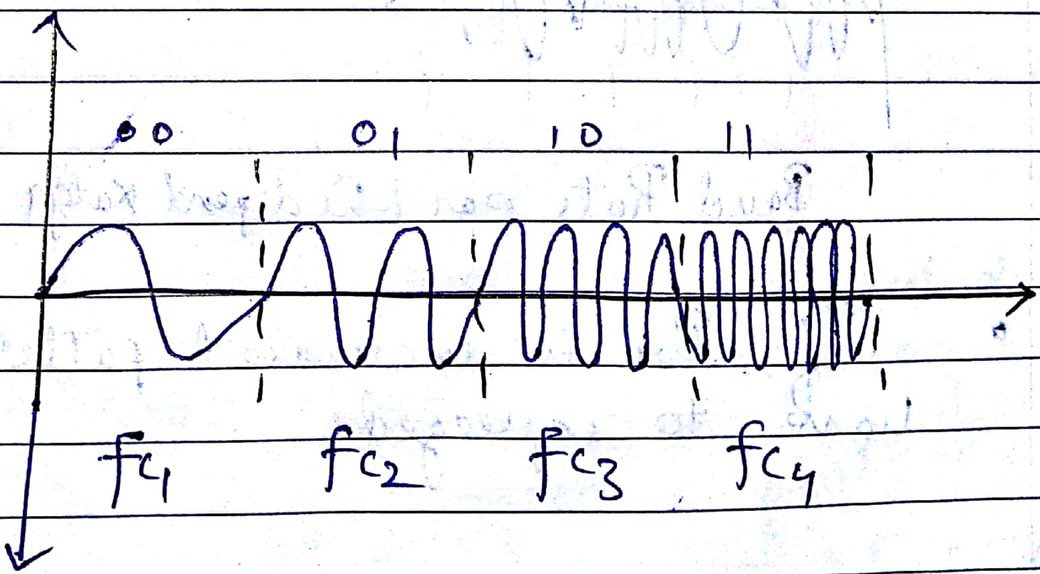
- Now after error checking the reciever finds error is very high, it will reduce the data rate and vice-versa

Always P is fixed. Thus based on environment and its associated noise $|V|$ is fixed.

FSK

We start from V level of frequency levels





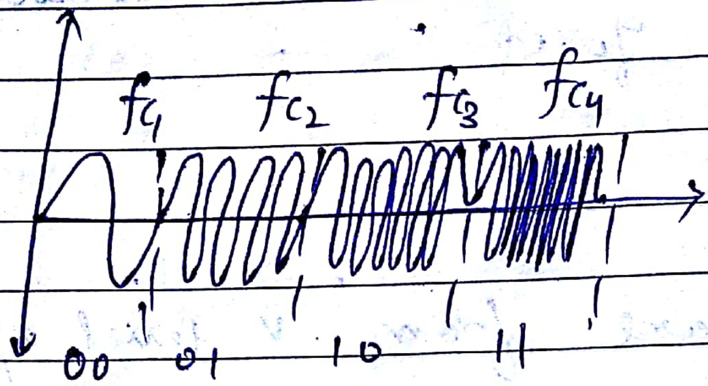
$$f_{c_1} < f_{c_2} < f_{c_3} < f_{c_4}$$

• Amplitude of all frequencies is fixed

Problems

1. Bandwidth

2.



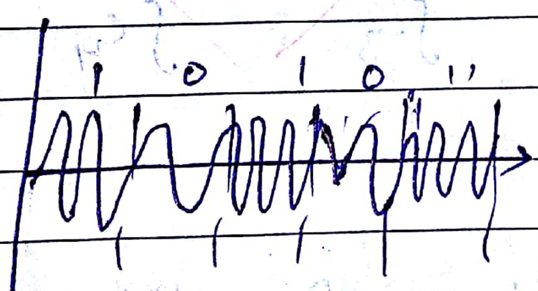
1 bit / baut → 2 levels of frequency

$f_L \rightarrow 0$

$f_H \rightarrow 1$

•

1 0 1 0 1 0



Baud Rate par bhi depend karga

• If B_r is increased pattern will have to squeezed.

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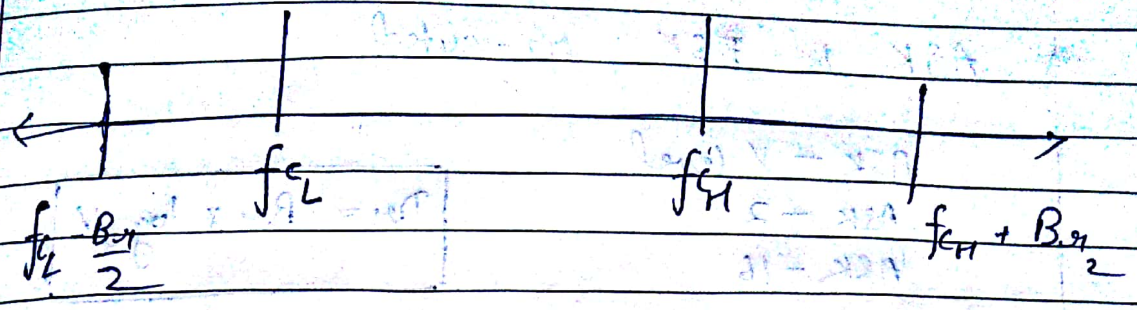


$$\boxed{BW_{FSK} = f_H - f_L + B_r}$$

$$\boxed{B_r = BW - (f_H - f_L)}$$

When no. of levels increases

→ $f_H - f_L$ increases

⇒ Baud Rate is reduced

$$BW_{FSK} = \underbrace{(f_H - f_L)}_{\text{This increases with the no. of frequencies}} + B_r$$

If no. of levels are increased

⇒ Baud Rate is decreasing

⇒ Bit Rate is reducing

$$D_r = \underbrace{B_r}_{\text{decreases}} \times \log_2 |V| \uparrow \text{increases}$$

Hence FSK is not done

16-3-18

ASK & FSK re-visited

ASK − V level
ASK − 2
ASK − 16

$$\boxed{D_r = B_r \times \log_2 V}$$

Now, $c(t) = C \sin(2\pi f t + \phi_c)$

- $P \propto C^2$ assuming $k = 1$ everywhere
- $P_{max} = C^2$

Gap b/w 2 levels $= \Delta g = \frac{C}{V}$ fixed

$$\Delta g \propto \frac{N}{S}$$

$$V = \frac{C}{\Delta g} \Rightarrow V = \frac{C}{\Delta g} \times \frac{S}{N}$$

~~If $\left(\frac{S}{N}\right)$ high~~

$\therefore$ V depends on $\left(\frac{S}{N}\right)$

Thus simple ASK is not good for modulation (only ASK).

