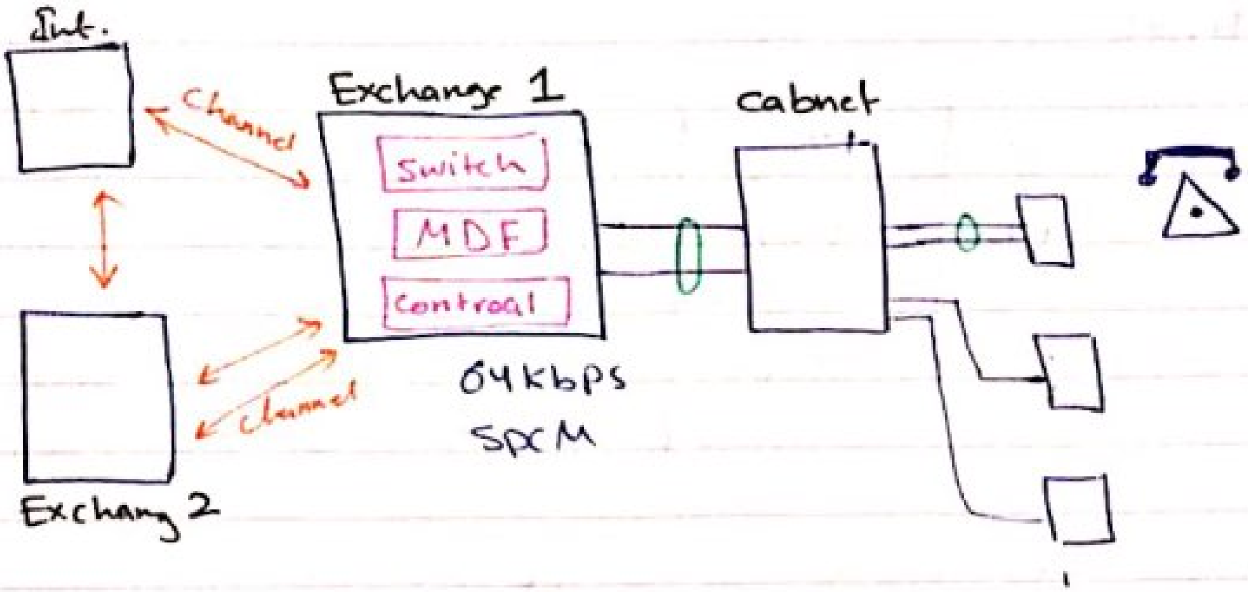
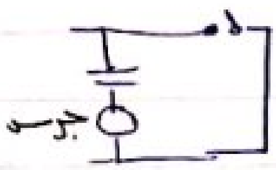
No

18/9 MON



MDF : protection → if the voltage rise ⇒ short ckt

E1 = 2Mbps → 30 channel
→ 2 controal



→ frequency reuse.
→ Shared resources.

$$A = \frac{Q_a \lambda}{60} \quad Er$$

from tabel

active users مو ال

N	1%	2%
10	4.08 122.4	4.54 136.2
20	10.97 329.1	11.77 353.1

→ * 30

traffic $A = \frac{Q_a \lambda}{60}$, $\lambda = 2min$

$Q_a \equiv (a) \Rightarrow$ active.

↳ active عدد الناس ال

$A = \frac{Q_a 2}{60} = \frac{Q_a}{30}$

$Q_a = 30A$

$Q_a = \% Q$ ⇒ Q ≡ total users customer

$Q = \frac{30A}{\%}$

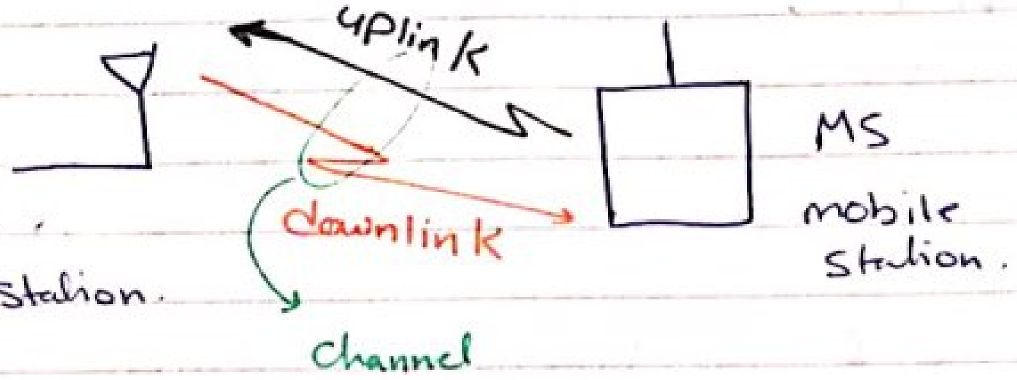
* ↑ resources in the same place

↑ channel ⟶ ↑ capacity

" capacity ≡ customer قديش بقدر اخدم عدد من ال "

* capacity → economical performance system
بتعتمد على → الناس

* of . channel the most critical number in cellular system.



data comprision → capacity زيادة السعة

ARPU: average return per user
ARPU ≡ $

* of channel relation not linear with customer. ⇒ its exponantial relation.

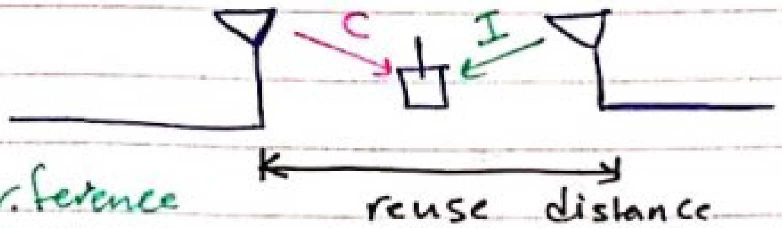
Q.O.S = Quality of survice.

- → Blocking probality BP
- → BER C/I
- → Failirs

* Basic cellular design:-

Frequency re use
" in different area , 2 area independant "

* بقرب كتير من عندي (I)
اكبر صد (Imin)
* مسافه اقل يستخدم نفس تردد



* Same freq channel.
* different area.

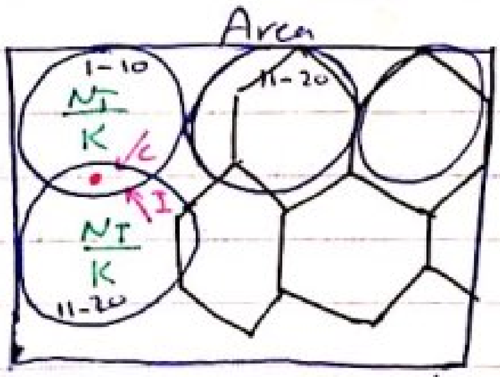
I ≡ Interference
C ≡ carrier

C/I → How to recive the signal

C/I → type of modulation
→ coding.

↑ Intereference → ↓ distance "مسافه اقرب"

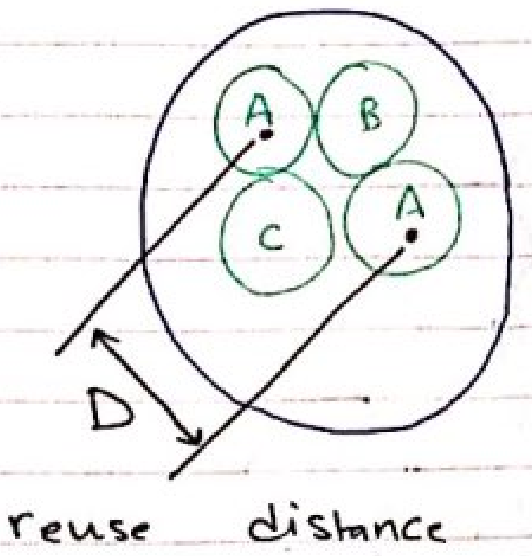
$\boxed{N_T}$ ≡ Number of channel



different Channel → No Interference.

* الطلب اني اعبي المنطقه كلها ⇐ أفضل شكل هو الشكل السداسي.
← like cells

K → resuce factor , C/I > min
→ fill all the space with K different type such that C/I > min in the worst case.
K → min to solve this problem
بدي اياها



N^2 → means two dimintion.

└→ group of integer

K types..

$$\frac{N_T}{K} = N_{cell}$$

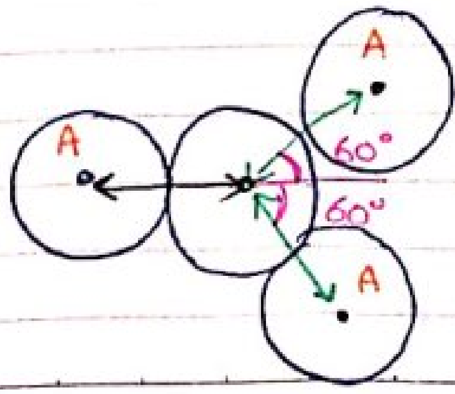
Same type → Co. channel cell ⇒
Co. channel Interference.

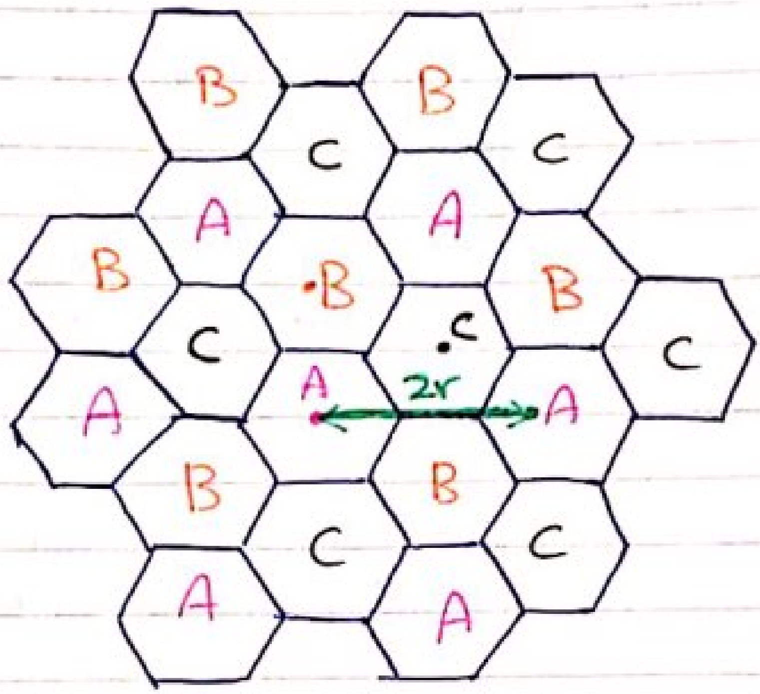
$$i^2 + j^2 + ij = K$$

i, j = integer $i, j \in N$

$i = 1$, $j = 1$ → $K = 3$
$i = 1$, $j = 2$ → $K = 7$
$i = 2$, $j = 2$ → $K = 12$
$i = 1$, $j = 3$ → $K = 13$

$K = 4$ acceptable ⇒ not include the equation.





- Interferance in base station (uplink)
- Interenferace down link ↓

Pr = powr recived

$$P_r = P_o \; e^{-\gamma}$$

$2 \leqslant \gamma \leqslant 4$

$\gamma = 3$ اذا ما اعطانا اياها بنفرضها

open area → γ ↑

$Pr = C + \sigma I$

C ↑ carrier

I ↳ interference

$\frac{C}{I}$ = CIR

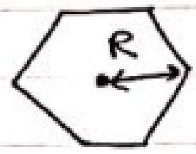
$$C/I\,R = \frac{C}{6I} = \frac{1}{6}\,\frac{C}{I}$$

$$C/I\,R = \frac{1}{6}\,\frac{P_o\, r_c^{-\gamma}}{P_o\, r_I^{-\gamma}} = \frac{1}{6}\left(\frac{r_c}{r_I}\right)^{-\gamma}$$

$$= \frac{1}{6}\left(\frac{r_I}{r_c}\right)^{\gamma}$$

$$\simeq \frac{1}{6}\left(\frac{D}{R}\right)^{\gamma}$$

R = cell radius



$$\frac{D}{R} = q$$

$$\boxed{q = \sqrt{3K}} \qquad \boxed{C/I\,R = \frac{1}{6}\,q^{\gamma}}$$

Ex A total Area of 200 km^2 is to be covered by cellular comp system with min C/IR = 4 dB if the avsalable number of channel is 90 ?!

Q_a = 40 K , 1% Bp , λ = 2min

γ = 3 .

No.

Sol: $CIR = 4\,dB = 10^{0.4} = 2.5$

$CIR = \frac{1}{6} q^{\gamma}$

$2.5 = \frac{1}{6} q^{3} \Rightarrow \boxed{q = 2.5}$

$q = \sqrt{3K} \Rightarrow K = \frac{(q)^2}{3} = \frac{2.5^2}{3} = 2.1$

$\boxed{K = 3}$

actual $CIR = \frac{1}{6}(q)^3 = \frac{1}{6}(3)^3 = \frac{27}{6} = 4.5$

$\boxed{CIR = 6.5\ dB}$ $dB = 10 \log(4.5) = 6.53\,dB$

$\Rightarrow N_c = \frac{N_T}{K} = \frac{90}{3} = 30$

$\Rightarrow A_c = 18.59$ (from table trafic per cell)

$\Rightarrow A_T = \frac{Q\lambda}{60} = \frac{40K * 2}{60} = 1333.4$

$$\frac{A_T}{A_c} = \text{Number of cell}$$

$$\frac{1333.4}{18.59} = 71.27 \Rightarrow \boxed{\#\ \text{Cell} = 72}$$

* If CIR = 7.5 dB → K = 4

$$N_c = \frac{90}{4} = 22$$

$$A_c = 12.45$$

Number of cell = 107.1
= 108

* If $N_T = 120$

$$N_c = \frac{120}{3} = 40$$

$$A_c = 26.58$$

Number of cell = 51

27/9 Wed

Basic design :-

1. flat earth
2. uniform user distribution
3. Omni directional cells.

antenna موجودة بالنص وبتبث بكل الاتجاهات ↲

$$(C/I)_{min} = \frac{q^{\gamma}}{6}$$

$$q = \sqrt{3K} \qquad K \in \{3, 4, 7, 12, 13, \ldots\}$$

N_T (total)

$$N_{cell} = \frac{N_T}{K}$$

* بدي K اصغر ما يكون ← لانو trafic ← non lineare

Ex

Area = 300 km^2

1 M customer → 15% active at busy hour

Q_a = 1M * 15% = 150 k user (active)

λ = 2min , BP = 1% , min C/I = 8.5dB

N_T = 180 , γ = 3 ?!

Sol:

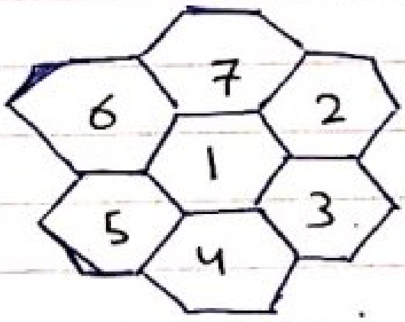
$$q = \sqrt[3]{6 * 10^{0.85}}$$

$$\boxed{q = 3.48}$$

$\Rightarrow K = \frac{q^2}{3} = 4.05$ $\qquad$ **K = 7**

$q = \sqrt{3*7} = 4.58$

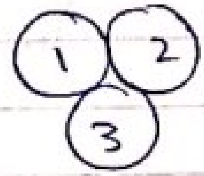
$\Rightarrow \frac{C}{I} = \frac{(4.58)^2}{6} = 16.03 \Rightarrow 12\ dB$

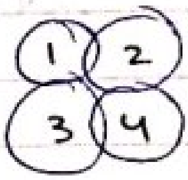
* 

claster

K = 7

K = 3



K = 4 ⇒ 

$\Rightarrow N_c = \frac{180}{7} = 25.7$

$25 * 7 = 175$

* عندي زيادة 5channel بوزعهم ع Celles لانه عندي 7

$\underline{\underline{2}} \times 25$ channel
$\underline{\underline{5}} \times 26$ channel
] 7cell

No.

25 Ch ⇒ at 1% ⇒ $A_c = 14.72$ Er

26 ch ⇒ at 1% → $A_c = 15.49$ Er

claster
29.42
77.45
106.87

29.42 → 14.72 * 2
77.45 → 15.49 * 5

$\Rightarrow A_T = \frac{150K * 2}{60} = 5K$ Er

$\overline{A_c} = \frac{106.87}{7} = 15.27$

$\# \text{of cell} = \frac{5K}{15.27} = 327.5$

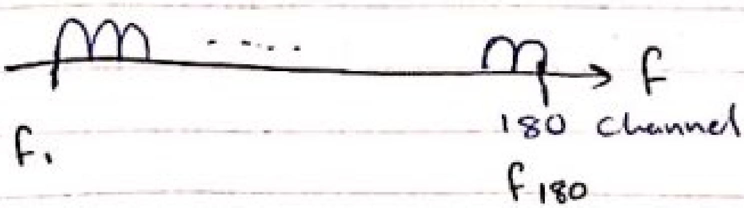
cell = 328

* if K = 3

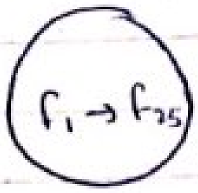
$N_c = 60$

$A_c = 43.2$

$\text{cell} = \frac{5K}{43.2} = 116$ cell



* Noises:-

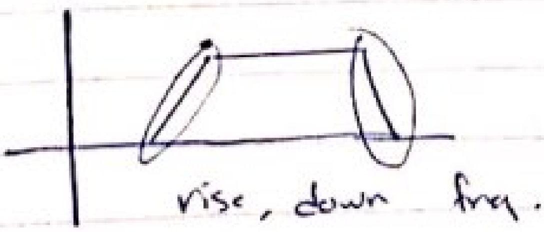


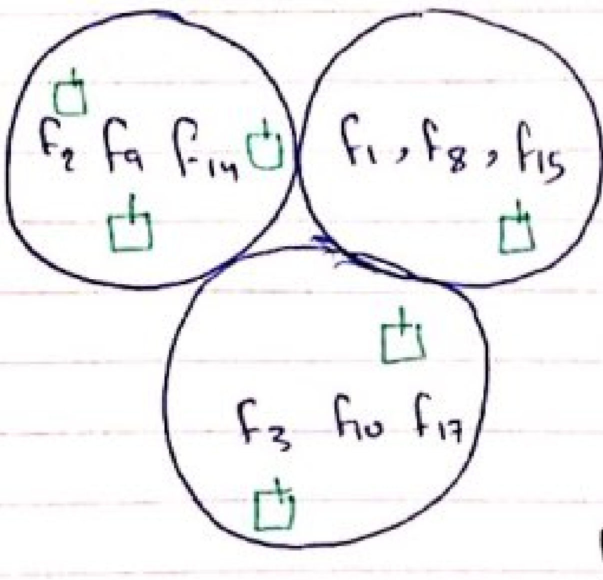
1- Co. Channel Interference.
2- whit Noise
3- Adjacent Channel Interference.
↳ بين ال chan وإلي جنبها

4- Man made Noise.

* Frequency Plan:-

1	2	3	4	...	K
f_1	f_2	f_3	f_4		f_K
f_{K+1}	f_{K+2}	...			
					f_{180}





No.

frequency plan average the adjacent freq inter. and reduce its effect

why avarage ?! لانو مابعرف الشخص الثاني وين واقف

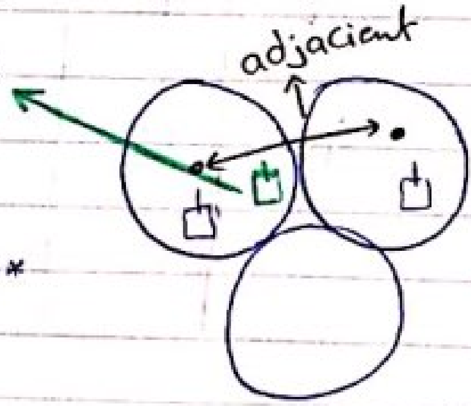
$$\frac{C}{\Sigma I} = \frac{C}{\Sigma I_{co} + \Sigma I_{adj} + \sigma_n^2}$$

* اذا ما اعطاني قيمة C/I ⇐ الكبير هو CD ← اذا راح بعيد زلمه كبير
$C/I \neq \infty$ دقيق

Near end far end

→ worst case.

* far end للـ station تبعتو .
و near end للـ station إلي جنبو .