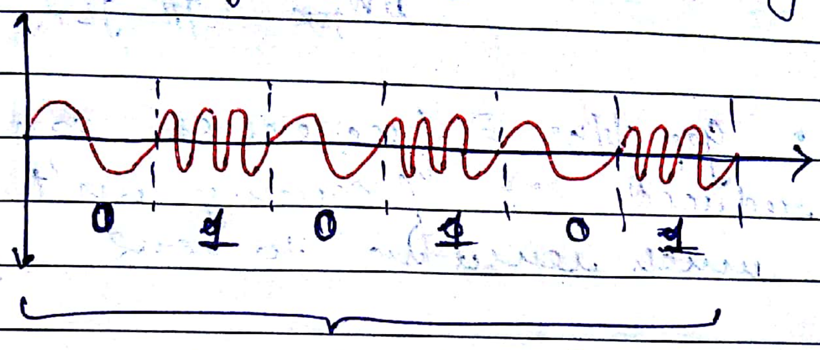
~~$c(t) = C \sin($~~

FSK

$$c(t) = C \sin\left(2\pi f_c t + \phi_c\right)$$

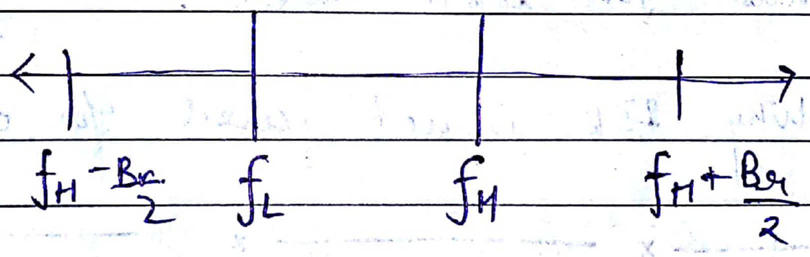
$f_L \Leftrightarrow 0$; $f_H \Leftrightarrow 1$

Suppose the signal we are sending = 101010



Composite sine frequency

So while sending The signal is varying again & again b/w



Bandwidth is a measure of changing

$$BW_{FSK} = (f_H - f_L) + B_r$$

$$\Rightarrow B_r = BW_{FSK} - (f_H - f_L)$$

If $V = 16$

0000 — 1
0001 — 2
⋮
1111 — 15

$D_r = B_r \times \log_2 V$.

$= BW_{FSK} - (f_H - f_L)$.

∵ Gap b/w 2 frequencies can be reduced ∵ frequency isn't not much sensitive to noise.

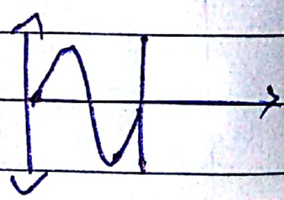
As soon as you increase V then $f_H - f_L$ increases ⇒ B_r reduces and ∴ as a whole (data rate) D_r reduces.

Thus FSK isn't used.

Q. Why FSK is not used for digital modulation

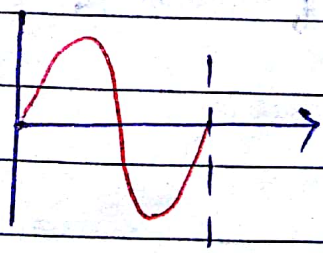
PSK

- V = 2
- Signalling Element



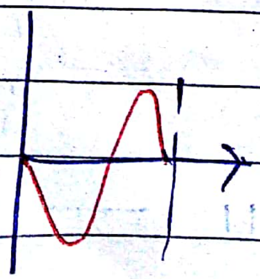
1 = Original phase

0 = opposite phase

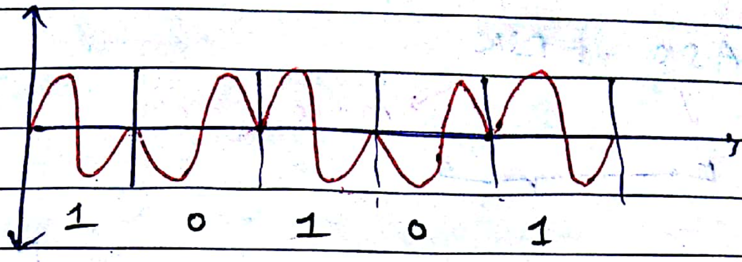


1

0

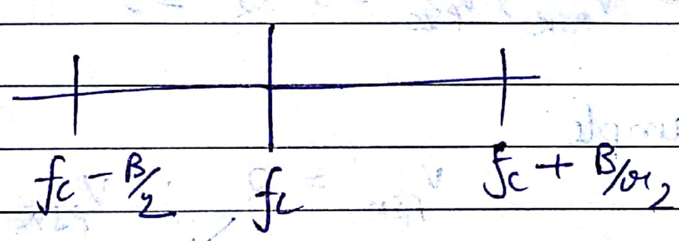


• Example
1 0 1 0 1 0



Now similar to ASK when Baud Rate is increased a single T will become more complex.

• Constant of Modulation should be 1/2
∴ 1/2 se kam → distortion

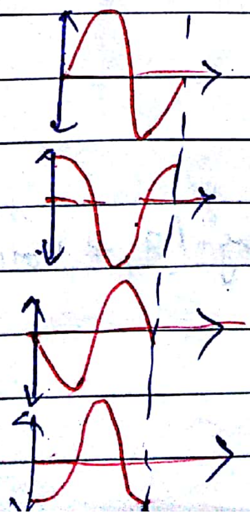


Now, if we increase Bit rate

$$D_r = B_r \times \log \frac{K}{2}$$

$$BW_{PSK} = B_r$$

V = D



Now, Phase isn't affected by noise; by Ag shapes & difference. Thus we see

$$D_r = B_r \times \log \frac{|V|}{2}$$

can be very good increased

When $V = 2$, Baud = Bit [Imp]

Q) ASK vs PSK → more no. levels

Combining ASK & PSK [Quadrature Amplitude Modulation] QAM.