* القريب من BS بتاخد power قليل ← Inter↓
(base station)

RSSI = recived signal strength Indicator

CDR complete data record
XDR

2/10 MON

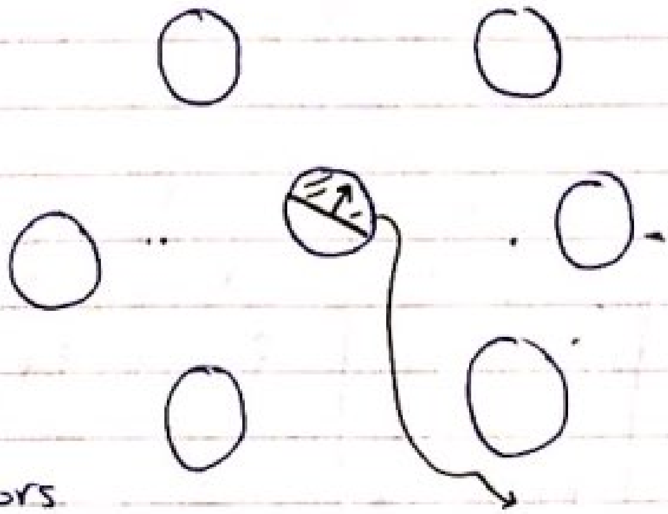
$$\frac{C}{I} = \frac{C}{\sum I's}$$

6 co-channel . عملها

~~Stat~~

* **Sectionization :-**

$$\boxed{\frac{C}{I} = \frac{C}{\frac{6}{n} I} = \frac{q^{\gamma} \cdot n}{6}}$$



هنا النصف بشوف 3 I's

$n \equiv$ number of sectors

$6 \geq n \geq 1$

Ex for $n = 2$ for same example.

Sol => $= 10^{0.85} = \left(\sqrt{3K}\right)^3 * \frac{2}{6}$ $= 9.5\ dB$

$K = 2.25 \rightarrow \boxed{K = 3}$

$N_c = \frac{180}{3} = 60$ → 30 /sector. , 30

30 ch at 1% → $A_{sect} = 18.59$

$A_{cell} = 37.18\ Er$

Total no of cells = $\frac{5K}{37.18}$ = 134.48

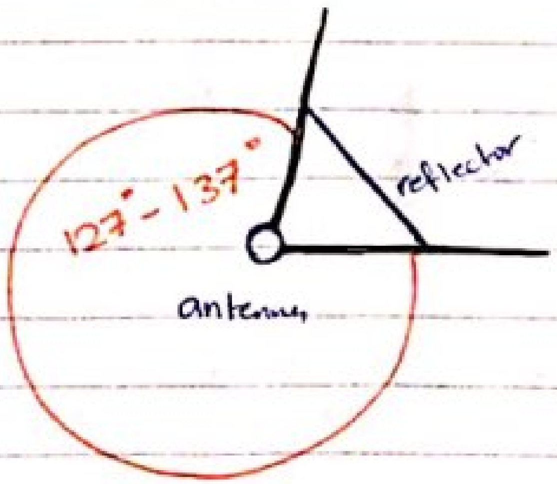
 # cell = 135 cell

K →

A		B		C	
1	2	1	2	1	2
f_1	f_2	f_3	f_4	f_5	f_6
f_7	f_8	..			

* sec I can control

and keep seq from about any freq.



No.

n=3 ⇒ $N_c = \frac{180}{3} = 60$ → 20 /sector, 20, 20

$\frac{C}{I} = 11.3$ dB $\left[(\sqrt{3K})^3 \cdot \frac{3}{6} \right]$

$A_{cell} = 32.91$ Er

20 ch at 1% BP → $A_{sect} = 10.97$

total no of cell $= \frac{5K}{32.91} = 151.9$

# of cell = 152 cell

K →

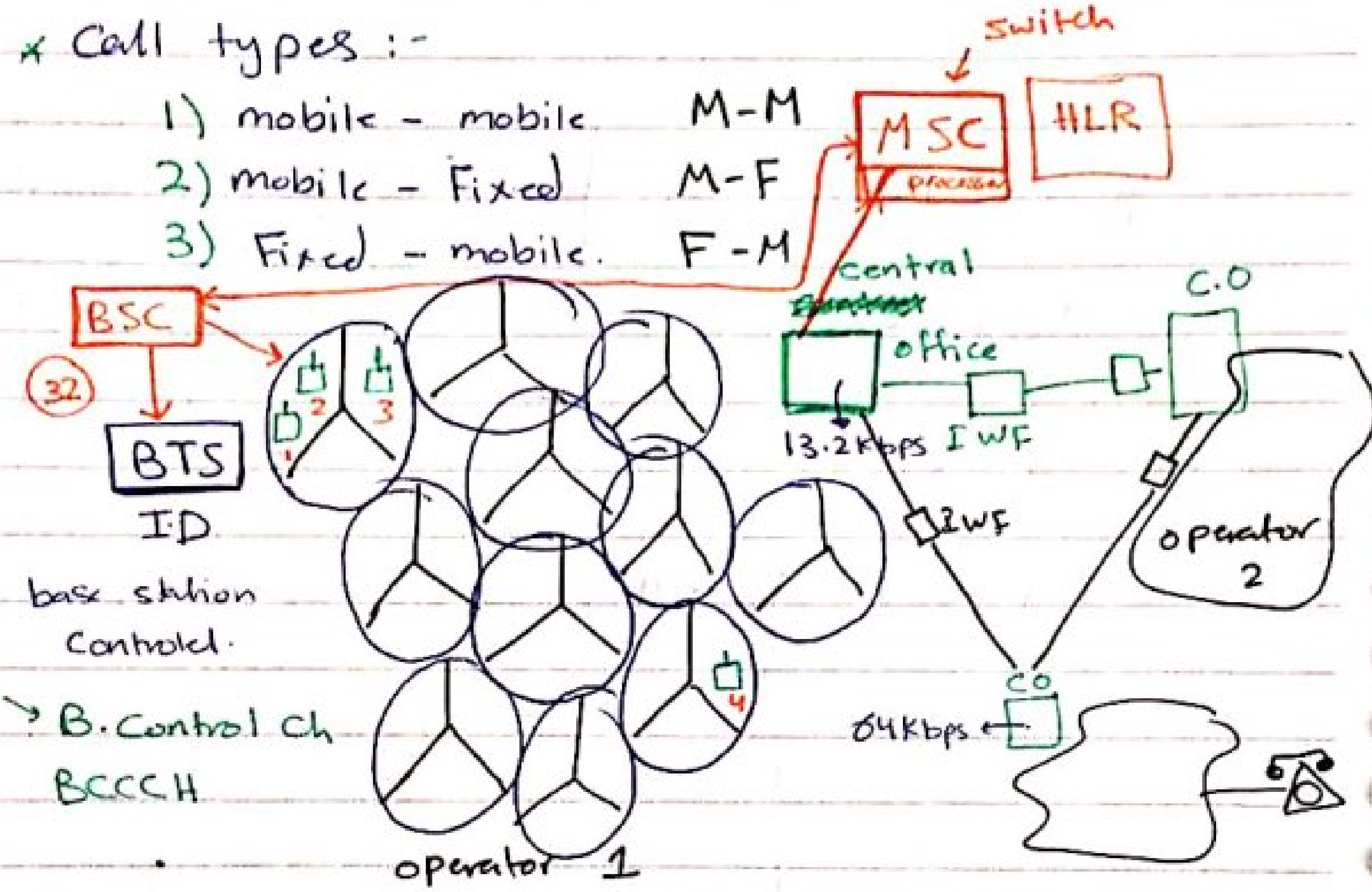
A			B			C		
1	2	3	1	2	3	1	2	3
f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9
f_{10}	f_{11}	.	. .					

Cell configuration K x n (3x3) ⇒ best solution for any cellular sys.

* Call setup 84

* Call types :-

1) mobile - mobile M-M
2) mobile - Fixed M-F
3) Fixed - mobile. F-M



BSC = base station Controled.

(broad cast) → B. Control ch

BCCCH

M-M → Intra cell داخل
- → sector (1-2)
- → cell (2-3) / (1-3)
- → operator

→ Inter cell خارج
- → sector (2-3)/(1-3)/(1-4)(3-4)(2-4)
- → cell (2-4) (1-4) (3-4)
- → operator
- → technology

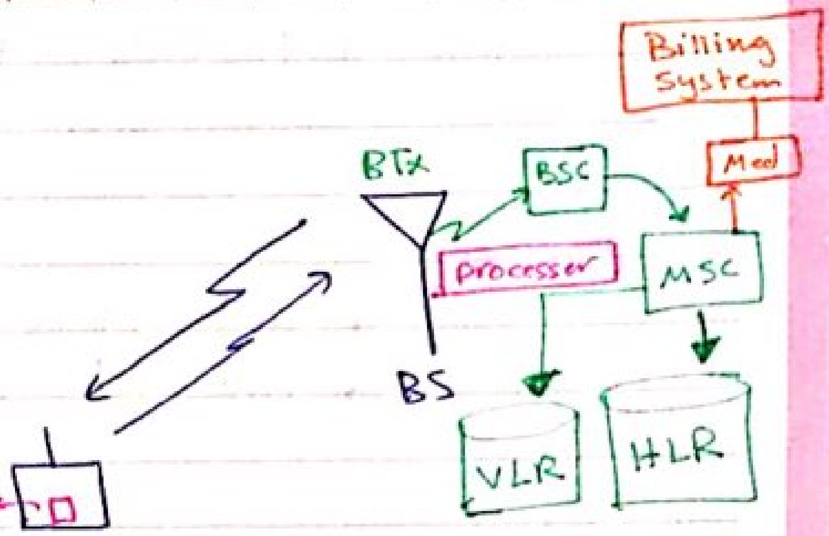
IWF : Inter working frame.

No. 4/10 Wed

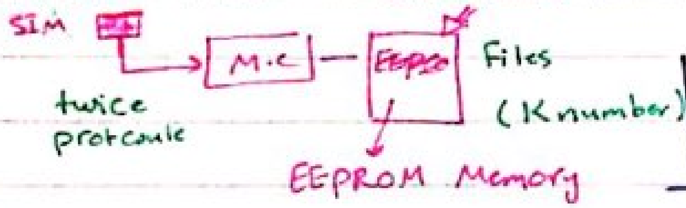
* Call setup 8△

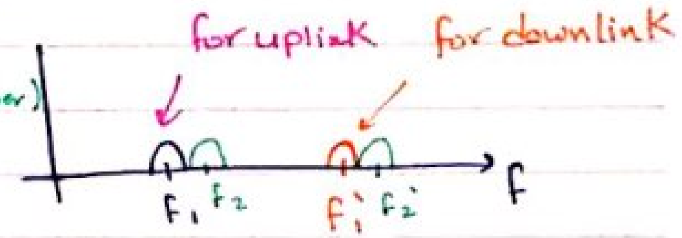
~~[illegible]~~

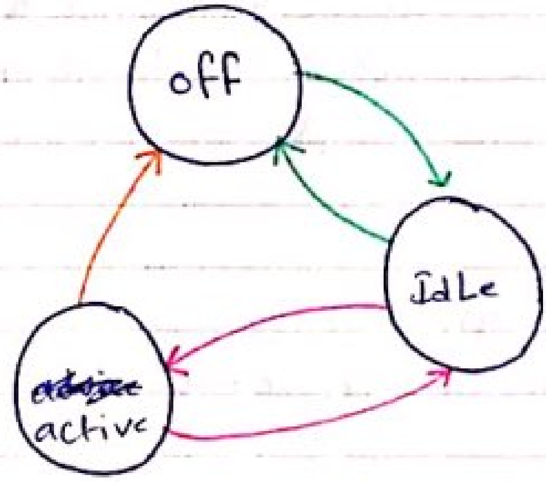
FDD and TDD



M.C ≡ Micro controler







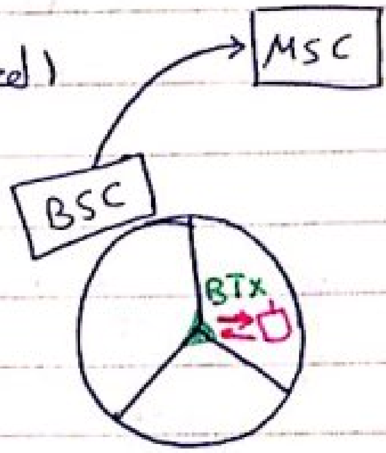
M.S
State

→ power ON
→ Network search (Random access)
→ Authentication

~~[illegible]~~ " Noise → best Password "
M-seq

use goald code to crate a passward.
↳ 2 m-seq.

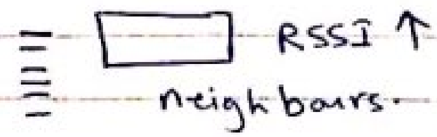
Idel →
→ send phone number (called)
→ call end



* Control data are transmitted through voice Channel when active mode. ((on call))

* لما تكون تكلم وبيعت مسج بيبعت على voice channel مش على control channel

* Idel ⇒
location update.
measurment report ✓
→ RSSI
for 7 nearest BTS then order them



→ (H.O request) " X مسك تغير ومسك "
H.O ≡ Hand over

No. 9/10 MON

RSS = Recive signal strength.

min power recived ≥ -110 dBm

min P_r (GSM) ≥ -100 dBm

* -83 dBm = $10^{-8.3}$ mW = 5pW

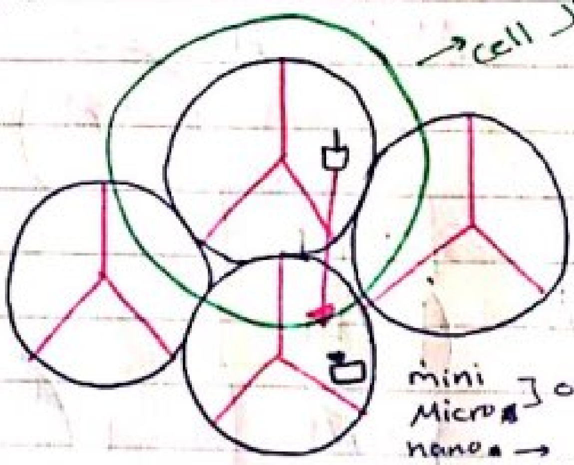
H.C "Home cell"

N_1 → Neighbuar.

N_2

⋮

N_6



(delayed H.O
cell breathing

mini] out doors
Micro]
nano → flat (طوابق)
pico (قاعة)

"H.O" Hand over Failiur 8

- NO Idle Channel in next cell (conjestion).
  ↳ delayed H.O "عالشغل، ماتلاقي ch فاضية"
- Stability of H.W "Hard ware"
  ↳ design
  ↳ base station
- C/I or Pr levels

→ Hard H.O ≡ hard hand over ' عالغيرال frq "

↳ ($f_1 \rightarrow f_2$)

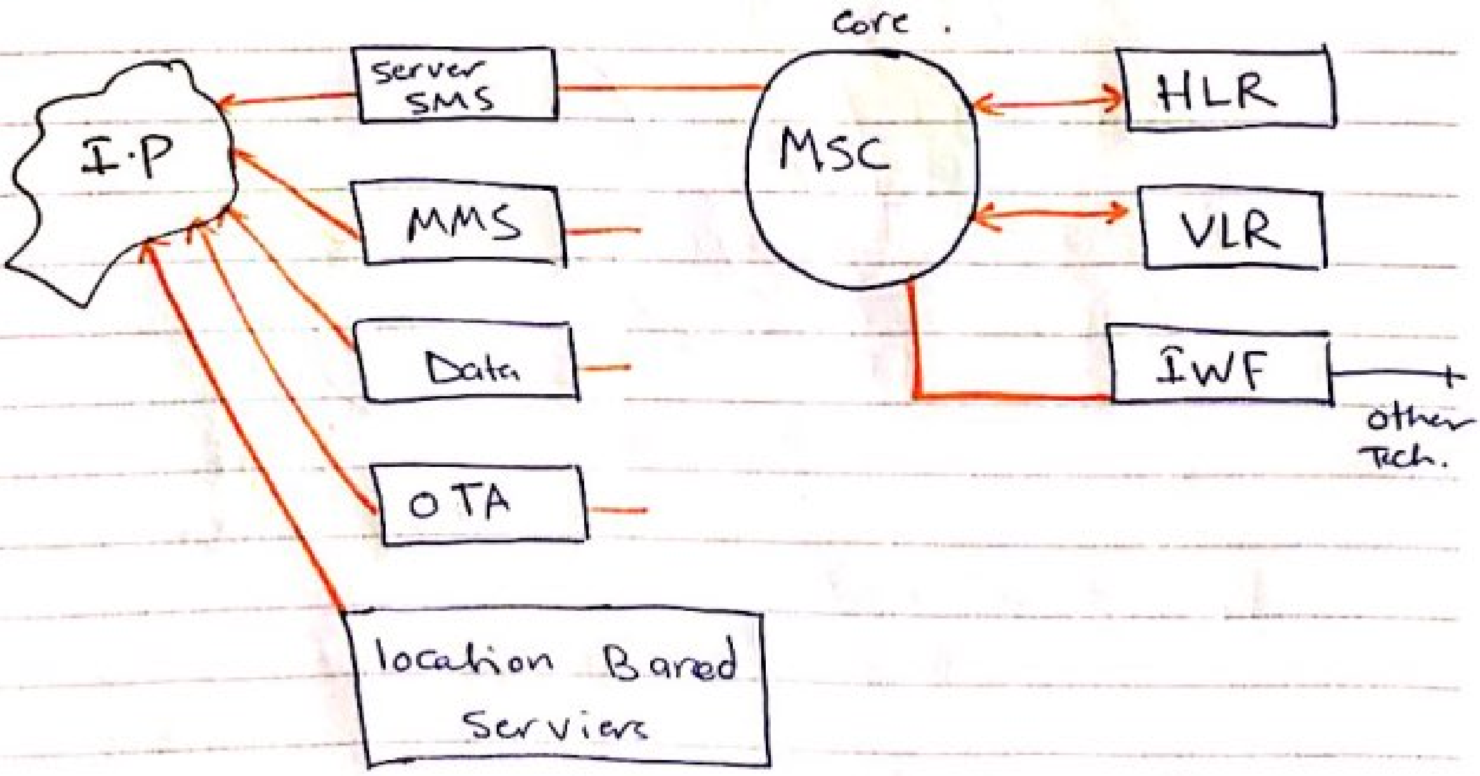
→ Soft H.O ' الأفضل "

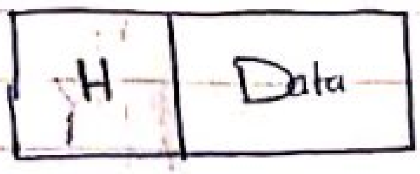
* Channel Assignment:
  - Fixed
  - Dynamic

"cluster : differnt type of cell"

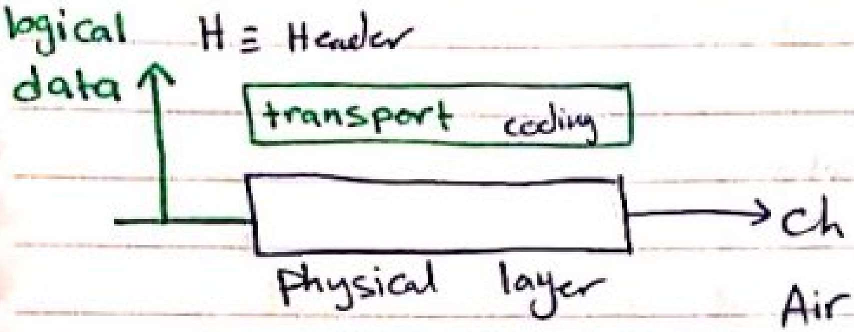
  - Hybrid → Fixed ✓ group
    ↳ Dynamic (S)

VAS ≡ value added cells.

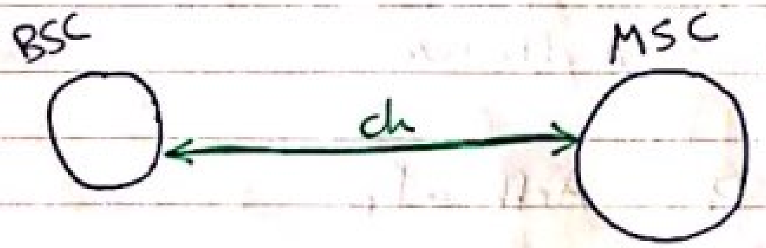




H ≡ Header



Air. Interface.