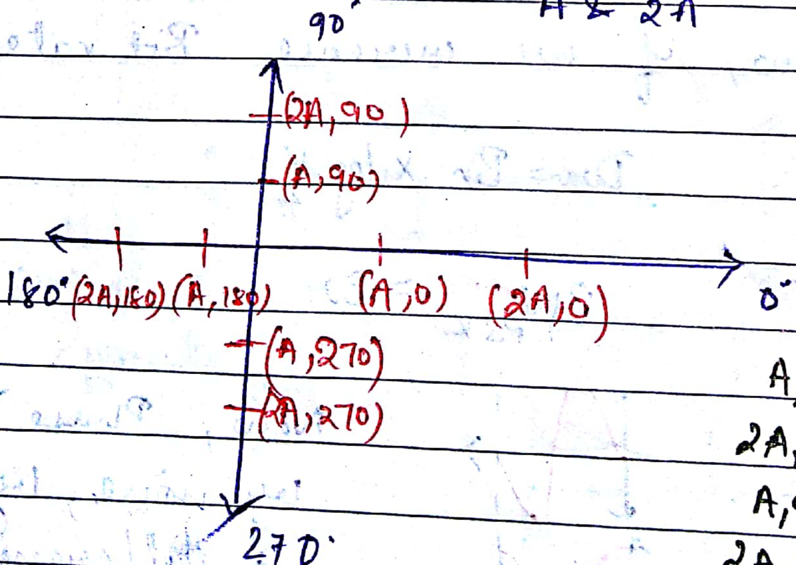
$V_{ASK} = 8 = 2^3$

$V_{PSK} = 128 = 2^7$

$V = V_{ASK} \times V_{PSK} = 2^3 \times 2^7 = 2^{10}$

Example

$V_{ASK} = 2$ → A & 2A ; $V_{PSK} = 4$ | $V_{QAM} = 8$



A,0 — 000
2A,0 — 001
A,90 — 010
2A,90 — 011
So on

Each V is given by (A, P) ordered pair

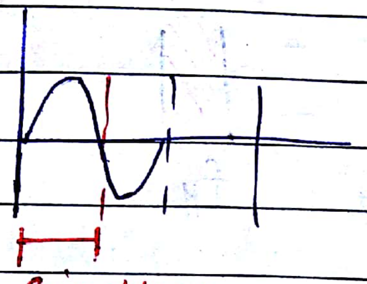
Date

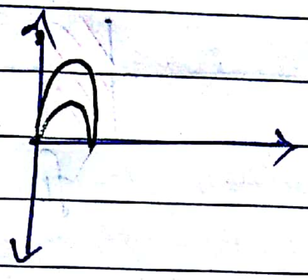
000 | 001 | 010

* Sender to Recieving Time to change the Data Rate.

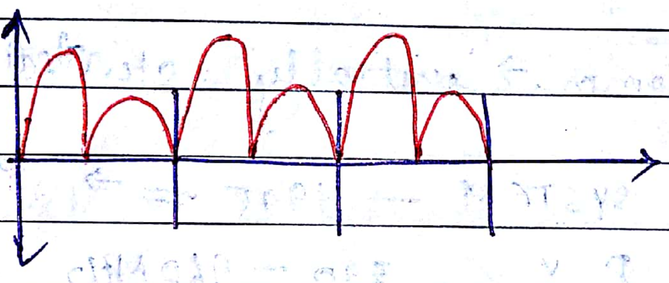
Imp

Suppose signalling element = ½ cycle



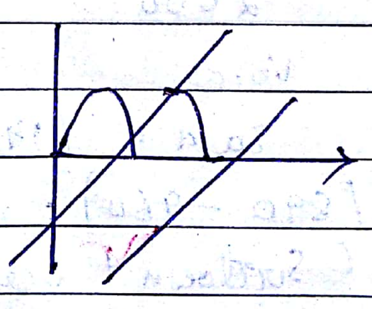


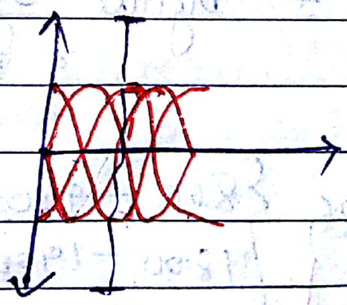
101010



Baud Rate =

//ly in PSK





V.Imp

If Signalling element = 1

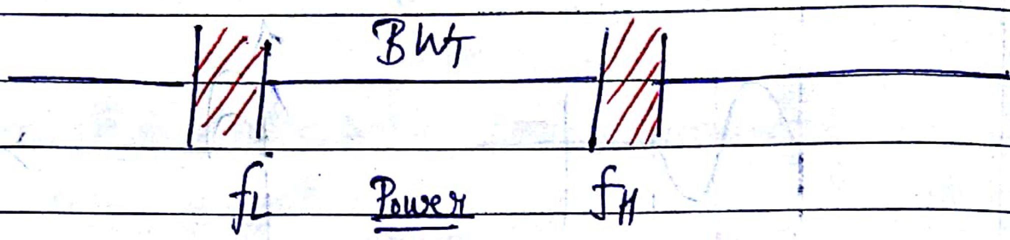
$Br = f_c$

If signalling element = ½

$Br = 2f$

$\boxed{BR = BW}$

MULTIPLE ACCESS SCHEME



(1) Mobile voice communication services
(2) WLAN – Wifi services

(1) voice comm. → initially started for voice communication

\# ANALOG SYSTEM – 1995 ⟹ communication → primary, secondary

1st Gen. Systems { P V 890 – 960 MHz — primary — VOICE
S D AMPS (Advanced Mobile Phone System) — secondary { DATA, almost X

\# Digital System – 2000
- Prim Voice
- Sec. Data – (14.4 Kbps)

gout. Allocated

2G { 800 – 900 MHz (890 – 960) – called (800 – 900) bcu
1800 – 1900 MHz (Sir doesn't remember)

GSM (India)

Now we wanted –
voice video data

Note : Japan and USA – Same System
Europe & India – Same System

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→ voice video data —— Wifi (HotSpot)

(2) WLAN – kind of free   2.4 — 2.6 GHz

→ 14.4 Kbps

800 — 900 MHz — 2G GSM (India) — $\boxed{\text{GPRS EDGE}}$
1800 — 1900 MHz   DAMPS — USA
3G — WCDMA — India + GSM
video
CDMA 2000 — USA
4G — LTE

* video also possible
HSPA

~~Multiple Access Scheme~~

~~Centralized – if more than users transmit within same b/w to prevent collision or access~~

Multiple Access Scheme

Centralized (scheme)   Distributed (scheme)

Mobile Communication   WLAN

Centralized (Laptops / smartphones)   Distributed

No C.C. (coordinate arrange)

Any generation phone

Mobile (M) stations

Base Station

is Centralized coordinator – will allocate channels to each MS to prevent collisions each other

20-3-18

Different Multiple Access schemes :

1. Primarily : for voice communication
Secondary : Data   Centralized Allocation

Mobile Communication — 1G - FDMA/FDD
— 2G —
— 3G —
— 4G —

2. Primary Voice Video Data
WLAN - Wifi — distrubuted allocated Scheme — DCF

Multiple Access Schemes

→ 1G : AMPS ——— FDMA/FDD ——— Analog
→ 2G : GSM ——— { TDMA/FDD, TDMA/TDD } ——— Digital
→ 3G : ——— CDMA ———
→ 4G :

Note 2 : ~~GSM Europe~~ — IS95
↳ CDMA based 2nd gen Digital communication
{CDMA/FDD}

- FDMA / FDD
- TDMA / FDD, TDD
- CDMA / FDD

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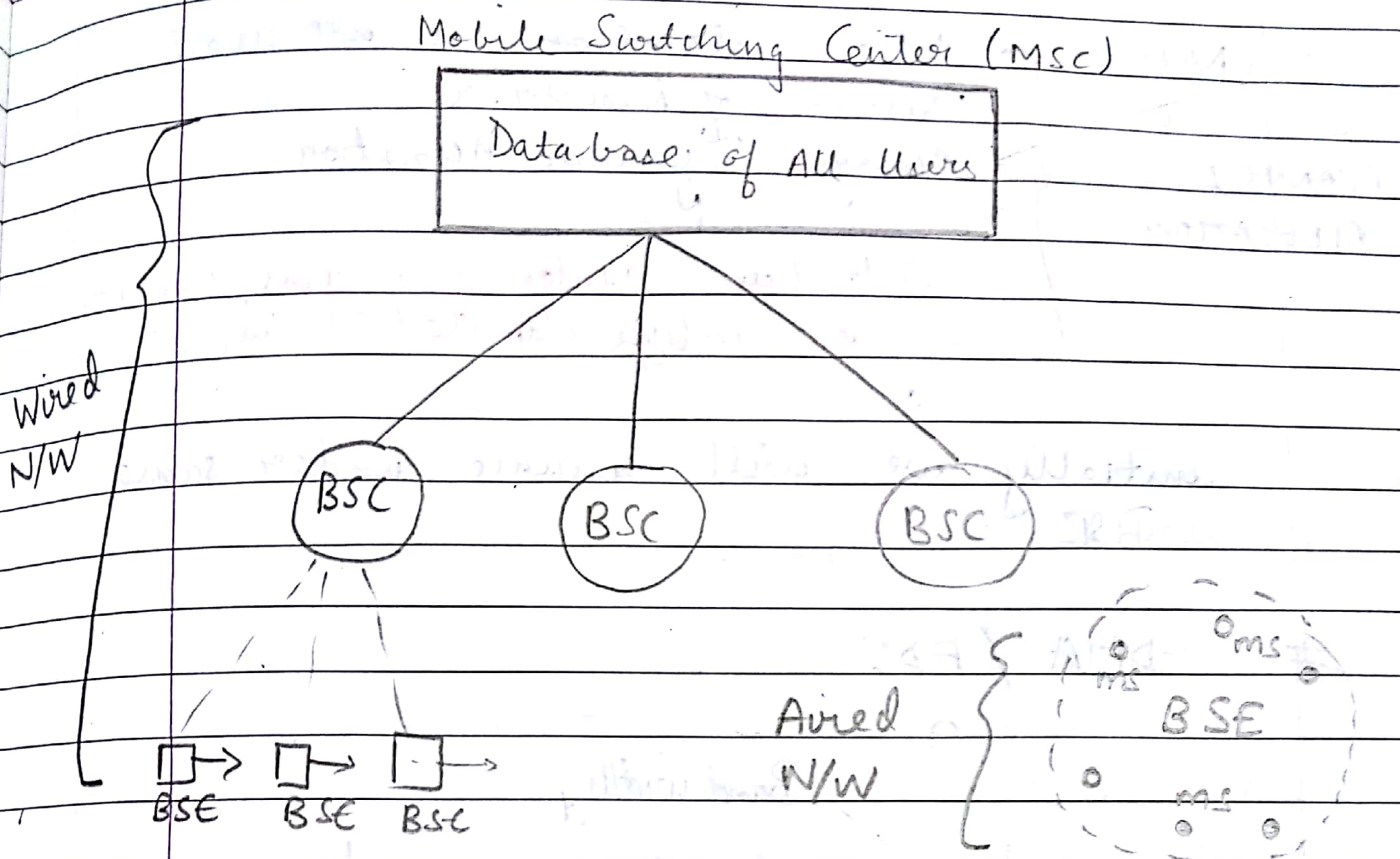
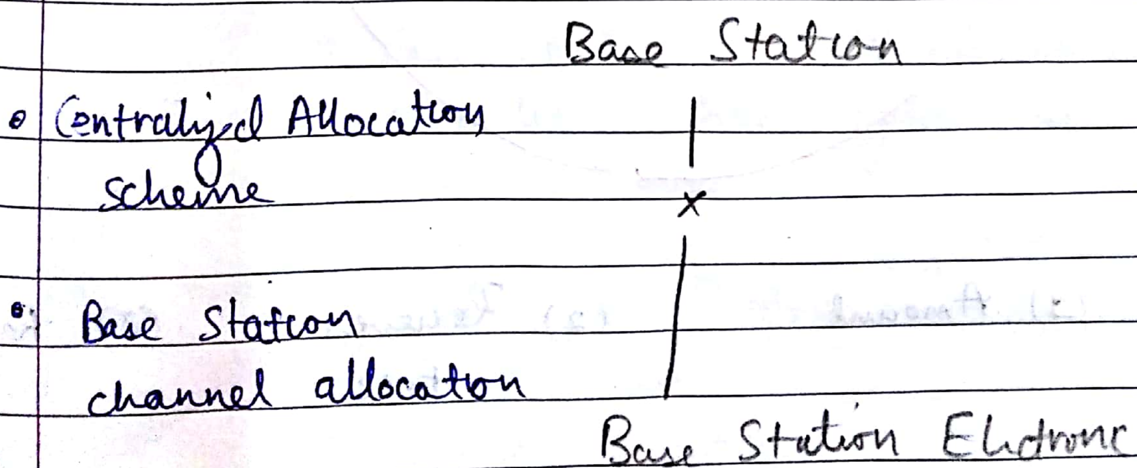