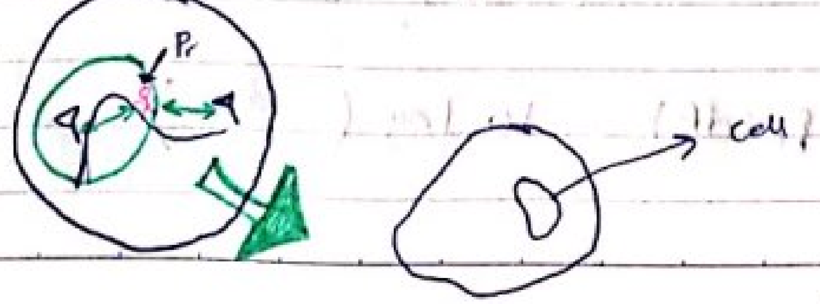


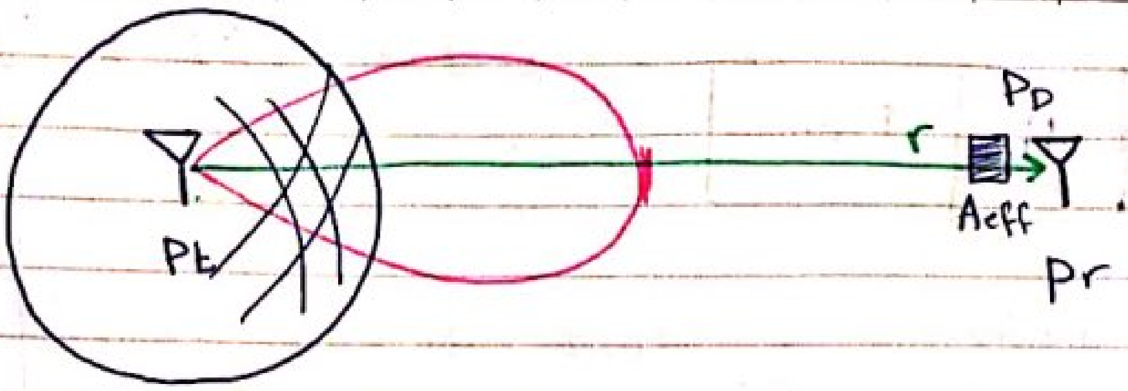
* Coverages:

- Time → reliability
  - H.W
  - supply
  - maintaneance.
- Space
  - Pr ?! "absolute value"
  - C/I ?! "critical factor"

persentage of time you make astablesh a succesful call in any location in the network.

Atoll





$P_D \equiv$ power density

$$P_D = \frac{P_t}{4\pi r^2}$$

$A_{eff} \equiv$ A effective

$$P_r = A_{eff} \cdot P_D$$

$$P_r = \frac{P_t \, A_{eff}}{4\pi r^2}$$

$$A_{eff} = \frac{G_r \lambda^2}{4\pi}$$

① free space model :-

$$P_r = \frac{P_t \cdot G_r \lambda^2 \cdot G_t}{(4\pi r)^2 \to 8}$$

$P_r(dB) = 10 \log (\;\;)$

No.

$$P_r(dB) = \underbrace{P_t + G_t}_{EIRP} + G_r - 20\log\left(\frac{4\pi r}{\lambda}\right)$$

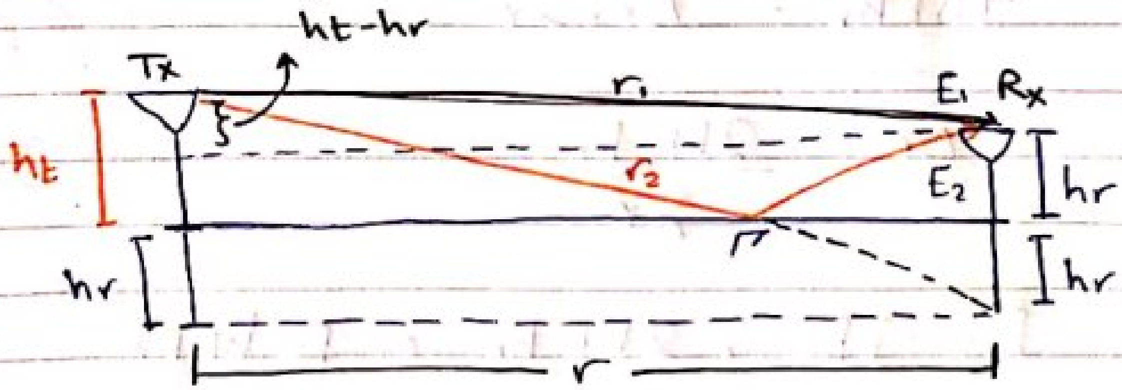
* $\lambda = \frac{c}{f}$

$$P_r(dB) = P_t + G_t + G_r - \underbrace{20\log\left(\frac{4\pi f r}{c}\right)}_{\text{free space loss}}$$

EIRP ≡ effective isotropic recived power.

$$P_r = P_t + G_t + G_r - loss$$

2 two ray model :-



* وصلت الـ signal نفسها مرتين.

$$\vec{E} = \vec{E_1} + \vec{E_2}$$

$$\Delta\theta = \frac{\Delta r}{\lambda} \cdot 2\pi$$

$$E_1 = E_0 \angle\theta$$

$E_2 = \Gamma E_0 \angle \Delta\theta$

$$\boxed{\Gamma = -1}$$

$e^{j\Delta\theta} \rightarrow \cos\Delta\theta + j\sin\Delta\theta$

$$E = E_1 + E_2 = E_0 \left(1 - e^{j\Delta\theta}\right)$$

$$= E_0 \, -j\sin\Delta\theta = -jE_0 \, \Delta\theta$$

$$r_2^2 = r^2 + (h_t + h_r)^2$$

$$r_1^2 = r^2 + (h_t - h_r)^2$$

$$(r_2^2 - r_1^2) = (r_2 - r_1)(r_2 + r_1)$$

$$4 h_t h_r = \Delta r \cdot 2r$$

$$\therefore \Delta r = \frac{2 h_t h_r}{\lambda r}$$

$$\therefore E = -jE_0 \cdot \frac{2 h_t h_r}{r} = \frac{E_0 h_t h_r}{r^2}$$

$$E_0 = \frac{E_t}{r}$$

$$\boxed{P_r = \frac{P_0 \, h_t^2 \, h_r^2}{\lambda^2 \, r^4}} \rightarrow \gamma$$

No. 16/10 MON

* free space :-

$P_r = P_t + G_t + G_r - \text{loss}$

($P_t + G_t$ = EIRP)

loss → $\left(20 \log\left(\frac{4\pi r}{\lambda}\right)\right)$

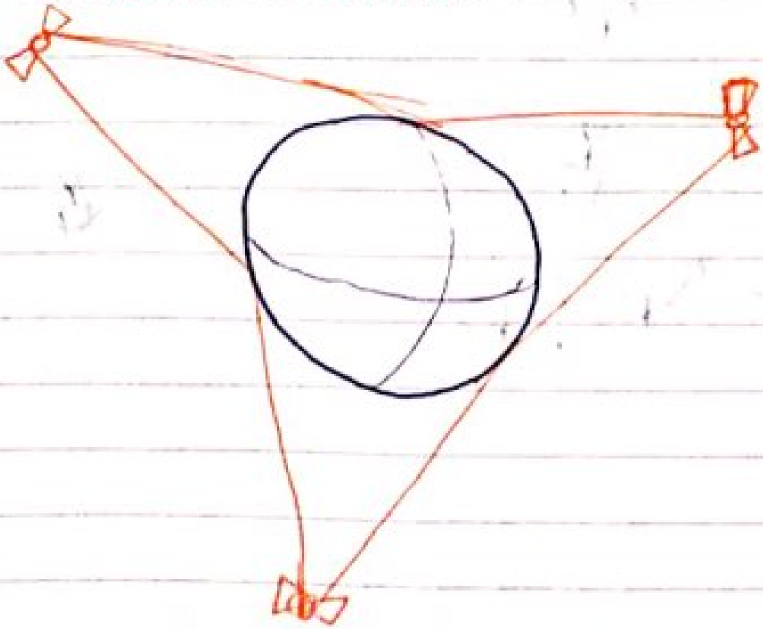
free space loss

* two ray Model :-

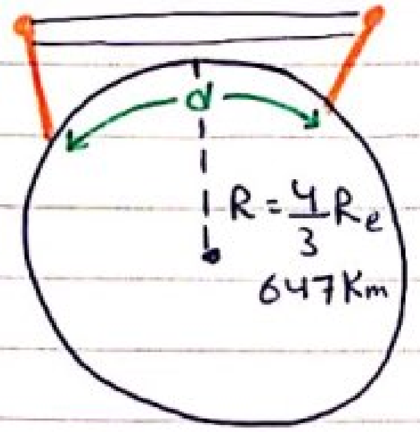
$$P_r = P_o \frac{h_t^2 \, h_r^2}{\lambda^2 \, r^4}$$

$$P_r = P_o + 20\log(h_t) + 20\log(h_r) + 20\log(f) - 20\log(c) - 40\log(r)$$

* Earth curveture effect :-



No.



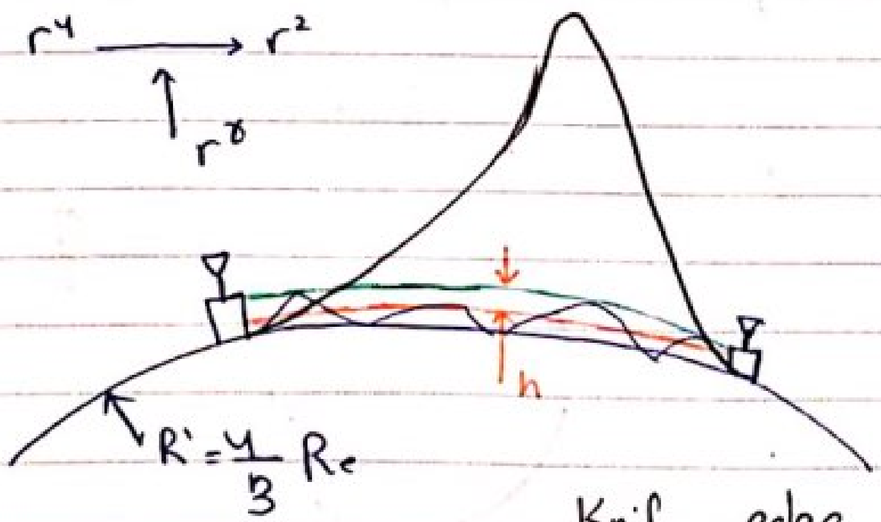
$d_{max} = \sqrt{17 h_r} + \sqrt{17 h_t}$ Km

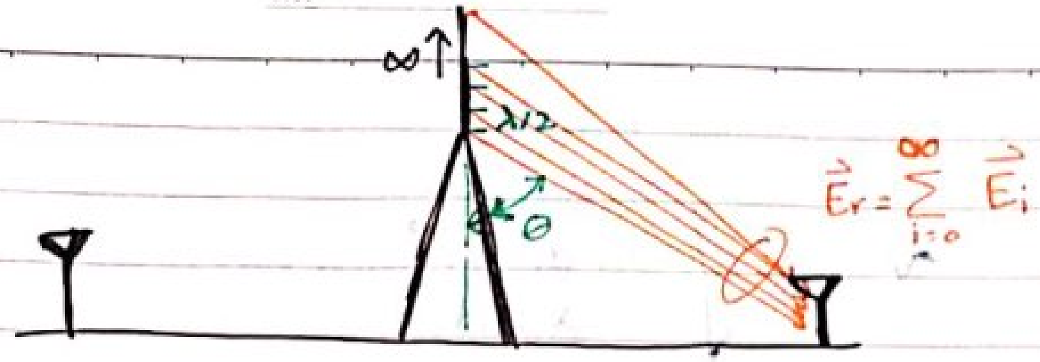
h_t, h_r in m.

$R_e \equiv$ radius earth.

* $r^4 \longrightarrow r^2$

$\uparrow r^0$

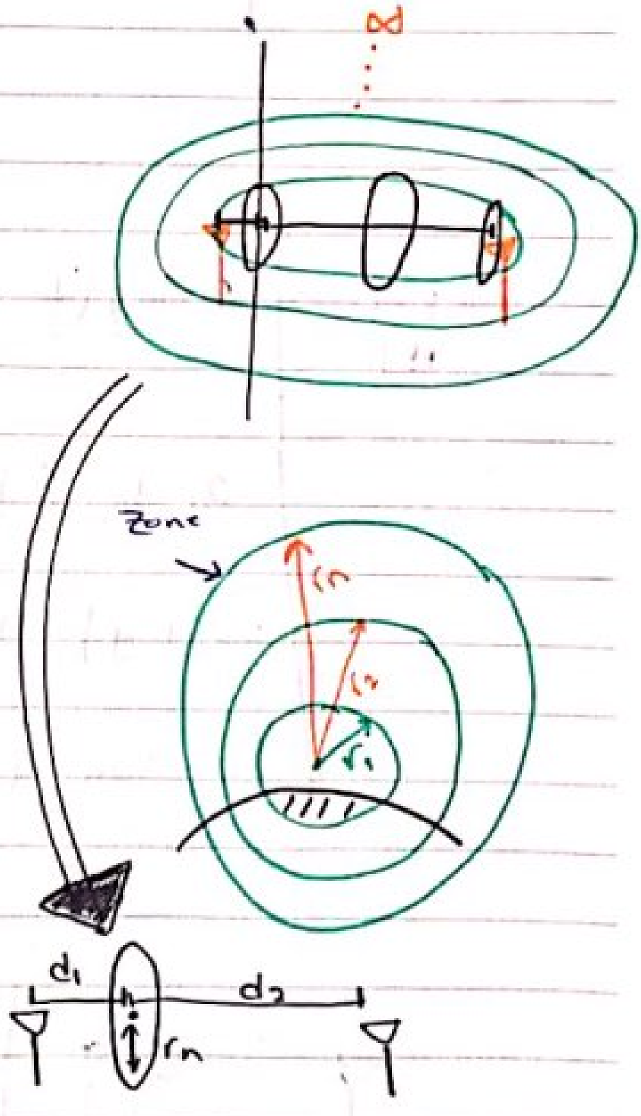




$$\Delta d = \frac{\lambda}{2} \cos\Theta$$

$$\Delta t = \Delta d \frac{2\pi}{T}$$

$$\Delta t = \frac{\pi \lambda \cos\Theta}{T}$$

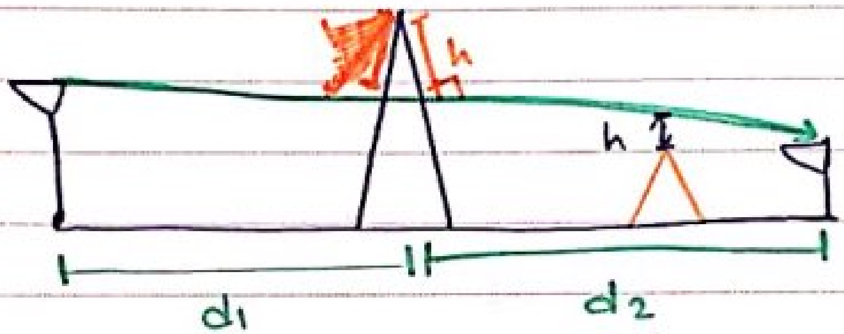


$$r_n = \sqrt{\frac{n\lambda d_1 d_2}{d_1 + d_2}}$$

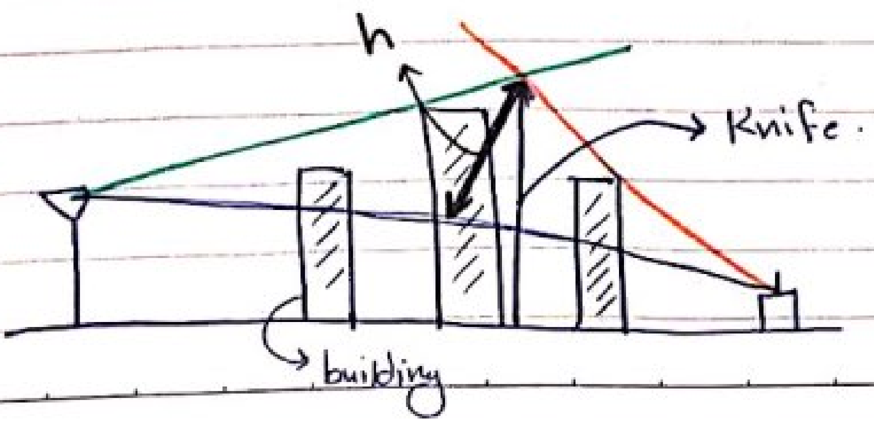
$n \equiv$ number of frazenel zone.

Knife edge loss:-

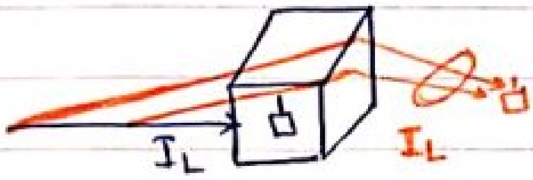
$$\nu = h\sqrt{\frac{2(d_1+d_2)^2}{\lambda d_1 d_2}}$$



$$\text{loss}_{(dB)} = L_{Knife} = \begin{cases} 20\log\left(\frac{1}{2} - 0.62\nu\right) & -1 \leq \nu < 0 \\ 20\log\left(\frac{1}{2}e^{-0.95\nu}\right) & 0 \leq \nu < 1 \\ 20\log\left[0.4 - \sqrt{0.1184 - (0.38-0.10)^2}\right. & 1 \leq \nu < 2.4 \\ 20\log\left(\frac{0.225}{\nu}\right) & \nu \geq 2.4 \end{cases}$$



smile

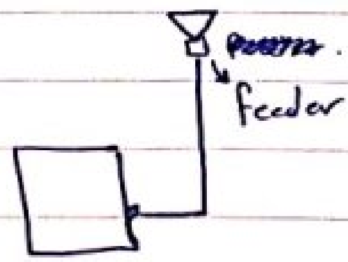


f_L = Insertion loss

* General path loss Model :-

$$P_r = P_t + G_t + G_r - Loss$$

$$Loss = Loss_{\text{free space}} + 10\gamma \log(r) + L_{\text{knife (if exist)}} + L_{\text{feeder}} + L_{\text{weather}} + L_{\text{others}}$$



18/10 Wed

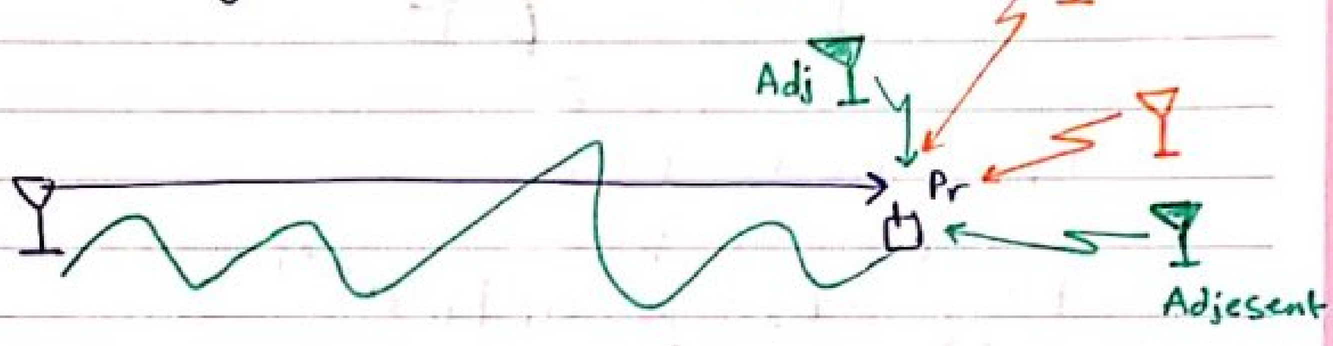
$$P_r = P_t + G_t + G_r - \text{loss}$$

path losses:-

dBW
dBm

$$\text{Loss} = L_{free} + L_{Knife} + L_{feeder} + L_{weather} + L_{others}$$

$$+ 10\log(r)$$ " dB " $+ L_{Adj}$ " ان وجد "



$P_r = C$ from Home

$P_r = I_{co.ch}$ from Co.channel interference Calls

$P_r = I_{Adj}$

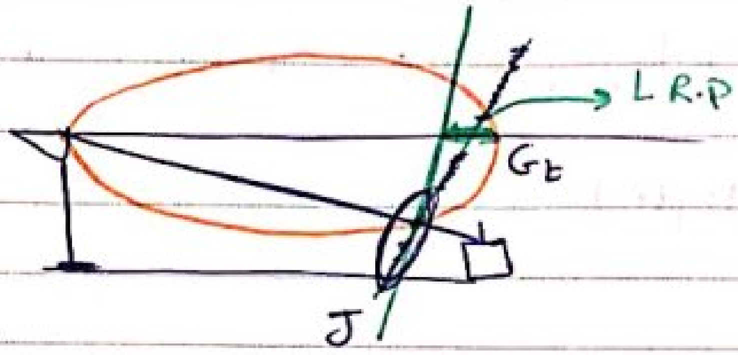
Loss adj = 40 dB

Actual C/I $= \dfrac{C}{\sum I's + \sigma_n^2}$

* اذا جه co.ch بيعمل ال adj ch. واذا ما وجد ال co.ch كسب ال adj ch.

No.

$$Loss = L_{free} + L_{knife} + L_{feeder} + L_{weather} + L_{other} + L_{adj} + 10\gamma \log(r) - a(h_t) - b(h_r) + L_{R.P}$$



$L_{R.P}$ = Radiation pattern

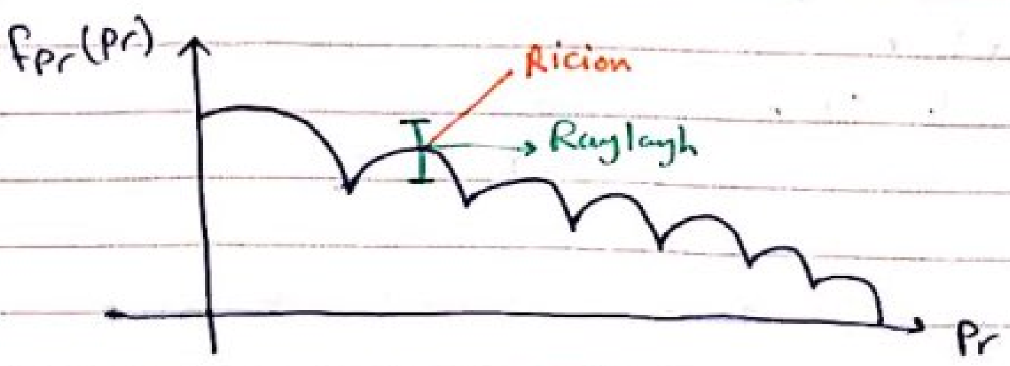
$$\vec{E} = \sum_{i=1}^{J} E_j = \sum_{i=1}^{J} \alpha_i E_t e^{j\delta_i}$$

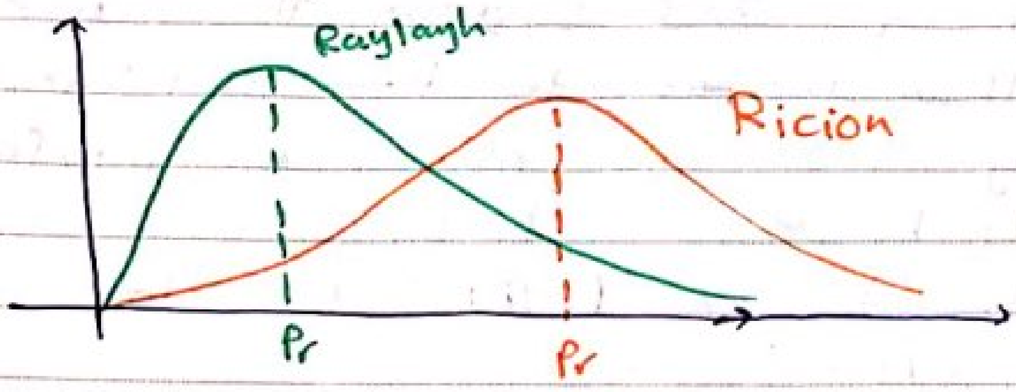
$$P_r = \frac{|E|^2}{\eta_0}$$

→ Ricion LOS
→ Raylagh LOS

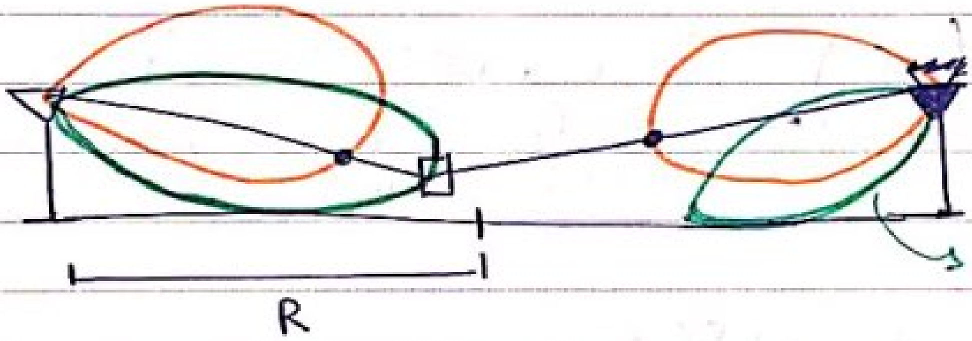
Long term is log normal R.V

Line of side (domenint compontent)





$P_r > P_r$



Down telting :-

$$\frac{C\uparrow}{I\downarrow}_{new} = \left(\frac{C}{I}\right)_{old} + \uparrow C + I\downarrow .$$

" Hata's Model "

$$P_r = P_x - 10\gamma \log(r)$$

$$P_r = P_o / r^{\gamma}$$

at certain constant.

Scanned by CamScanner

No.

Ex for a 3X3 system the down telting increase the Home cell signal by 2 dB and reduces the interference I_1 by 1 dB I_2 by 2.5 dB

Find the new (C/I) if the old.

C/I = 7 dB ?!

sol:- $\left(\frac{C}{I}\right) = \frac{C}{I_1 + I_2} = \frac{C}{2I}$ "$I_1 = I_2$"

$$\left(\frac{C}{I}\right)_{new} = \frac{C * 1.58}{\frac{I_1}{1.25} + \frac{I_2}{1.77}}$$

"C increase (*) $10^{0.2}$

I decrease (÷) $\frac{I_1}{10^{0.1}}$, $\frac{I_2}{10^{0.25}}$"

$$= \frac{C}{2I} \frac{* 1.58 * 2}{\left(\frac{1}{1.25} + \frac{1}{1.77}\right)}$$

$$= \left(\frac{C}{I}\right)_{old} * 2.31$$

$\Delta(C/I)$ [redacted] = 3.6 dB "10 log (2.31)"

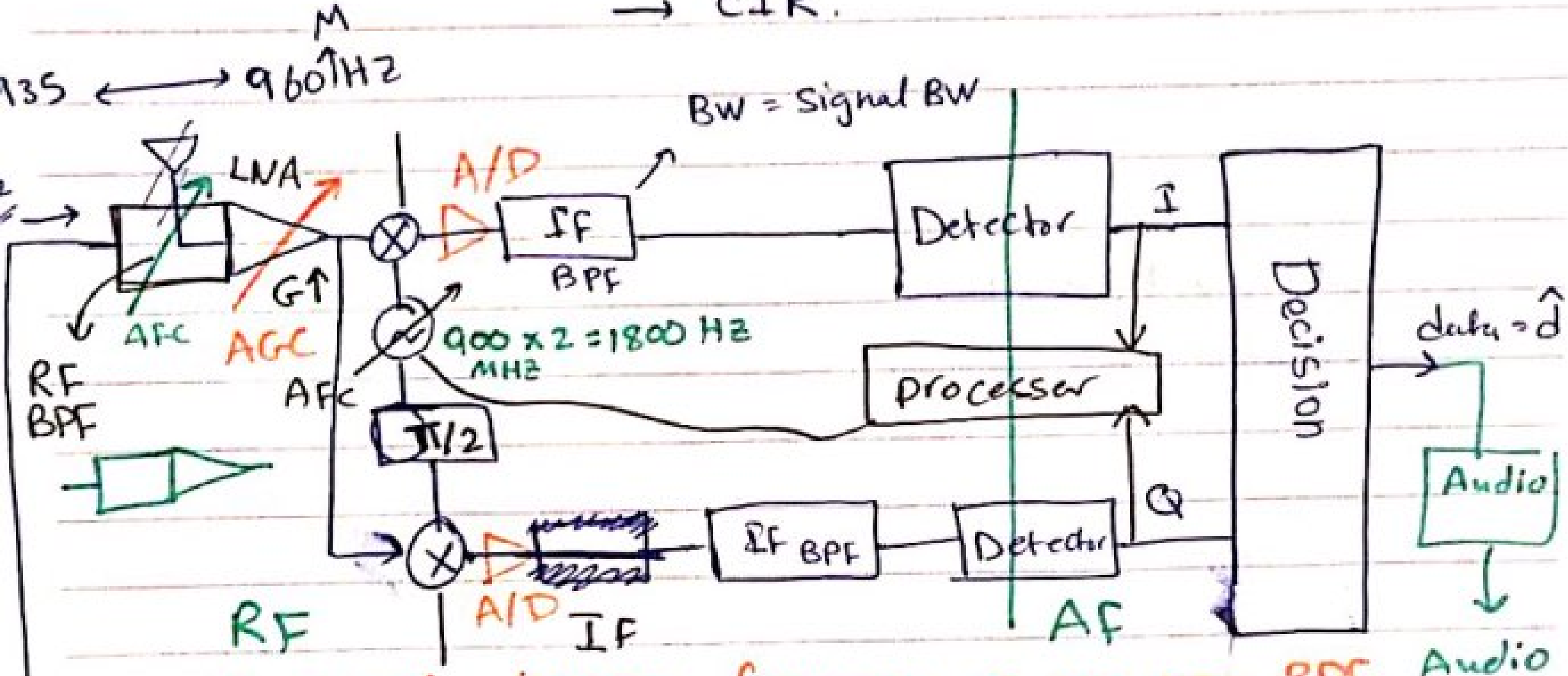
$(C/I)_{new}$ = 10.6 dB "3.6 + 7 = 10.6 dB"

25/10 Wed

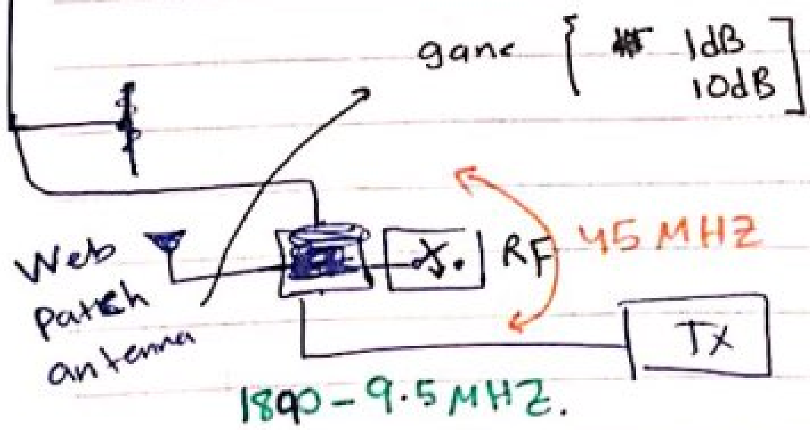
* Coverage :-

time → ~~[illegible]~~ reliability of equibment.

Space → propogation loss
→ Pr
→ CIR.



to reject image. freqency → we use BPF



120 = (20dBm) ← (80-120) mW [illegible]
100 pW. [illegible] PR
(-70dBm)

Rx Sensentivity (Pr كم)) = min Pr.

Pr → antane. بعد ال

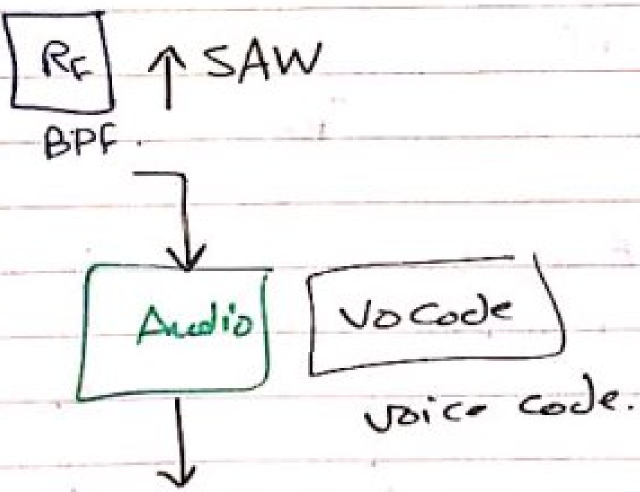
PD → ant قبل ال

$G = \underline{A_{eff} * \lambda^2}$

PD = power density.

$P_r = P_D \cdot A_{eff}$.

[AGPS Rx $P_{min} = -170$ dBm.]



Audio processor.

No.

30/10 MON

1- Network cell Info like freq.

2- Cell Towers.

for ASK, PSK, QAM, ...

↳ $BW = \frac{r_b}{m}(1+\alpha)$ HZ   for a 1 and 2 dimension

for. FSK, Multi Carrier, N-D modulation.

↳ wide band modulation.

- w_1, w_2, ...

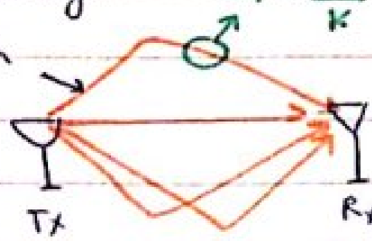
sin, cos ((not FSK))

→ SS ((spread spectrum))

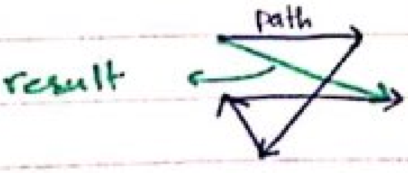
FSK $BW = M \frac{r_b}{m}(1+\alpha)$ "BW كبير"

↳ using for ~~fading~~ fadding. $E_i = \sum_k E_k$

Multi path



* Fadding :-

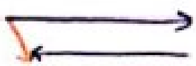


phase

$E_k = E_o e^{j\delta_k} * \alpha$

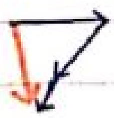
$\alpha \equiv R.V$

$\delta \equiv R.V$



worst Case

~~from~~ two ray model



ℓ paths

No.

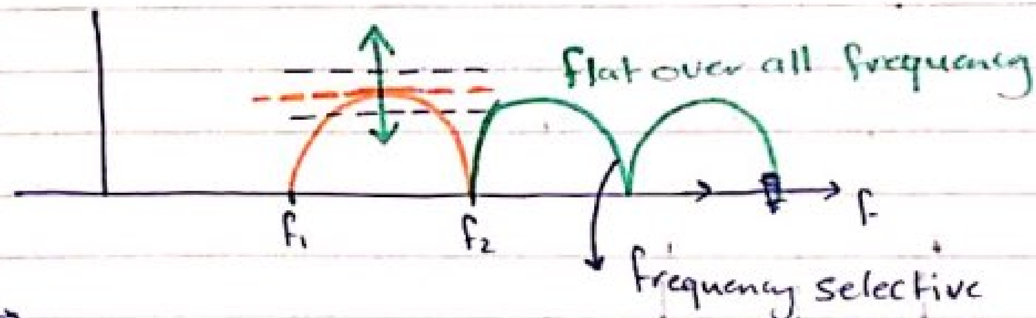
$E_i = \alpha_i E_o$

- fadding → تغيرات بتصير في الـ Channel → slow / fast.

Slow fadding → slow (flat fadding)
→ quzi slow (quzi static شبه ثابت)
channel equalizer. لازم استخدام

fast fadding

channel in frequency domain:-



$\Delta\theta = \frac{2\pi}{\lambda} \Delta d$

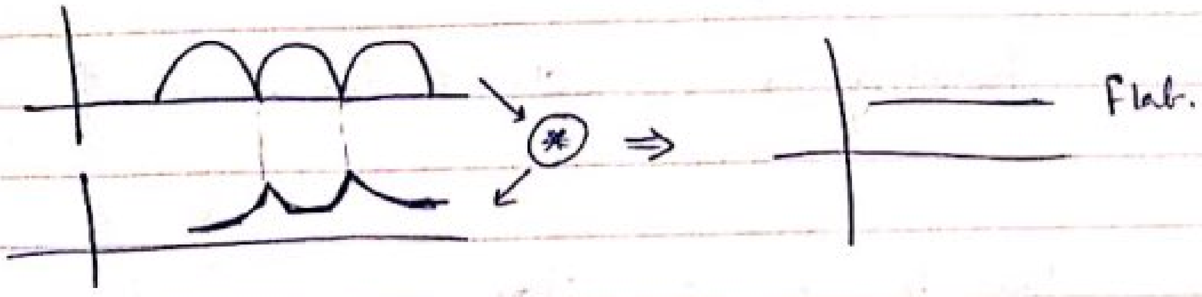
frequency band ↑ → λ مختلف

[worst case. ← frequency selective اذا كان] *

selective → band كبير.

smile...

* equilaizer.

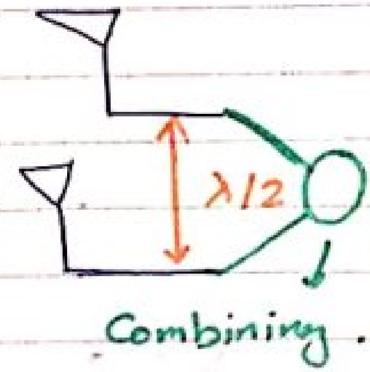


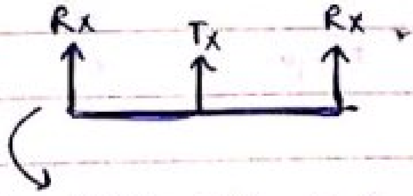
~~appr~~ "

two apprach → Combining → diversity.
→ Equalization.

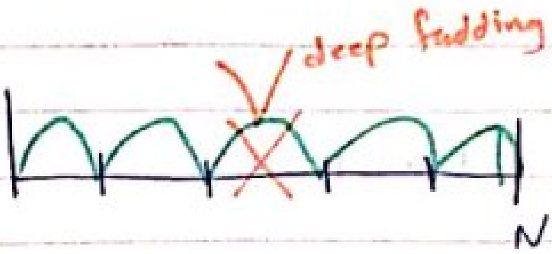
need 2 independents 'anntena.

combinging → 2 signal zap.
phase shift = 180°



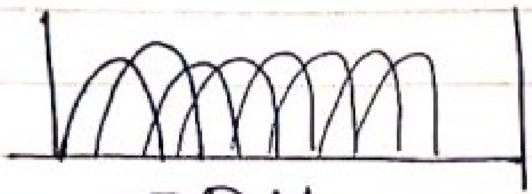


Tx بالنص , 2Rx عشان modem بال
. fadding عشان الـ



قسمت الـ data
sub channel
↳ sub carrier.

حولت الـ selective
non selective لـ



OFDM => FSK مشابه

↳ orthogonal

2G – GSM → اوروبي

IS 54
IS 36
IS 95 → NCDMA N ≡ Narow

3G – CDMA → WCDMA W ≡ wide band.
→ UMTS ↳ power control اللي فيه

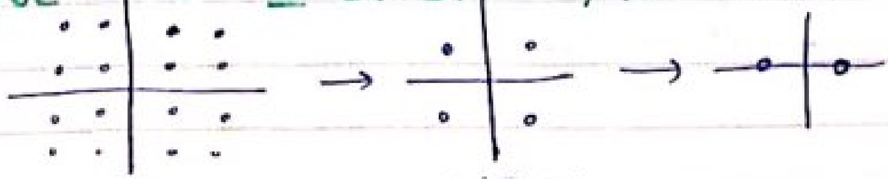
((power control))

2.5 EDGE
GPRS

3.5 G OFDM (Y-Max)
4G OFDM
} for IP

* each sub carrier:

((2004)) Adeptive Mod ≡ Claster Mod ((1996))



16 QAM 4QAM

* مستخدم في Ymax, ...

No.

1/11 Wed

Quiz 1:

given the path loss equation as:

$L = 65 + (1.3 h_t + 31) \log(r)$

find the C/I from a user 500 as from his own base station. and average 2.5 km from each cells.

the cell configuration is 3x3

$h_t = 20$ km.

find γ ?!

$\gamma = \quad = 3.1$

$\frac{C}{I} = (EIRP - L_t) - (\hat{I}) - (L_I + 3) - L_c$

$$\boxed{I = EIRP - (L_I + 3)}$$

$\frac{C}{I} = 68 + (26 + 31) \log(r) - 65 - 57(\log(r))$

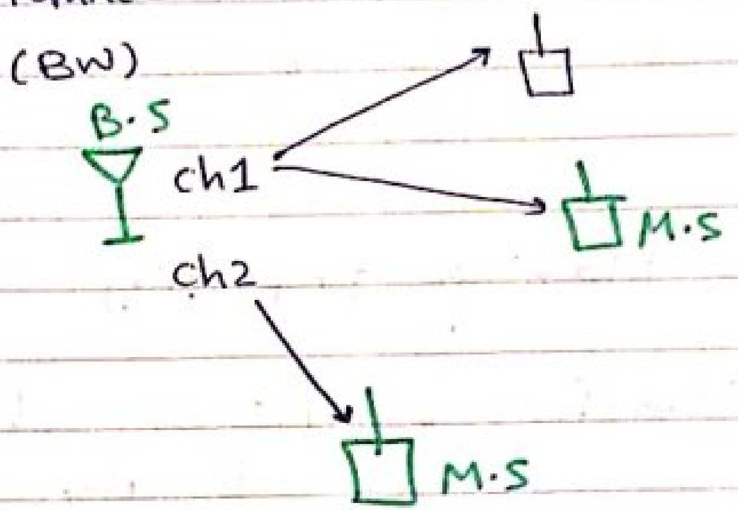
$= 3 + 57 \log(2500) - 57(\log(500))$

$= 42.8$ dB.