- Each BSE controls an area called Cell.
- Roaming : Leaving 1 MSC and joining another MSC
  : Home MSC — Local Calls
  : Visiting MSC



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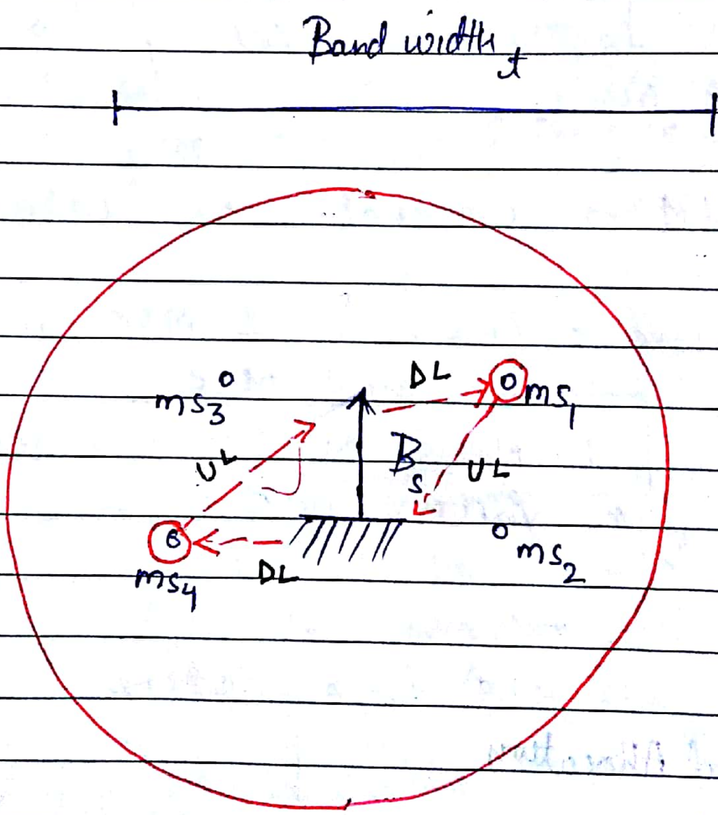
CHANNEL ALLOCATION

Note : Static allocation is not used
Wastage of Resource
Always Dynamic Allocation

Jab hum dialer par dial karte hai tabhi allocate hota hai.

initially we will assume under same BSE

FDMA / FDD



UL - Uplink
DL - Downlink

(1) Amount (2) Reciever is Free (3) Reciever is Busy

Dynamic mai unused channels nhi hoga

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⇒ Network Busy — Because all dynamic channels are full

⇒ Destination Out of Reach - [1hr - 2hr]

⇒ Switch Off

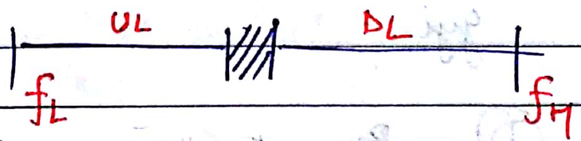
Note — For Voice ~~channels will suffice.~~ — 1 Uplink, 1 Downlink } only 2

FDMA / FDD

how to differentiate uplink & downlink

making use of frequency for Multi Access

BW



Rule of Thumb:

⇒ Higher frequences, More Radiation, More Noise

⇒ Base station tolerate more

⇒ Down link has higher frequency

$$BW_u = BW_t/2$$

$$BW_d = BW/2$$

Date

$$\frac{BW_u}{n} = \Delta ch = CH_w = \text{Channel width}$$

Note : In analog higher BW for better quality.

First parameter = ch_w on this we determine 'n'.

$$\boxed{n_u = \frac{BW_u}{ChW}} \qquad \boxed{n_d = \frac{BW_d}{chw}}$$

- channel no $< f_L, f_H >$

ch_w = For uplink = For downlink

Note ⇒ uplink & downlink are different

Jaise hi button dabaya to request gyi

(D) – Request kaise jayegi?

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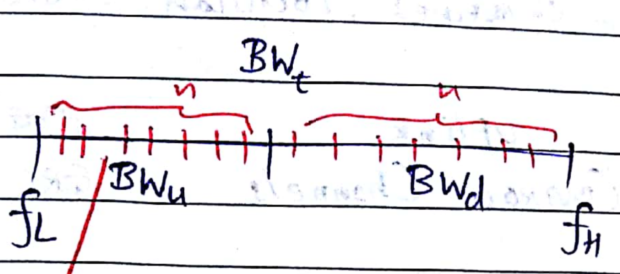
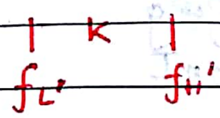
FDMA / FDD



$$BW_u = BW_d = \frac{BW_t}{2}$$



$$n_u = \frac{BW_u}{ch_w}$$

$\langle K, u, f_L', f_H' \rangle$

$$n_d = \frac{BW_t}{Ch_W}$$

- Channel is allocated by the base station.
- Communication also takes place through the base station.