Channel :

- fadding

- Interferance



⇒ max capacity. ⇒ under Quality of Service

Q.O.S

- V.A.S
- B.P
- BER
  Voice Quality
- dropped calls

dropped calls:

- Congestion (H.O) ((Hand over)) → (traffic)
- synch (H.O)
- C/I ↓ } coverage.
- Pr ↓

Voice Quality

- source code (Data compression).
  ((related to Modulation))
- Channel code E.CC

B.P ≡ blocking propability

↳ Traffic → No of channel.
  ↳ BW
  ↳ spectral effeciency
    η% ⇒ dimention of modulation.

$$BW_{ch} = \frac{r_b}{m}(1+\alpha) \cdot BW \text{ expantion factor } \left(\frac{n}{k}\right)$$

$$r_b = r_b^{\circ} * \text{compression ratio.}$$

$$BW_{ch} = \frac{r_b}{m\uparrow}(1+\alpha) \cdot \underset{\downarrow\ \downarrow BER\uparrow}{BW \text{ expantion factor}} * \underset{\downarrow}{\text{compression ratio.}}$$

BER ↑ → BW_{ex} ↑

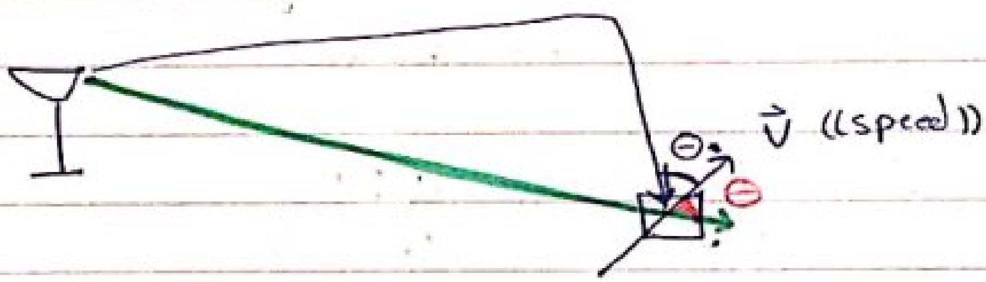
((انا بدي BER أقل))

$$BER_{coded} \simeq (BER_{ch})^{t+1}$$

$$\uparrow t \longrightarrow \uparrow \frac{n}{k}$$

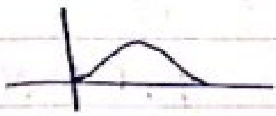
Doppler effect :-

related to fadding



$$\Delta f = \frac{V \cos \theta}{C}$$

, $\Delta f \equiv$ R.V (Random variable)



Multiple Access :

- TDMA "Time"
- FDMA
- Hybrid (TDD, FDD)
- CDMA (soft H.O)

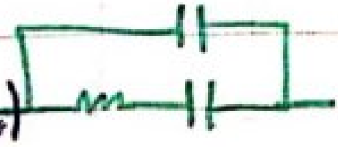
No.

⇒ GSM → binary.

GMSK gaussian minimum shift keying.

↓

gaussian filter (~~RC~~)



(RC$_\alpha$)

$\pm \pi/2$ "0", "1"

$r_b^c = 13.2$ ~~kbps~~ Kbps

⇒ IS ⇒ use different type of modulation " non binary ", more effcient.

IS 36, 54 : π QDPSK. (m = 2)

$r_b^c = 16$ Kbps

⇒ IS95.

NCDMA

$$\phi = \sum_{i=1}^{N} v_i(t)\, C_i(t)$$

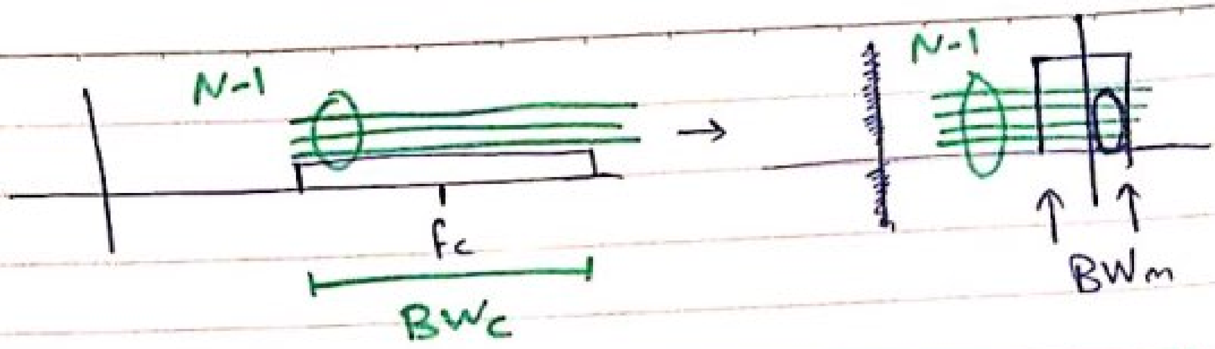
$$\hat{v}_K = \langle C_K , \phi \rangle = V_K + \int \sum_{K \neq i} v_i(t)\, C_i(t) \cdot C_K(t)$$

تكامل

MAI

MAI ≡ multiple access interference.

No.



$$MAI = \frac{P}{\left(\frac{BW_c}{BW_m}\right)} = \frac{P}{C.G}$$

$$C.G = \frac{BW_c}{BW_m}$$

$$\frac{C}{I} = \frac{C.G}{(N-1)\cdot\frac{3}{8}} \Rightarrow \frac{C}{I} = \frac{C.G\cdot 8}{(N-1)\cdot 3}$$

C.G ≡ coding gain.

N ≡ capacity.

$(\uparrow C.G \rightarrow \uparrow N)$

* power لازم توصل متساوية للـ base station

فلازم اعمل power control.

power control (fast)

└ speed = 15K

* ($\frac{3}{8}$ of time have interference.)

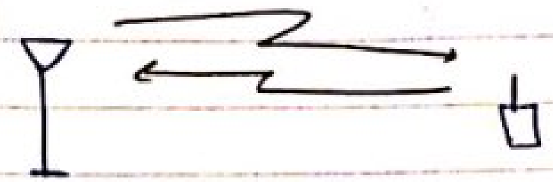
$$\Rightarrow \boxed{\zeta = \frac{3}{8}}$$

$$\frac{C}{I} = \frac{C.G}{(N-1)\cdot\zeta + \sigma_n^2}$$

PN

6/11 MON

* Multiple Access 8∆



total BW / rb limit the capacity:

- 1- TDMA
- 2- FDMA
- 3- TDMA / FDMA (GSM)
  - ↳ rb = 13.2 Kbps.

* Analog (AMPS)

$$\frac{25MHZ}{0.2} \text{ (total BW)} = 125 \text{ ch for analog.}$$

200K HZ (center freq)

قسمنا لـ ١٨ أقسام.

Ts 1 ... 8 TDMA

4- CDMA ⇒ C/I limit the capacity.

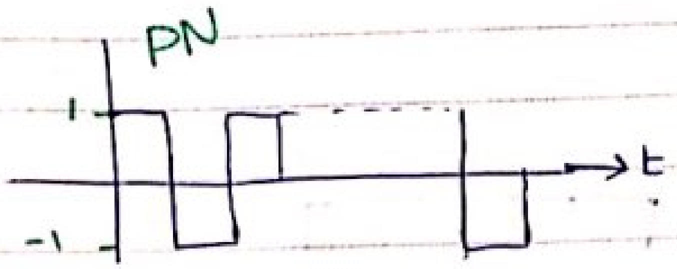
$$\frac{C}{I} = \frac{C.G}{(N-1)\xi + \sigma_n^2}$$

SS = Spread Spectrum

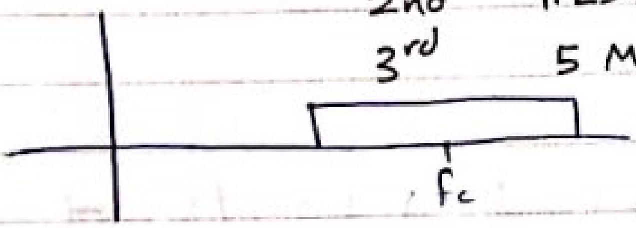
$$C.G = \frac{BW\ (\text{channel})\ S.S}{BW\ \text{user}} = \frac{r_c}{r_b}$$

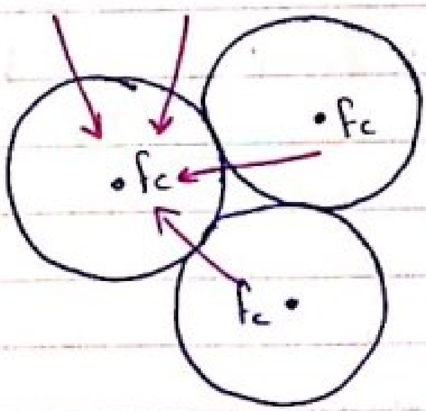
No.

$V_i = C_i * d_i \longrightarrow \phi = \sum_{i=1}^{N} V_i$



2nd 1.25 MHZ.
3rd 5 MHZ





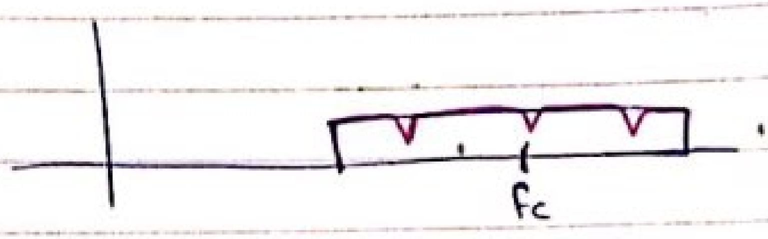
استخدمت
نفس BW

Codes → Channelization code
→ scrampling code. (SC)

$V_i = C_i^{ch} \cdot C_K^{sc} \cdot d_i$

same freq K = 1 → " SC بميزهم "

$$\frac{C}{I} = \frac{CG}{(N-1)\xi + \sigma_n^2 + I_{\text{other cells}}}$$

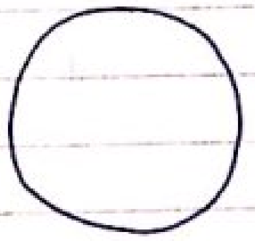


→ frequency selective fadding channel.

Matched filter Rx. for SS ≡ RAKE

power control 15 K times/S ⇒ fast

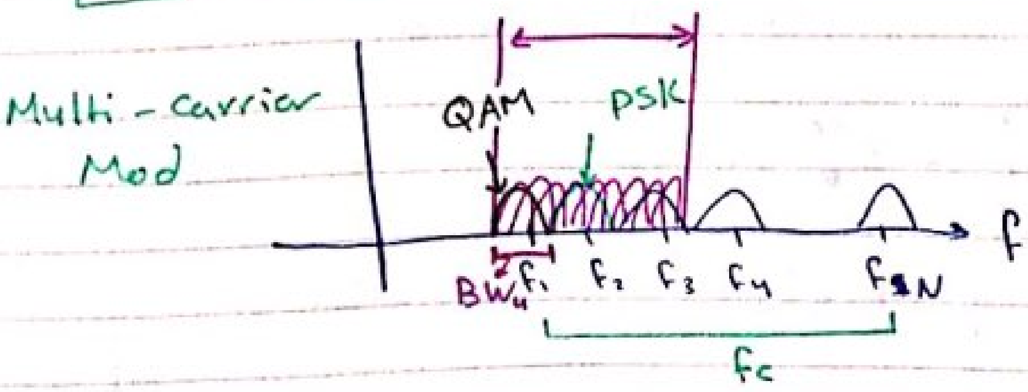
F.H = frequency hopping



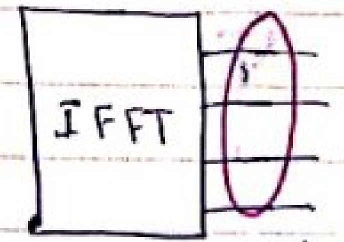
FH in busy hour.

F.H ⇒ to average interference ~(C/I) equal.

5- OFDMA :-



$BW = N \cdot BW_u$



sub carrier.

Orthogonal → No I.C.I

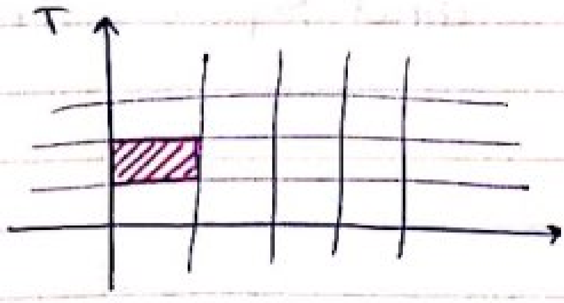
I.C.I ≡ Inter carrier Interference.

لا يصير على fading على freq معينة ← بتأثر على sub carrier .

[Sub carrier → Modulation (2D) QAM
[time slot.

↳ R.B ≡ resource block.

* كل RB بستخدم Modulation معين .



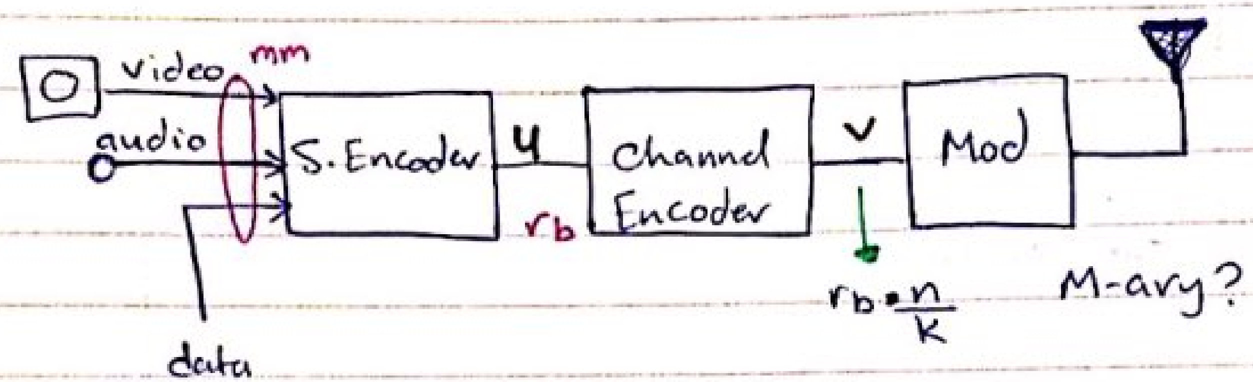
PAPR ≡ peack average power ratio.

↳ (watter filling algorithm)

8/11 Wed

GSM → GPRS

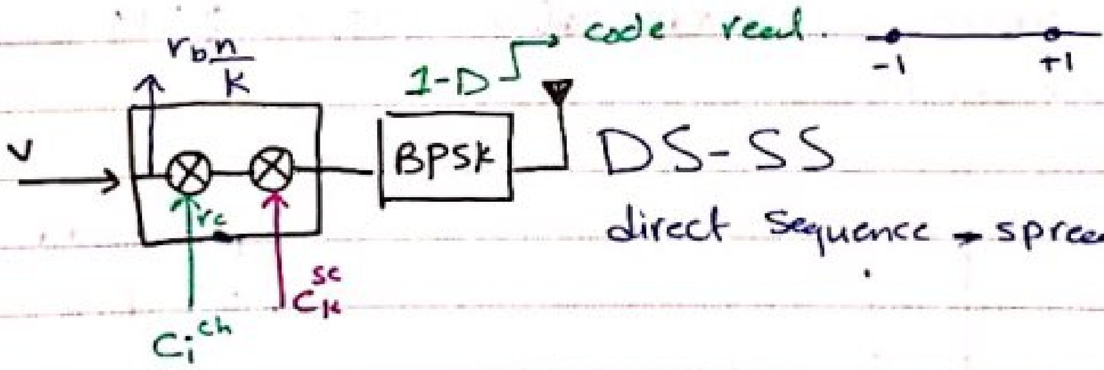
GMSK   π/4 - QDPSK



$$BW_{ch} = \frac{r_b \cdot \frac{n}{k}}{m}(1+\alpha)$$

{ FDMA
  TDMA

$$BW_{user} = BW_{ch} / N_{user}$$



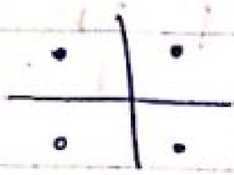
DS-SS

direct sequence - spread spectrum

speed C_K = speed C_i'.

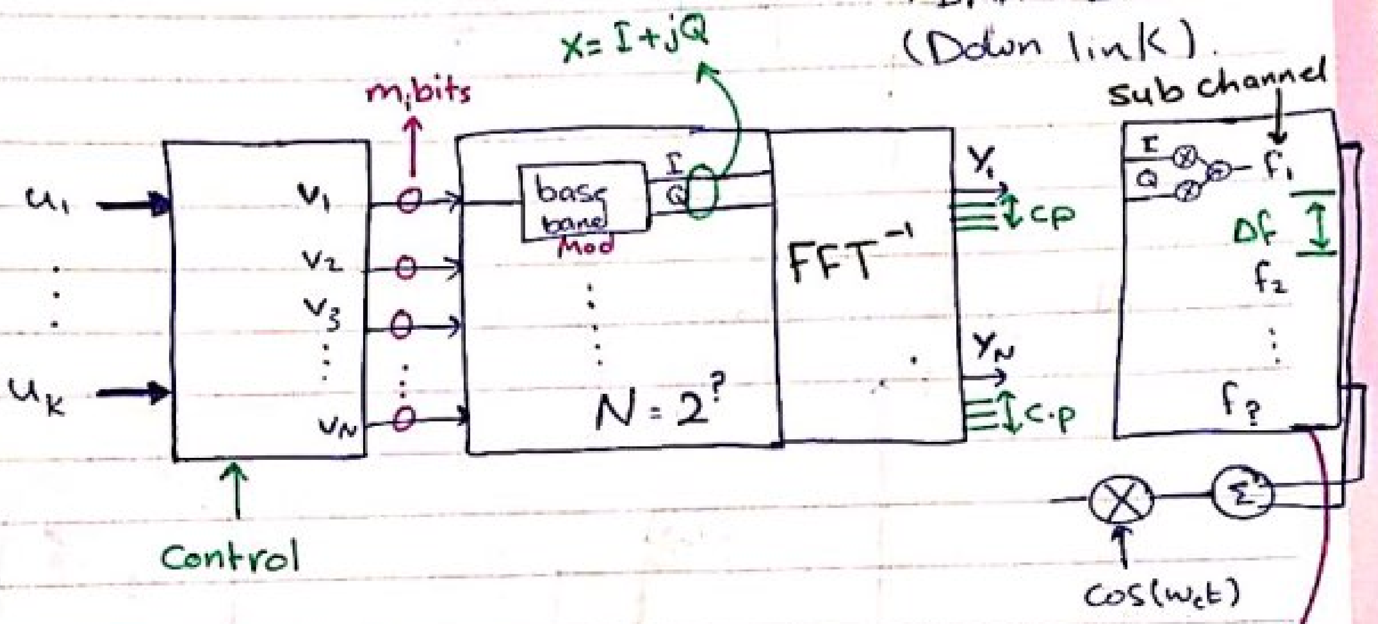
BPSK ≡ Binary phase shift Keying.

if 2-D ⇒ $c_i = c_i^{real} + j\, c_j^{Im}$



Multi - Carrier Modulation :-

OFDM = UL (up link)
OFDMA = D.L (Down link).



FFT^{-1} ≡ fast fourier transformer inverse.

$(N + C.P)\,\Delta f = BW_{total}$

$$\vec{y} = A_{N \times N} \vec{X}$$

$$A = \left[e^{j\frac{nm\pi}{N}} \right]$$

$$A^{-1} = A^{H} = A^{*T}$$

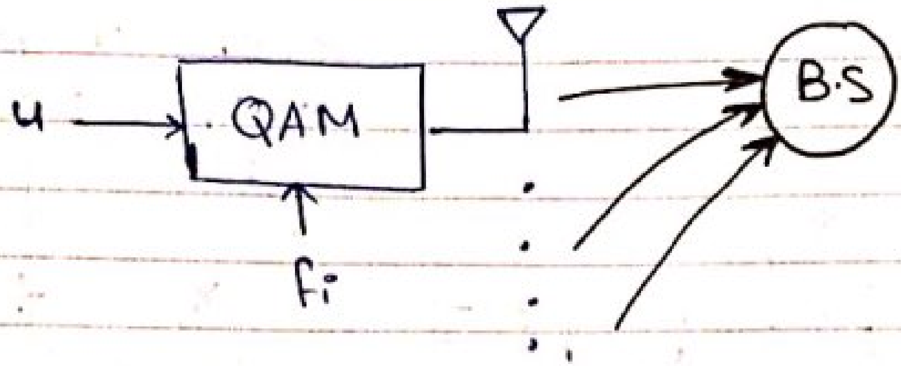
→ CP ≡ cyclic prefex. (12% from total signal).

* OFDMA :-

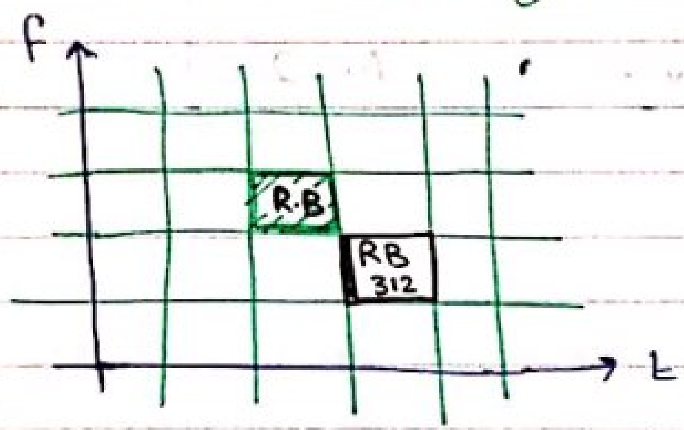
total data rate. $= \sum_{i=1}^{N} m_i \longrightarrow BW_{ch} = (N + CP)\,\Delta f$

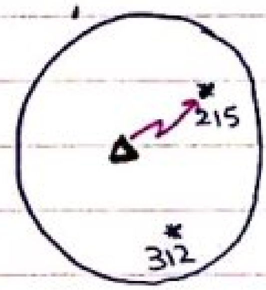
53 $\Delta f = 10\,KHZ$ ⟵ $\Delta f = \frac{f_s}{N}$ $f_s = f$ sampling

UL: UP link



RB ≡ resource block. (capacity).





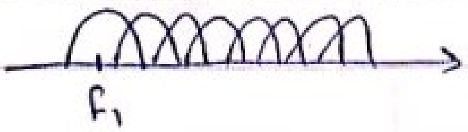
data → loss less compretion.

video
audio] lossy compretion.

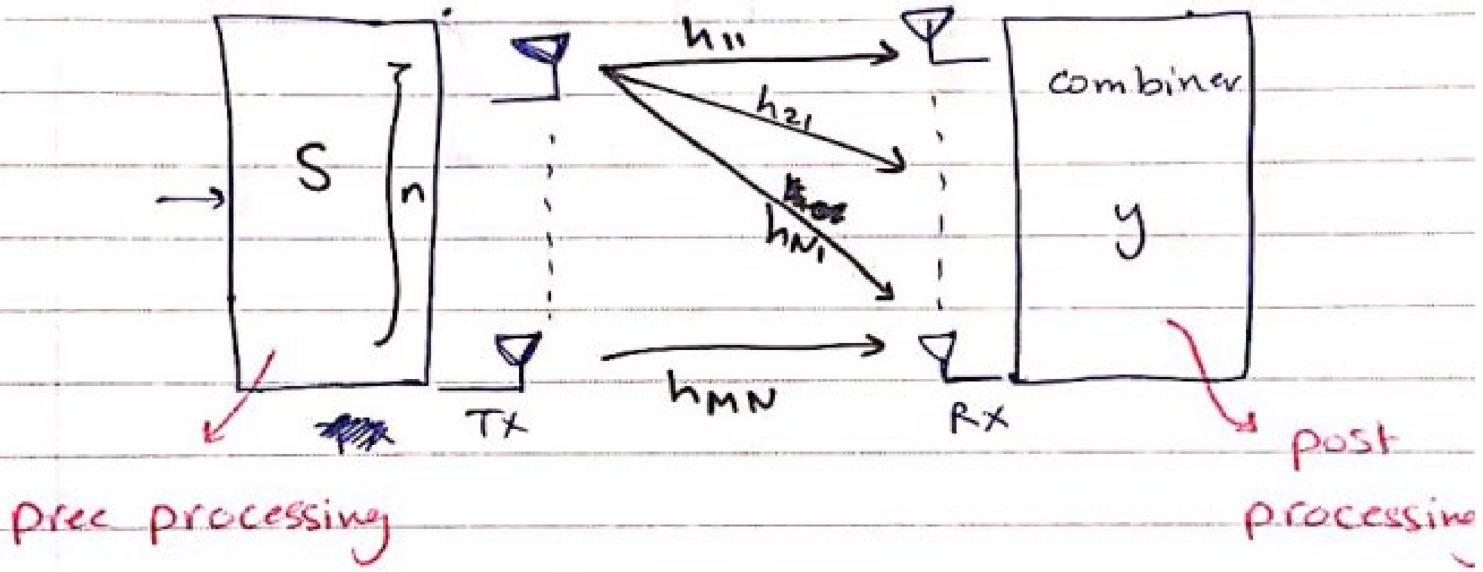
data ⇒ real use GSM.

"Mid ⇒ 20/11/2017 Monday"

- coding gain
- Diversity gain



OFDMA → flat fading

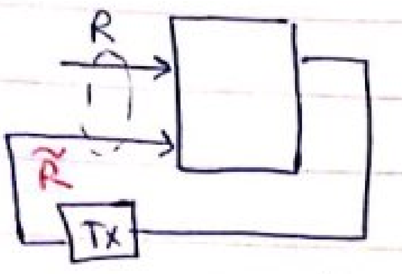


MIMO System.

$$H = \begin{bmatrix} h_{11} & h_{21} & h_{\dots} & h_{n1} \\ h_{12} & h_{22} & h_{\dots} & \vdots \\ & & \dots & h_{MN} \end{bmatrix} \quad Y = HS$$

$$S = H^{-1} Y$$

$$H^{-1} = \{ H H \}^{TH}$$

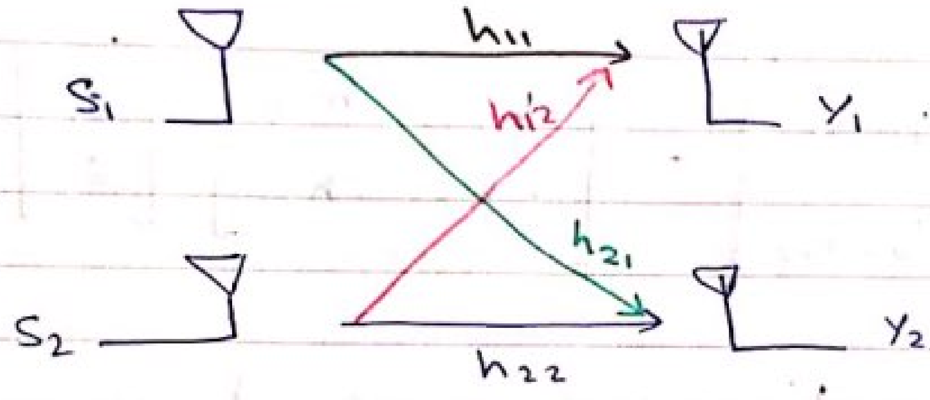


estimator

* Maximual combiner ratio

$$CN = \frac{\lambda_{max}}{\lambda_{min}}$$ $\lambda \equiv$ eigen value

* Condition number measuring stability.



	TS1	TS2
out 1	S_1	S_2
out 2	S_1	$-S_1$

	TS1	
y_1	$S_1 h_{11} + S_2 h_{12}$	$S_2 h_{11} - S_1 h_{12}$
y_2	$S_1 h_{21} + S_2 h_{22}$	$S_2 h_{21} - S_1 h_{22}$

$$y_1 = \begin{bmatrix} y_{1\,TS1} \\ y_{2\,TS2} \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{12} & h_{11} \end{bmatrix} \begin{bmatrix} S_1 \\ S_2 \end{bmatrix}$$

No.

$$\Delta = |h_{11}|^2 + |h_{12}|^2$$

determine of reseving matrix is positive = دائماً *

* أنا اللي بهمني انه يكون في det عشان يكون في inverse

$$y_2 = \begin{bmatrix} y_2 T s_1 \\ y_2 T s_2 \end{bmatrix} = \begin{bmatrix} h_{21} & h_{22} \\ -h_{22} & h_{21} \end{bmatrix} \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}$$

Time and space diversity.

No.

15/11 Wed

Basic design:-

- Traffic (capacity)
- No. of channel
- C/I
  - → secterization
  - → down tellting
  - → F.H.

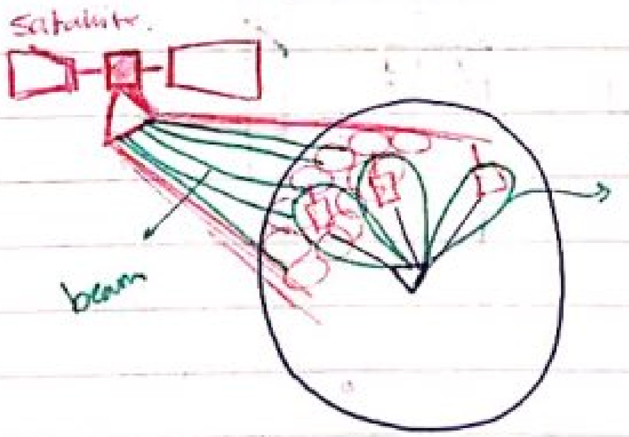
modulation
multiple access
Ecc
Source Encoding → Audio, → video, → Data

special Filtering

" capacity ≡ data rate not number of users "

source encoding

- → lossy → Audio, → Video
- → lossless → Data.



- Iridium "66 sat"
- Global star "44 sat"
- Odessy !?
- Al Thuraya ✓

∇ ≡ base station
" K = 1 "

No.

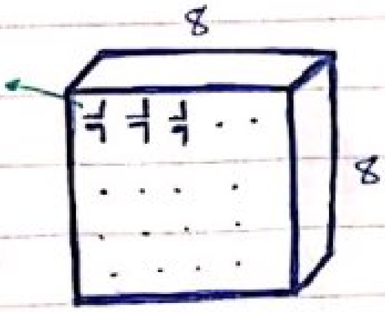
* Spacial Filtering by using Antenna - arrays

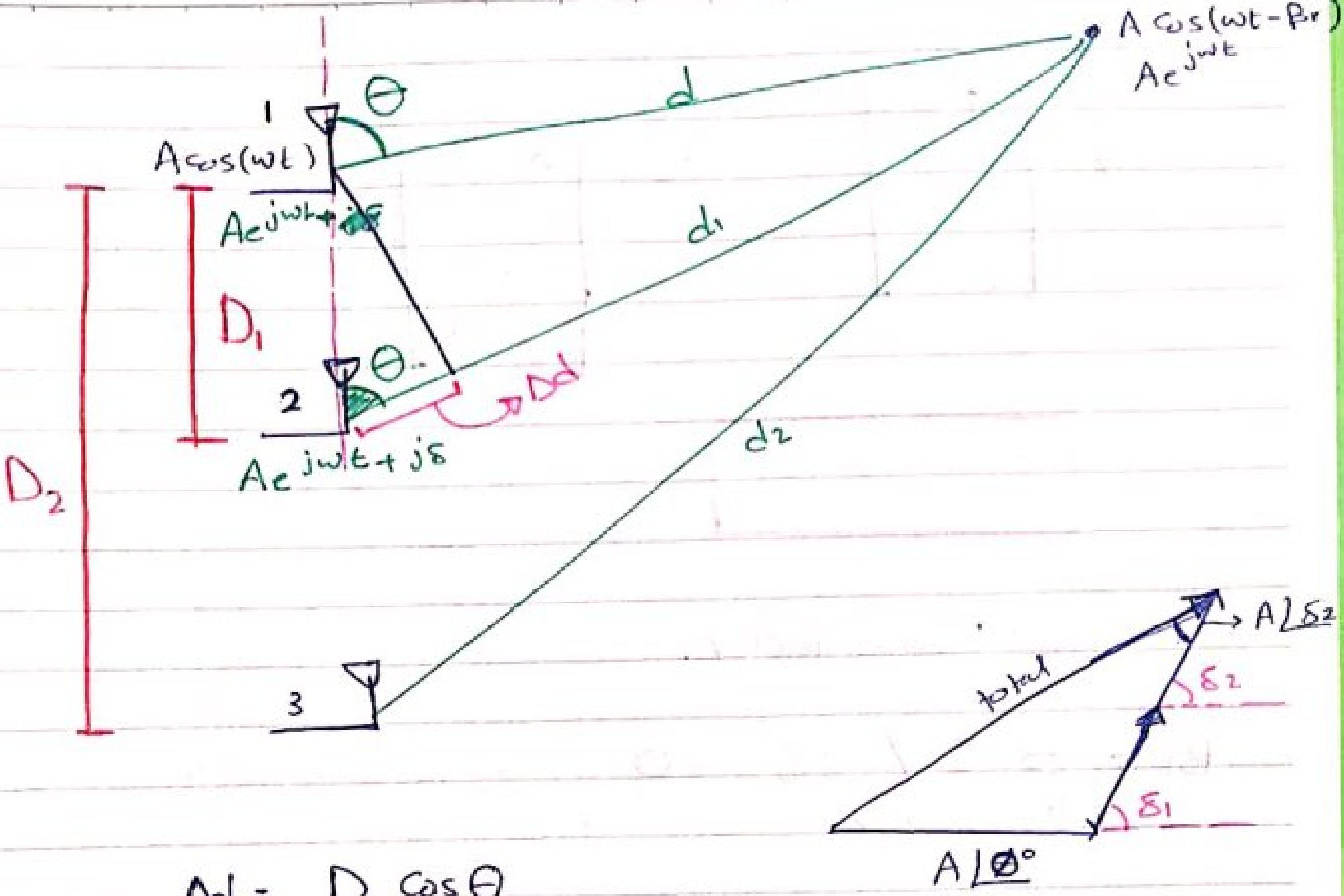
* space time codes. STC → STBC, → STTC } → smart diversity

STBC ≡ Space time block code.
STTC ≡ space time ~~convolutional~~ Trilles code

* Smart Antenna.
  - "can provied beam"
  - → Beam forming
  - → Adaptive beam antenna.

8x8 Grid



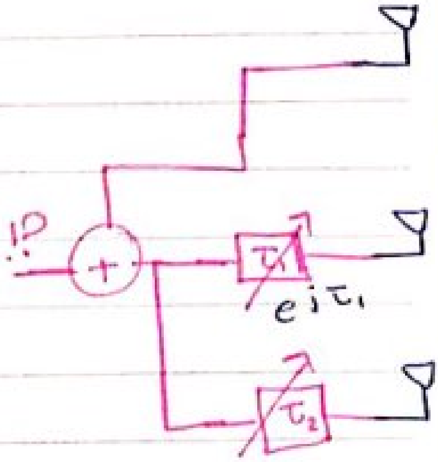


$$\Delta d_{12} = D_1 \cos\Theta$$

$$\Delta d_{13} = D_2 \cos\Theta$$

$$\delta_1 = \frac{2\pi D_2 \cos\Theta}{\lambda}$$

$$V = \sum_{i=1}^{L} A\, e^{j\left(\frac{2\pi D_i \cos\Theta}{\lambda} - \tau_i\right)}$$



for each Θ find τ_i's

$$V = \sum e^{j\underbrace{\frac{2\pi D_i}{\lambda}}_{a_i}} \cdot e^{j\cos\Theta \cdot a_i} \cdot e^{-j\tau_i}$$

No.

$$\vec{\Theta} = \begin{bmatrix} e^{j\theta} \\ e^{j\theta} \\ \vdots \\ e^{j\theta} \end{bmatrix} \qquad \vec{\tau} = \begin{bmatrix} e^{-j\tau_1} \\ e^{-j\tau_2} \\ \vdots \\ e^{-j\tau_L} \end{bmatrix}$$

$$BF = \Theta^t \tau$$

BF ≡ Beam Factor.

$$BF = \Theta \tau / \omega \tau = 0$$

↳ Θ matrix

General equation.

ω ≡ weigh vector.

No.

$$\vec{\Theta} = \begin{bmatrix} e^{j\theta} \\ e^{j\theta} \\ \vdots \\ e^{j\theta} \end{bmatrix} \qquad \vec{\tau} = \begin{bmatrix} e^{-j\tau_1} \\ e^{-j\tau_2} \\ \vdots \\ e^{-j\tau_L} \end{bmatrix}$$

$$BF = \Theta^t \tau$$

BF = Beam Factor.

$$BF = \Theta \tau / \omega \tau = 0$$

↳ Θ matrix

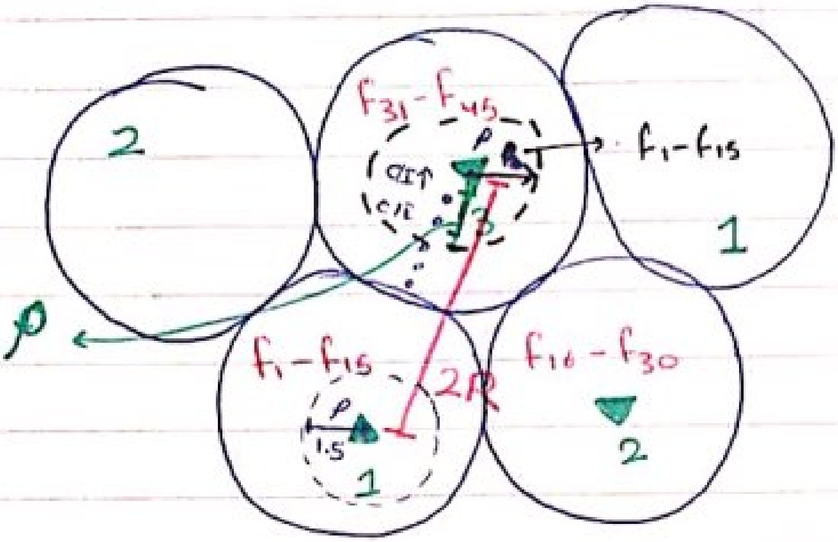
General equation.

w = weigh vector.

No.

22/11 Wed

* Micro cells :-



Find ρ that satisfy $(C/I)_{min}$

$$C = d^{-\gamma} = \rho^{-\gamma}$$

$$I_1 = 3(2R-\rho)^{-\gamma} \quad \text{on average.} \Rightarrow I = (2R)^{-\gamma}$$

$$\frac{C}{I} = \frac{\left(\frac{2R}{\rho}\right)^{\gamma}}{3}$$

Ex $\gamma = 3$, $R = 2\,Km$ $\left(\frac{C}{I}\right)_{min} = 8\,dB$

Find ρ ?!

$$(C/I_{min}) = 10^{0.8} = 6.3$$

$$\frac{2R}{\rho} = \sqrt[3]{3 * 6.3}$$

$$\rho = \frac{2 * 2\,Km}{\sqrt[3]{18.9}} = 1.5\,Km$$

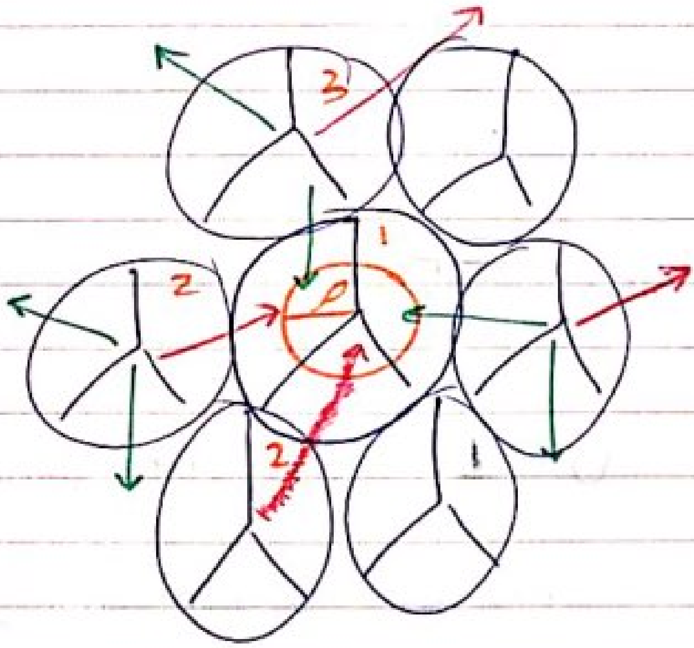
No

27/11 MON

Quiz 2

for a 3x3 cell configuration each sector uses 15 channel in a certain cell we implement a Mcell by using 2 channel from each surrounding sector find the M-cell radius if the min C/I is 9dB ?!

12 channel



I at 2R
((I = 1))

$$\frac{C}{I} = \frac{\rho^{-\gamma}}{2R^{-\gamma}}$$

$$\frac{C}{I} = \left(\frac{2R}{\rho}\right)^{\gamma}$$

$$\sqrt[3]{10^{0.4}} = \frac{2R}{\rho}$$

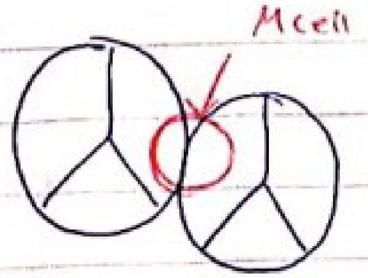
$$R = \rho$$

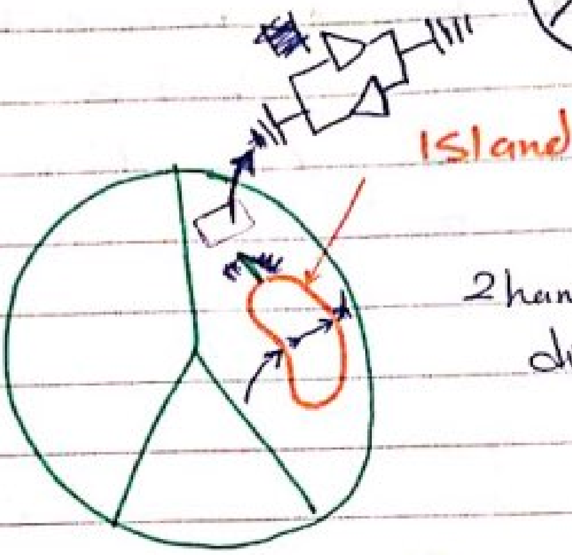
at 15 dB $\frac{2R}{\rho} = \sqrt[3]{31.6}$

$$\rho = 0.63R$$

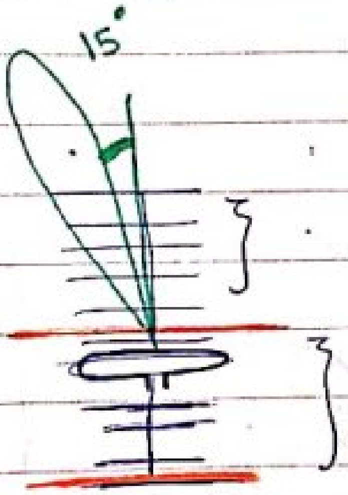
No.

if Mcell btween 2cell





2handover. in a small distance.