By dialing in a no. — A request message is framed

C-REQ : Call Request
C-DIS : Call Disconnect

Call Connect : [CON]

REQ
SN
DN
⋮

Binary Message

Destination Alerted

Alerted using Paging message

Call Disconnect : [DIS]

C-DIS
SN
⋮

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Now, there must be some Request Channels, Disconnect channel, Location channels.

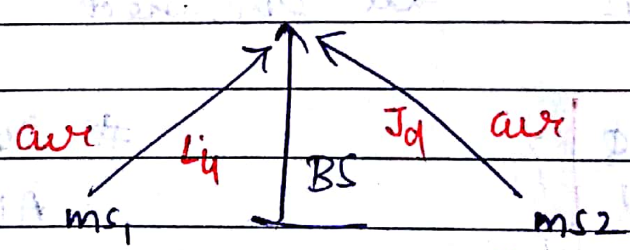
All these in details we will study later on

CON	Uplink		PAG	Downlink
DIS	CONTROL Channels		GRA	Control Channels
LUP				
connect			Paging	
disconnect			Grant	
Location Update				

Note: ◦ How these channels are created, we will discuss later in further details.

◦ After allocating UL & DL, Base Station will send to ms_1 – Li using GRANT channel. ms_1 – Jd

◦ Source & Destination ~~leave~~



Now, suppose source & Destination are in separate B Stations / Cells.

In 2 different cells

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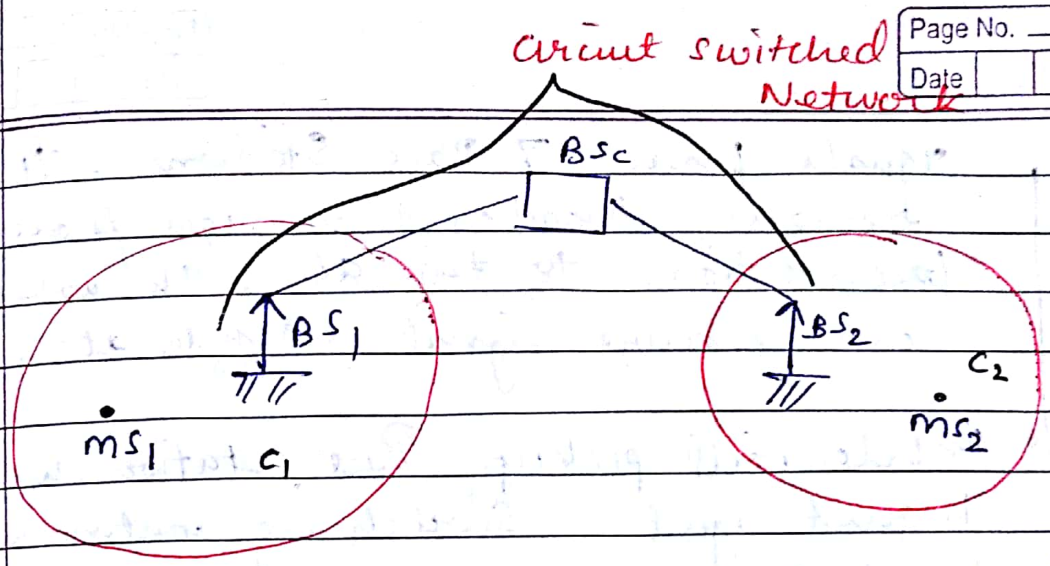
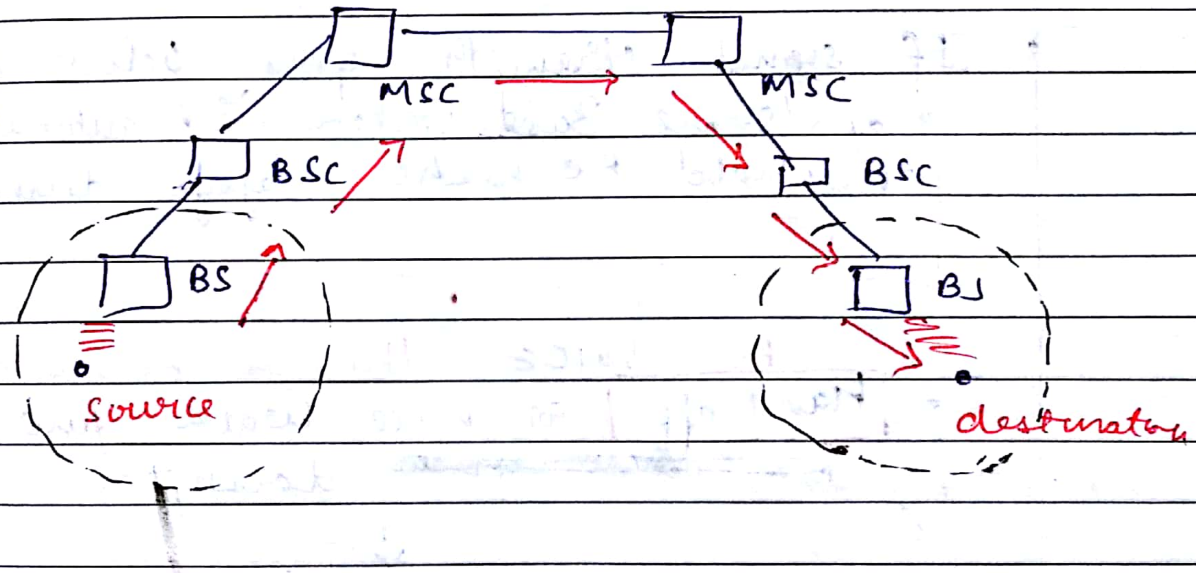
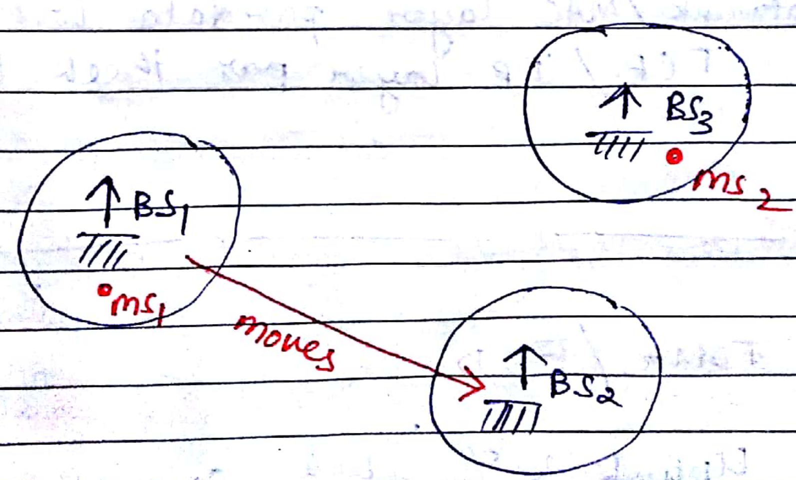


If 2 different cities



Another scenario



Now whenever a mobile is switched on. Then it will recieve ~~it~~ different

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signals from 7 Base Stations. It will recieve broadcast messages from the base station to ~~the~~ all. The mobile can measure signal strength etc.

These things are handled by control signals

- Mobile will pickup Base station with highest signal. Switching continous based on:

(1) Highest Signal (2) Service Compatibility.

- If signal strength goes below threshold of some Base Station. Ek automatically threshold ke neeche jayega dusra upar.

For VOICE this is known as

- Handsoff. For voice works fine, data ~~No~~ ~~[illegible]~~ doesn't.

↓

The DATA will be lost at MAC Layer.

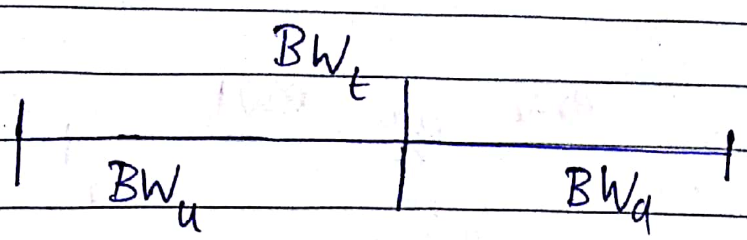
Dual Layer Error Check

{ Data Link / MAC layer par data loss ho gya
TCP / IP layer par theek ho jayga

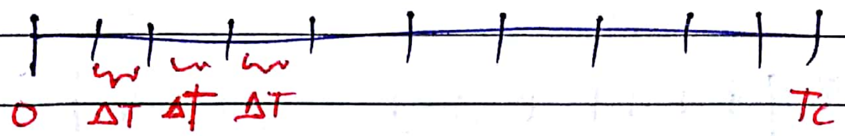
TDMA / FDD

Uplink & Downlink can go together.