UAGI ANTENNA Passive Reciver

btween 2antenna → 2amplifier.

No.

4/2 MON

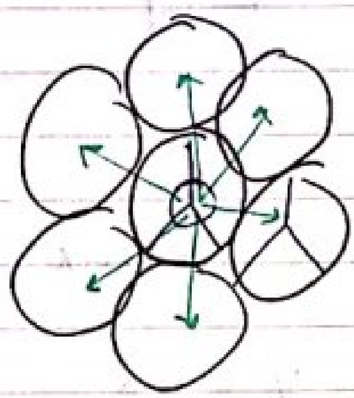
Quiz 3

For 3x3, cellular system operates at ~~8~~

$\frac{C}{I} = 8.5\,dB$ if micro cell is inserted inside of

cell with radius $r = 0.4R$ and $P_{tM} = \frac{1}{10} P_t$

⇒ find the new C/I in the surrounding Macrocell?!



$$\frac{C}{I} = \frac{R^{-\gamma}}{2D^{-\gamma} + \alpha(2R-r)^{-\gamma}}$$

$$\alpha = \frac{P_{tm}}{P_t}$$

$$\frac{C}{I} = \frac{R^{-\gamma}}{2D^{-\gamma} + \frac{1}{10}(1.6R)^{-\gamma}}$$

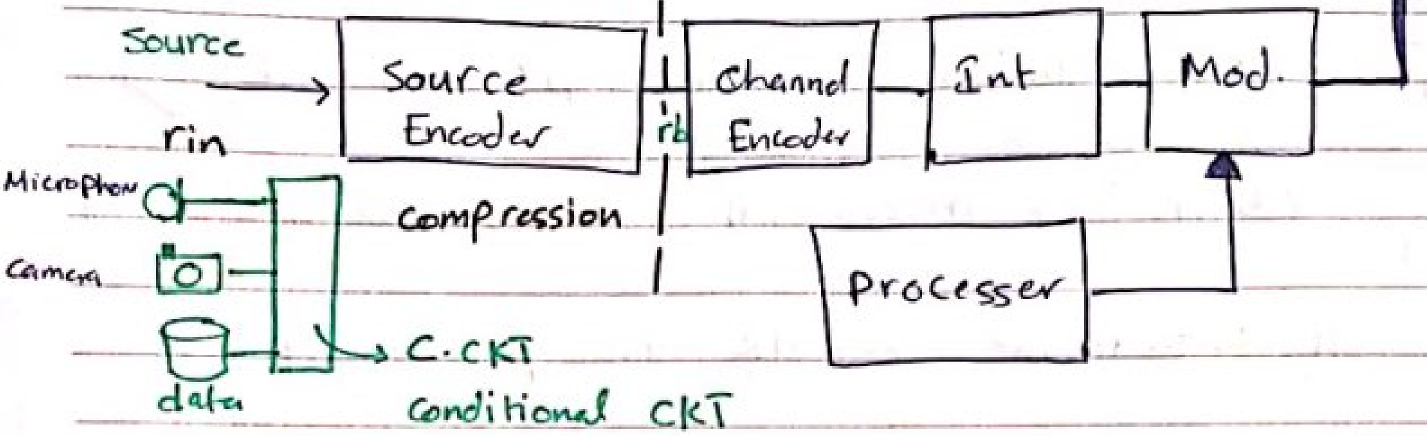
$$= \frac{1}{2\left(\frac{D}{R}\right)^{-\gamma} + \frac{1}{10}(1.6)^{-\gamma}}$$

$$\frac{C}{I} = \frac{(D/R)^{\gamma}}{2} = 7.08 \qquad \frac{D}{R} = 2.41$$

$$\left(\frac{C}{I}\right)_{new} = \frac{1}{2(2.41)^{-3} + \frac{1}{10}(1.6)^{-3}} = 5.97 \rightarrow \boxed{7.76\ dB}$$

mean square error ≡ mse

A/D → $mse = \frac{\Delta^2}{12}$ (Δ: step size)



Inside Frame → pilot data.

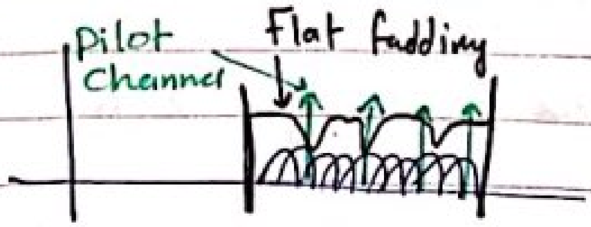
X ≡ Transmit signal (vector)
y ≡ Received signal (vector)
H ≡ Matrix

$$\vec{y} = H\vec{X}$$

↳ $h = [h_0 \;\; h_1 \;\; h_2 \; \dots]$ (vector عبارة عن)

H for slow fadding, fast fadding.

In OFDM



Water filling Algorithem

equalily likely → equlization

الصغير بكبرو و صغير كبير يصغرو.

إلي جاي attenuation كبير بصغرو

" " " صغير بكبرو

طول frequency selective → flat

pilot-channel → synchronization "
↳ amp pilot > amp signal. , channel estimate.

L_{packet} = 1K bytes. 8K bit

total size = 1000 * 8K

BER required = $\frac{1}{8M}$ = $1.25 * 10^{-7}$

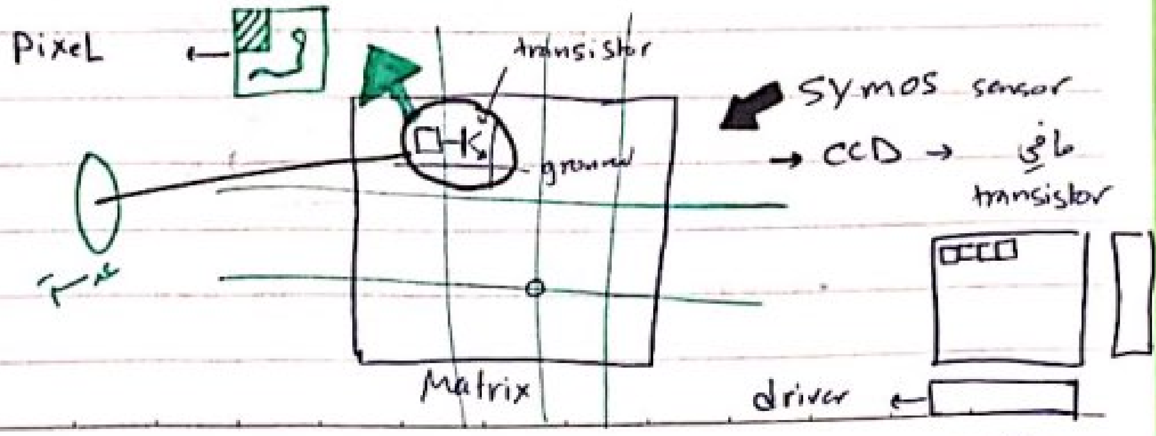
using channel coding to get BER required.

BW ∝ r_b ⇒ linear

↓ BW → signalال نضغط ((compress))

Source Encoding:-

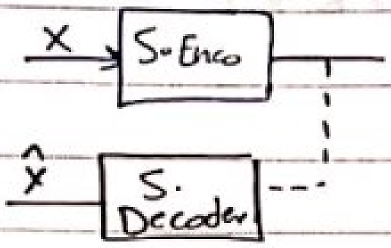
- loss less "use for control data" ⇒ compach
- lossy (audio(A), (V) Video) ⇒ compression.



Rate ≡ bits (bits per sample)

use

* compression ratio = 5 → صغرتها خمس أضعاف



$$mse = E\{|x - \hat{x}|^2\} = D$$ random → (audio)

$= L_2$ ↳ طلع ال average

↑ mse → ↑ distortion.

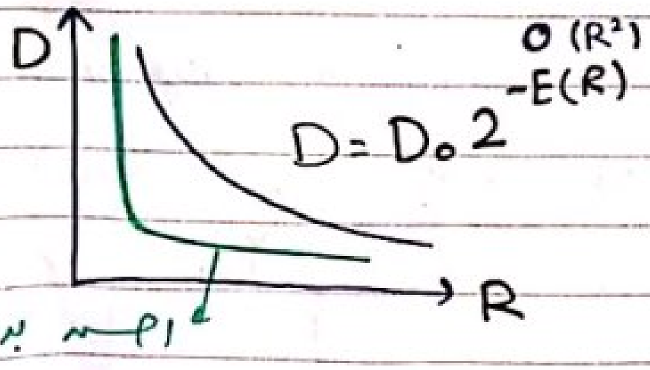
$$E\{|x - \hat{x}|\} = L_\infty$$

↑ norm

L_2 ≡ second norm ((used))

R-D : Rate Distortion theory. for each type of source encoder

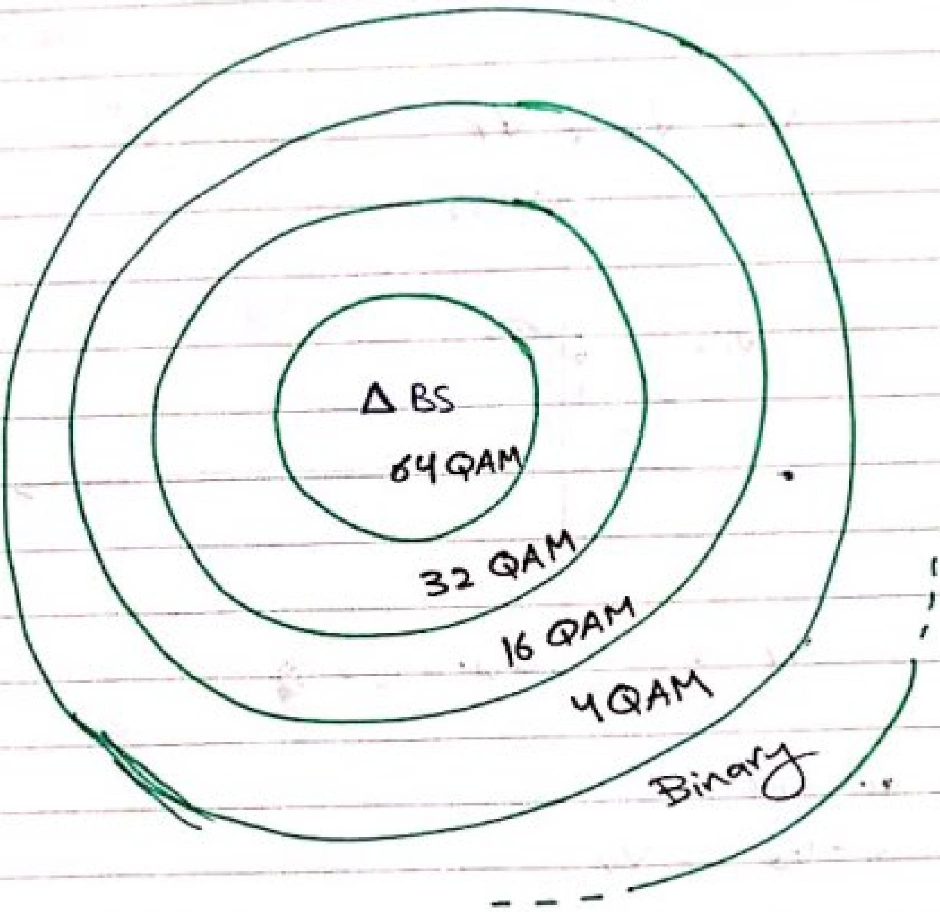
↑R → D↓



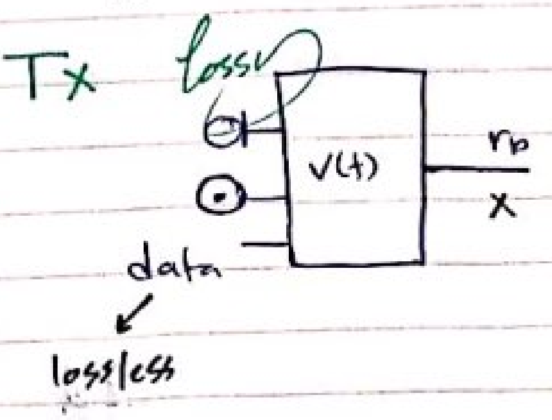
E ≡ energy function of R.

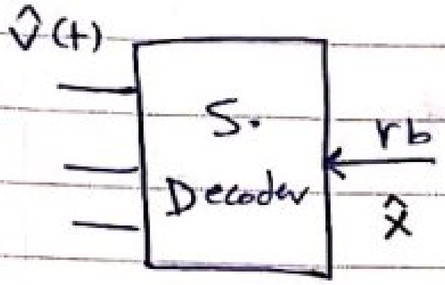
6/12 Wed

α = attenuation factor at low freq.



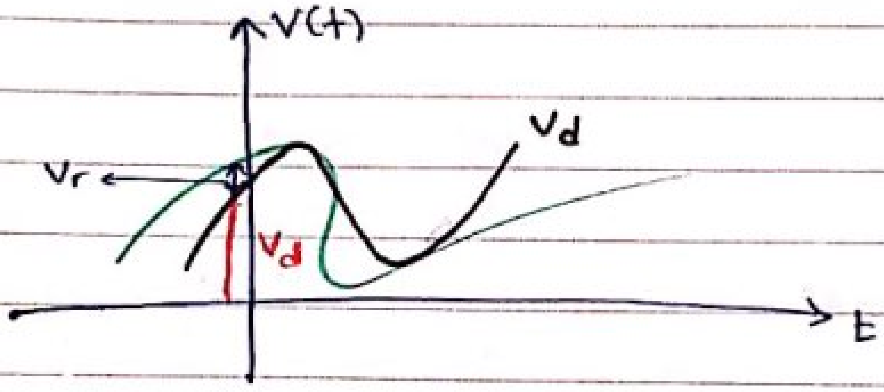
$BW_{ch} \propto r_b$





$V = V_d + V_r$ "Voltage"

r ≡ random
d ≡ determinstic



$V_r \rightarrow$ تجي المعلومات

at TX

$V - V_d = V_r$

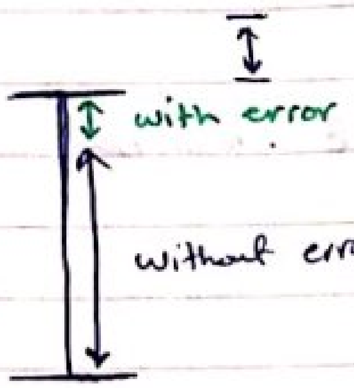
at Rx

calculate V_d

ماعرف V_r

$V_r + V_d = V$

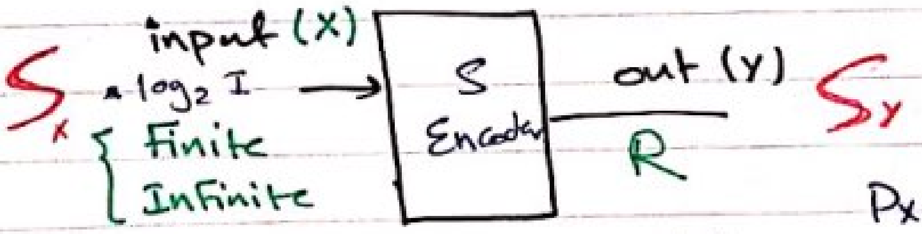
$V_r \Rightarrow$ levels small



* lossless → data digital
  → Finite elements.

~~for bounded input~~

use for Finite input levels.



$P_X = \{P_0, P_1, P_2, \cdots, P_{I-1}\}$

Infinite in analog data.

in Finite, data use lossless.

$X \in \{X_{01}, X_{02}, X_{03} \ldots X_{I-1}\}$
→ symbols

$Y \in \{Y_0, Y_1, Y_2, \ldots Y_{J-1}\}$

source is consist of ↑(letter, word, symbols) [group]
and a prob destribution function for these letters.

$$H = \sum_{i=0}^{I-1} P_i \log_2 P_i \quad \text{bits}$$

* Entroby of the source represent number of bits.
عشوائية التفاعل

* بقيس كمية المعلومات إلي في ال source.

we can compress any source to its entropy without loss.

$$R \geq H$$

H ⇒ actual number عدد ال
مش $(\log_2 I)$

* $\log_2 I$ → just for equaly likely.

Example

$S_x = \{a \ \ b \ \ c \ \ d\}$ "4letter → 2bit if equaly likely"
$P_x = [0.1 \ \ 0.1 \ \ 0.4 \ \ 0.4]$

Sol:

$H = -2 * 0.1 (\log 0.1) - 2 * 0.4 \log_2 (0.4)$
$= 1.722$ bits.

Its a non convex problem ?!

11/12 MON

No.

loss less codes:

1- Huffman code.

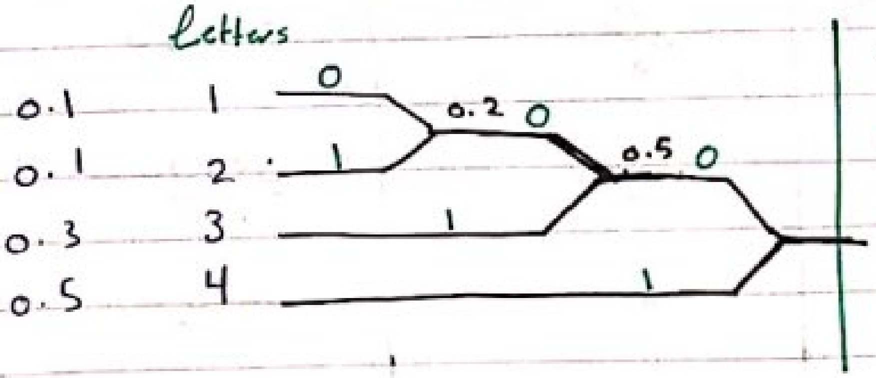
2- L.Z

Source :-

$\mathcal{L} = \{1, 2, 3, 4\}$ "letters"

$P = \{0.1, 0.1, 0.3, 0.5\}$

$C = P \log P_i$



	P.L	
000	0.3	← 0.1 × 3
001	0.3	← 0.1 × 3
01	0.6	← 0.3 × 2
1	0.5	← 0.5 × 1
⊕	1.7	

compine lowest prop.

$\sum P.L = R$

data = [4 3 4 4 2 1 4 1

d = 1 01 1 1 001 000 1 000

4 3 4 4 2 1 4 1

73

* "دايماً letter 4 عند Rx بتكون مقيمة 1".

No.

$R_{xx}[m] = E\{X[n] \cdot X[n+m]\}$

* LZ :-

Ex

d = 10110011 | 000 1111 01 010 1111 00 11 0

	(m) i (index)	data	(m+1) code word = # of bit index + 1
I.C	0000	0	0000 0 (i, d)
	0001	1	0001 1
	0010	01	0000 1 (index for 0)
	0011	10	0001 0
	0100	011	0010 1
	0101	00	0000 0
	0110	0111	0100 1 0111
	0111	101	0011 1
	1000	010	0010 0
	1001	11	0001 1
	1010	110	1001 0
	1011	0110	0100 0

No.

Ex d: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

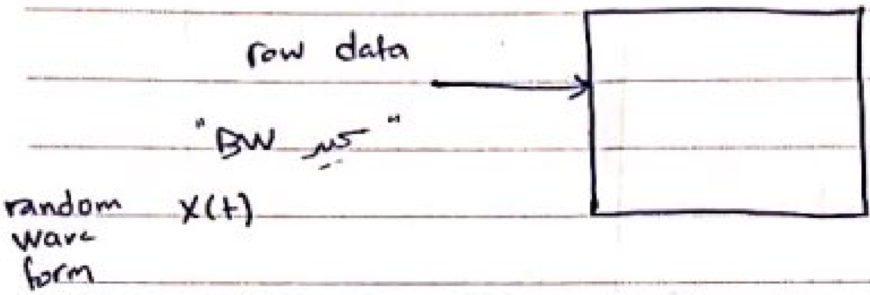
	index (m)	data		Code word (m+1)
I.C	0000	0		00000●
	0001	1		00011
	0010	11		00011
	0011	111		00101
	0100	1111		00111
	0101	11111		01001
	0110	111111		01011
	0111	1111111		01101
	●1000	11111111		01111
	1001	11···1	9 ones	10001
	1010	11···1	10 ones	10011
	1011	11···1	11 ones	10101

No.