Scanned by CamScanner



$T_c\ (u)$

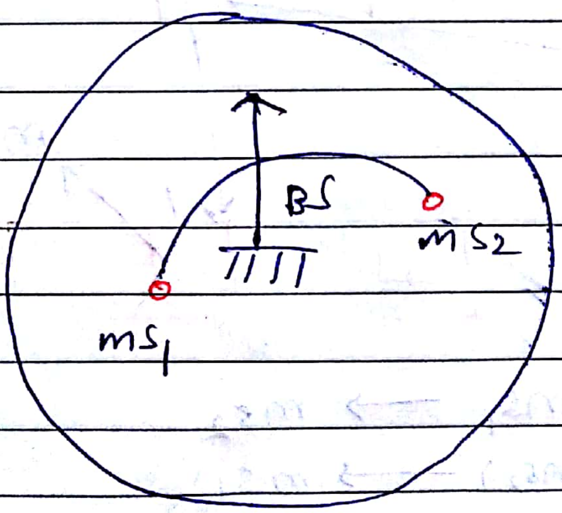


$\Delta T = \frac{T_c}{n}$

$n = \frac{T_c}{\Delta T}$

$T_c(d)$

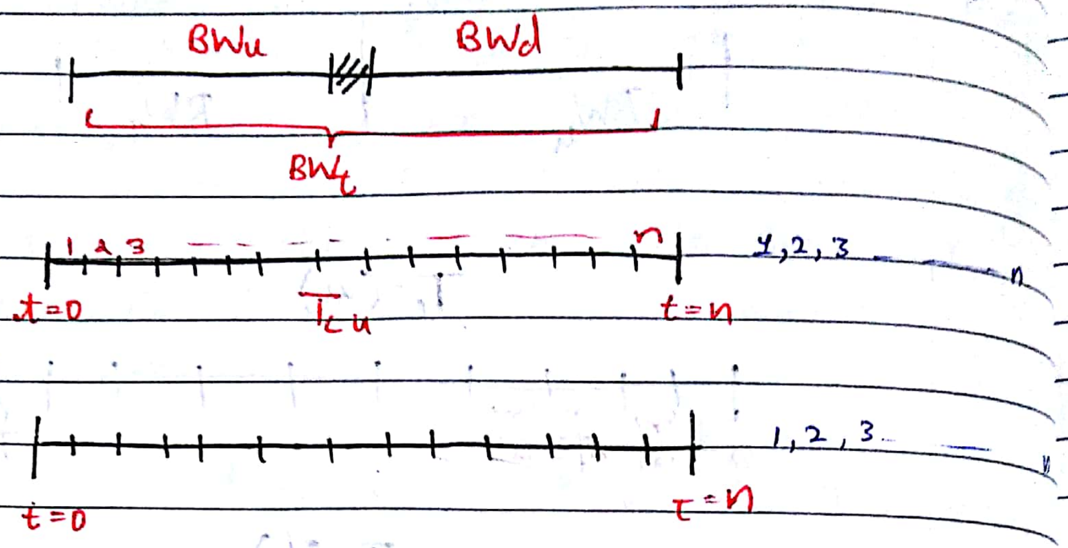
$$\boxed{\Delta T = \frac{T_c}{n}}$$



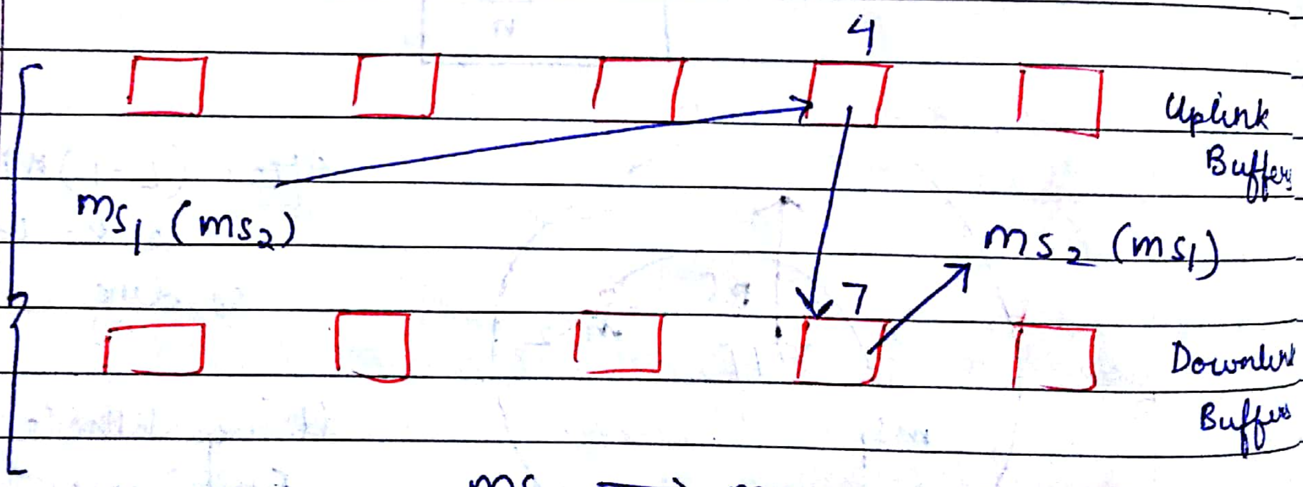
After $(L-1)\Delta T$ hone ke baad sending

Using Whole Frequency Spectrum

Note :
Whole B/W mil gya but time bhtkam milega ab.



Uplink & Down link : Don't take place at the same time. Thus, there should be buffering.



Note: This is possible in same Base station

$ms_1 \longrightarrow ms_2$

$(ms_2) \longrightarrow (ms_1)$

Control Channels are Digital — always

Note : MSC — makes use of distributed DataBase

If both BS are different then channels can't be shared.

When ms_1 & ms_2 are in same cell then there is no circuit switched path

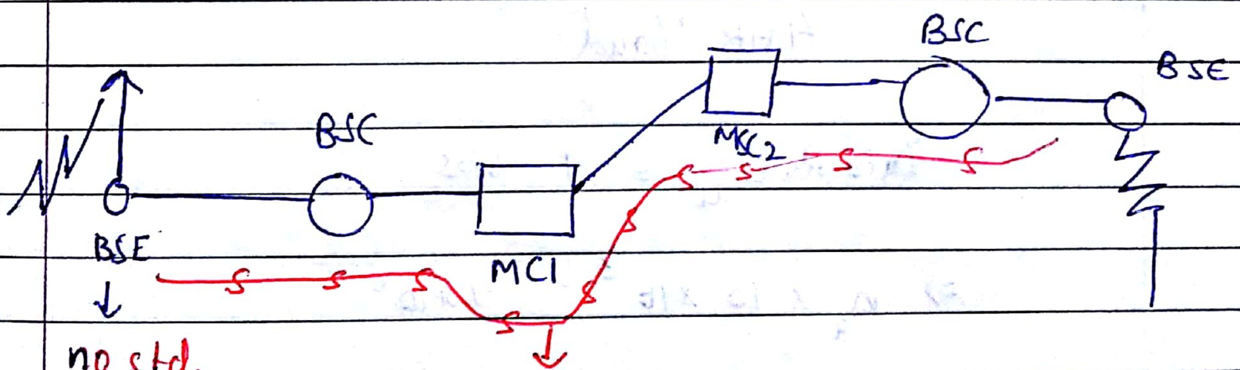
Cross Check — Circuit Switch sharing ?? X No / Yes ?

This is Packet Switching

Difference b/w Circuit & Packet Switching ?

In both cases UP etc is set up using Packet Switching & using this circuit switched N/w lona rhe ho.

B/w 2 nodes there are multiple no. of switches.



no std. Controller

circuit switched N/w

2 Types of Resources = s (switch)

- Uplink & Downlink at source & destinat-

Network Busy
1) Unavailability of UL & Donk
2) Switch not available

Backward ~~chain~~ se ~~switch~~ khol de

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Signalling #7 – PROTOCOL STACK

Controlling N/W is Packet Switch

Note : For a No. of Service Providers Each TDMA is FDMA b/w SP $\underrightarrow{\text{SP}}$ using FDM

— x — x — x — x — x —

TDMA / FDD

VImp

- $BW_t = 2\,MHz$ 10 Kbps → avg data rate

Modulation QAM = 16

$\text{Baud Rate}_{dl} = 1\,M$ baud/sec

$BW_{dl} = 2\,MHz$

4 bits / baud

$\text{Data Rate}_{ul} = 4\,Mbps$

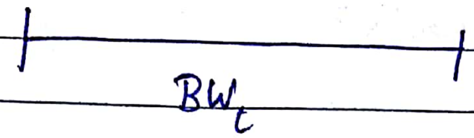
$\Rightarrow n_u \times 10 \times 10^3 = 4 \times 10^6$

$\Rightarrow \text{Average data rate} = \dfrac{\text{Max Dr}}{n_u}$

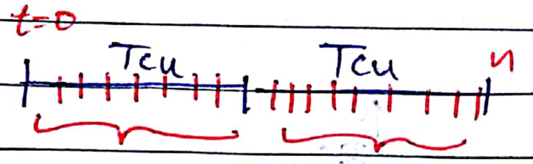
$\Rightarrow \boxed{n_u = 400}$ + $\cancel{\boxed{n_d = 400}}$

Scanned by CamScanner

TDMA / TDD : Uplink & Downlink don't operate in the same cycle



$T_c = T_{cu} + T_{cd}$



Note : Eg

2 in Uplink
2 in Downlink

$T_{cu} + (i-1)\Delta T$

- $BW_t = 2MHz$

1 slot / 2n slots in Uplink

- Baud Rate$_t$: 2M baud/sec
- Data Rate$_t$ = 2 x 4 Mbps
- 10×10^3 =