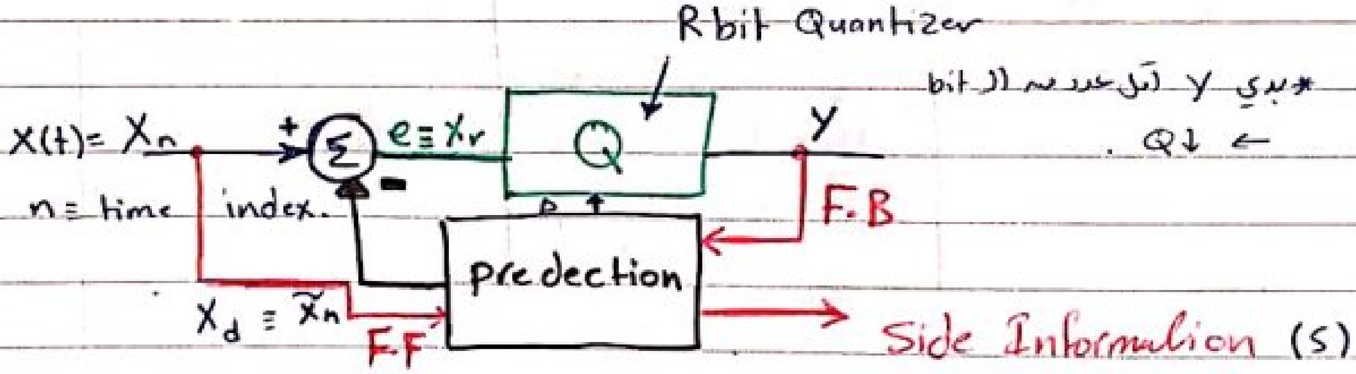
13/12 WED

* lossy :-

➡ Audio:-



$X(t) = X_d(t) + X_r(t)$



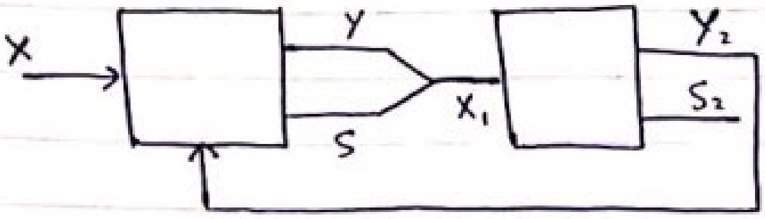
• Q = Quantization"

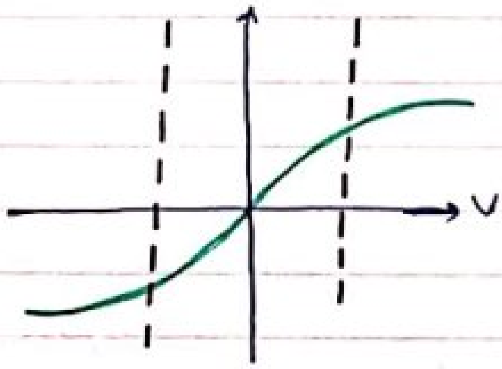
* Δ = Q and Prediction
بكره بين

F.F = fead forward.
F.B = Fead Back.

" data كبير = Y + side inf."

Fead F out performe the Fead Back preduction

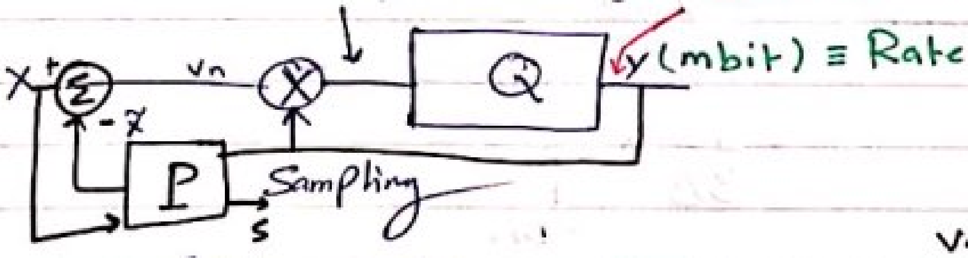




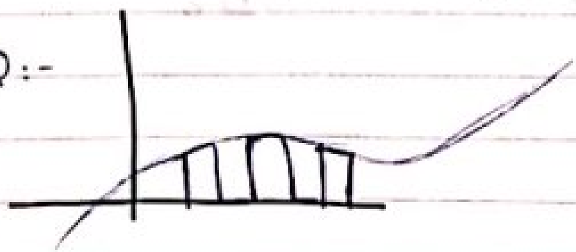
Basic :

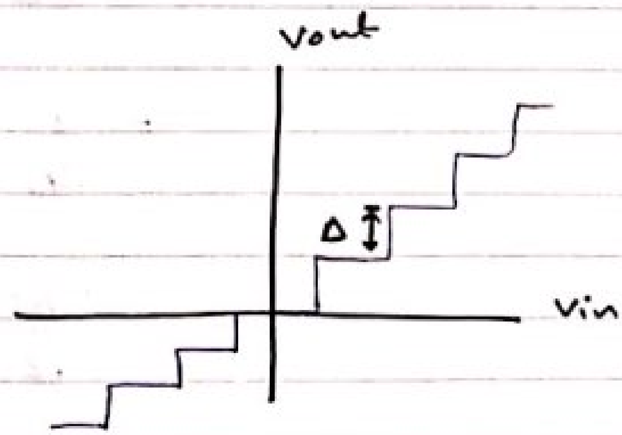
1- A/D :-

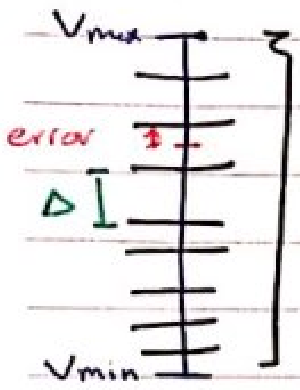
Discrete Signal after Q ⇒ digital Signal



after Q :-







2^m levels

Δ = Step size

$$\Delta = \frac{V_{max} - V_{min}}{2^m}$$

uniform Quantizer

Δ متساوية.

$$mse = E\{Error^2\} = \int_{-\Delta/2}^{\Delta/2} \frac{1}{\Delta} e^2 \, de$$

↳ mean square error

$$= \frac{1}{3\Delta} u^3 \Big|_{-\Delta/2}^{\Delta/2}$$

$$= \frac{2}{3\Delta}\left(\frac{\Delta}{2}\right)^3 = \frac{2\Delta^3}{3\Delta 8}$$

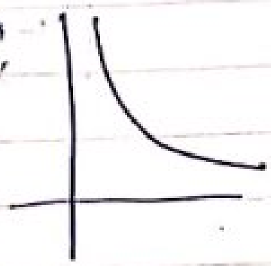
$$= \frac{\Delta^2}{12}$$

$D \equiv$ Distortion.

$$D = \frac{\Delta^2}{12} = \frac{(V_{max} - V_{min})^2}{12} \cdot 2^{-2R}$$

ΔV_{PP}

$$D_n = \frac{(V_{max} - V_{min})^2}{12\ \sigma_x^2}\ 2^{-2R_u}$$



Δe_{PP}

$$D_n = \frac{(e_{max} - e_{min})^2}{12\ \sigma_x^2}\ 2^{-2R_c}$$

* قسمت على σ_x
عشان اعمل normlized

$\Delta V_{PP} = \gamma\, \Delta e_{PP}$ " $\gamma > 1$ "

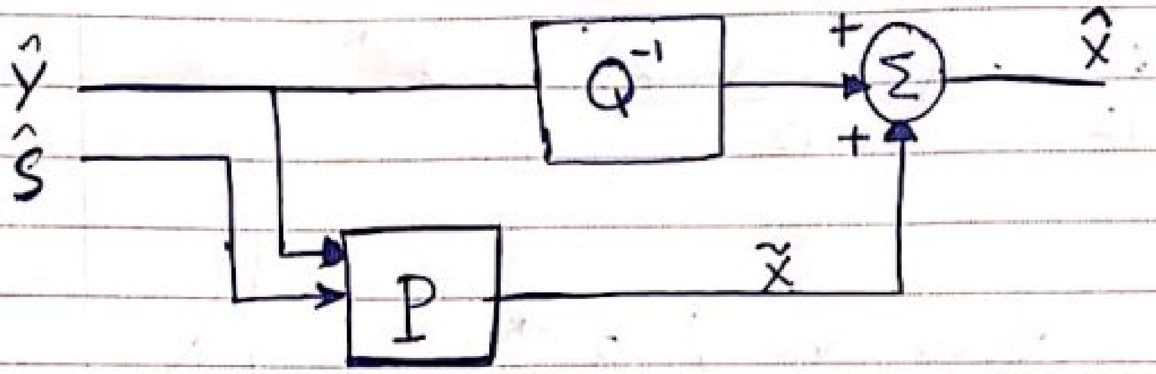
اذا كان 2D متساويات ←

$R_c \equiv$ R compressed
$R_u \equiv$ R uncompressed

$$R_c < R_u$$

* lossy comes from quantization.
$\Delta \uparrow \longrightarrow$ error $\uparrow \longrightarrow$ Rate $\downarrow$

at RX:-



~~[illegible]~~

S ≡ control signal "يهمني احميها"
لانو e فيها اكثر

Y ≡ row data ("sample")

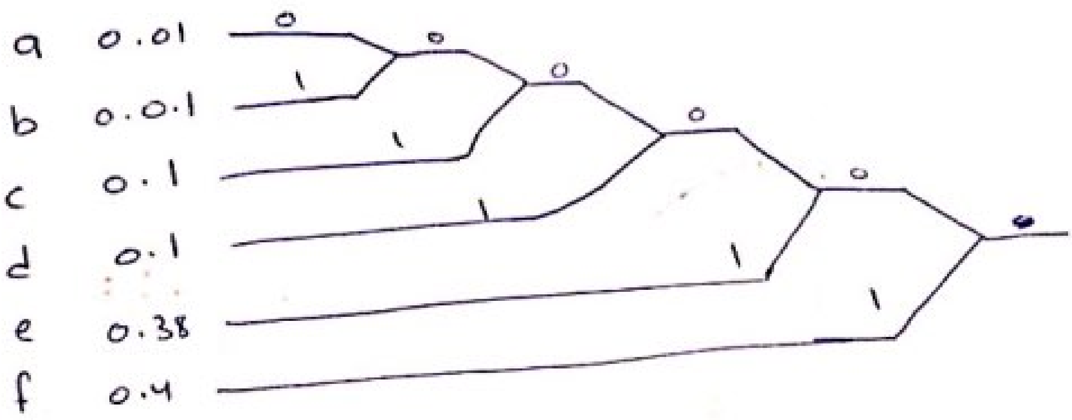
MON 18/12

Quiz 3

Given $\ell = \{a\ b\ c\ d\ e\ f\}$

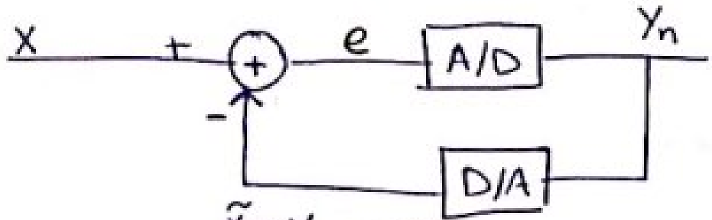
$P = \{0.01, 0.01, 0.1, 0.1, 0.4, 0.38\}$

Find the huffman code and Rate ?!

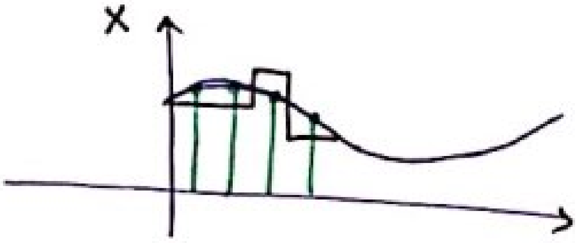


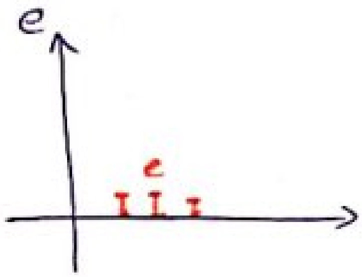
00000	a	5 * 0.01	= 0.05
00001	b	5 * 0.01	= 0.05
0001	c	0.1 * 4	= 0.4
001	d	0.1 * 3	= 0.3
01	e	0.38 * 2	= 0.76
1	f	0.4	0.4
			1.96

II DPCM 8Δ



$\tilde{x} = y_{n-1} + x_{n-1}$

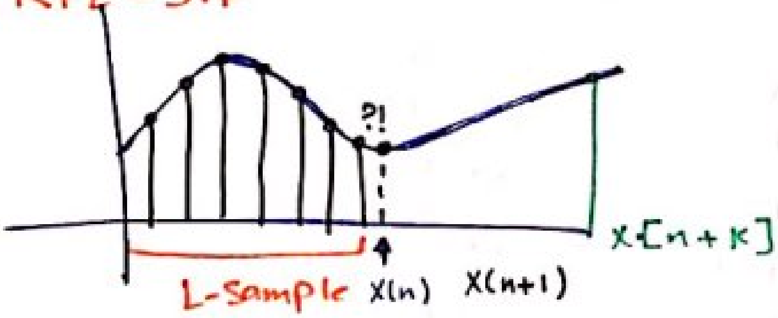




III RPE-LTP 8Δ

RPE-STP

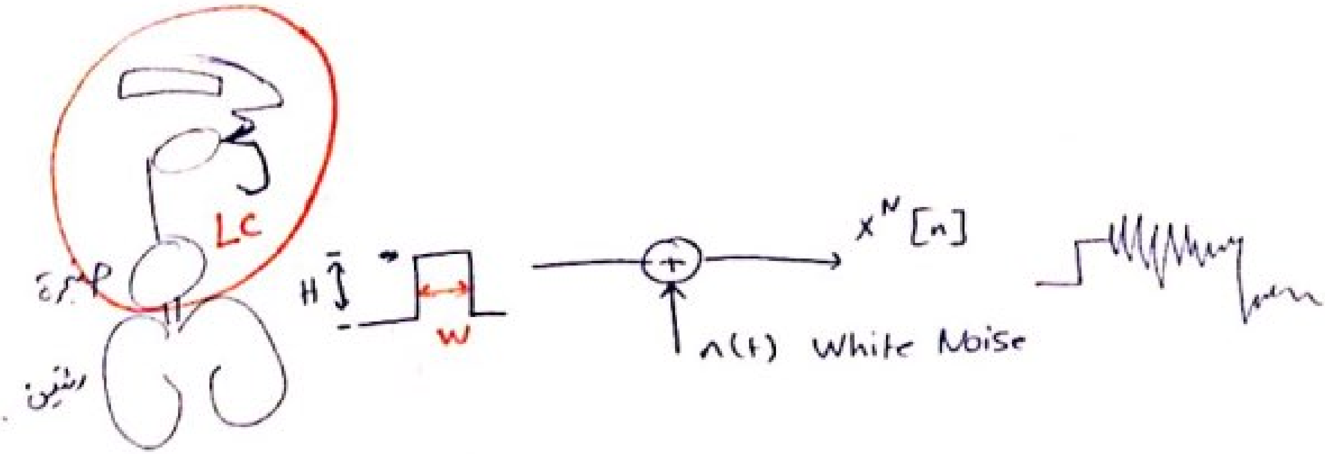
Long Time prediction ≡ LTP

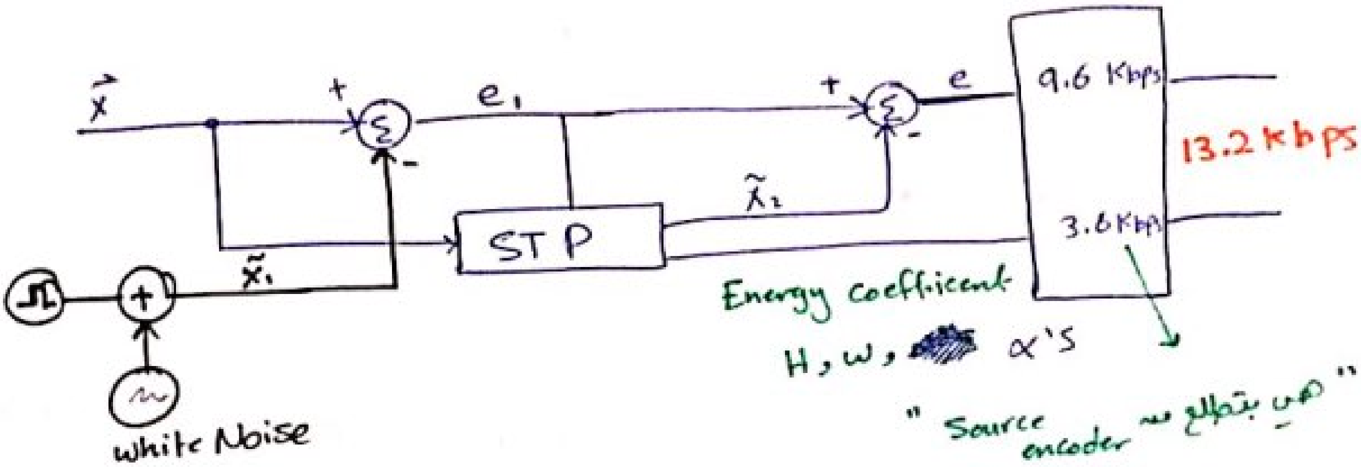


$$x(n+1) = \sum_{i=0}^{L-1} \alpha_i \, x[n-i] = \alpha^T X$$

$$X = \begin{bmatrix} x_n \\ x_{n-1} \\ x_{n-2} \\ \vdots \\ x_{n-L+1} \end{bmatrix} \qquad \alpha = \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \\ \vdots \\ \alpha_{i-1} \end{bmatrix}$$

$$H[z] = \sum_{i=0}^{L-1} \underset{(h_i)}{\alpha_i} \, z^{-i}$$





length phoneme

20ms
8 K Sample
(160 Sample)

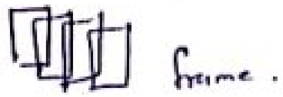
VO Coder
" voice "

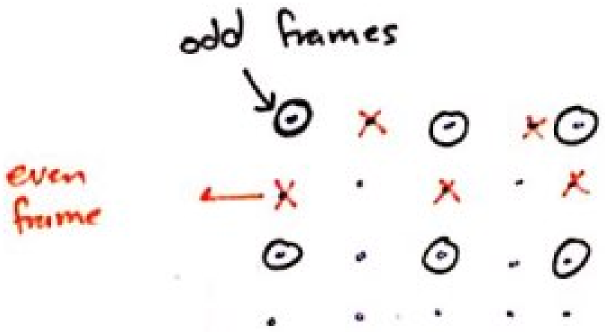
$\vec{\alpha} = eig(E[XX^T])$

9.6 K in 1sec ⇒ in 20ms = 192 bits
3.6 K in 1sec ⇒ in 20ms = 72 bits

(+) 264 bits

MP3 84



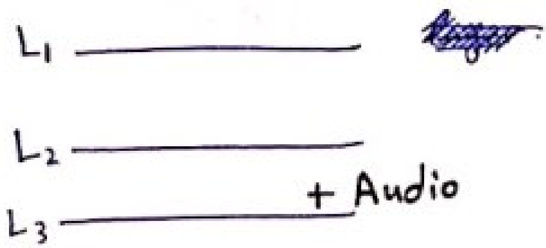


$(1920 * 1080) * 15$

$31M * 3 = 100M$ bytes

800 M bps → 27.5 Mbps

DVB ≡ Digital video broadcasting.



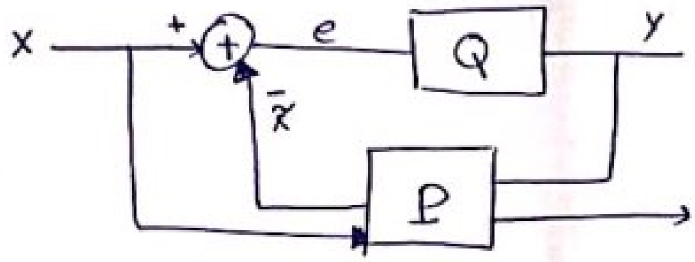
MP3 ≡ M player 3

20/12 WED

Quiz 4 Draw the block diagram of general Source Encoder if the Prediction Filter can predict 90%. of the input signal

Calculate the compression ratio ?!

Sol:



$$(V_{PP})_e = \frac{10}{100} (V_{PP})_x$$

$$D_1 = \frac{(V_{PP})^2}{12\, \sigma_x^2}\; 2^{-2R_1}$$

$$D_2 = 0.01\, K\, 2^{-2R_2}$$

$$\frac{D_1}{D_2} = 1 = 100 \frac{2^{-2R_1}}{2^{-2R_2}}$$

$$2^{-2R_2} = 100\, 2^{-2R_1}$$

$$-2R_2 = \log_2(100) - 2R_1$$

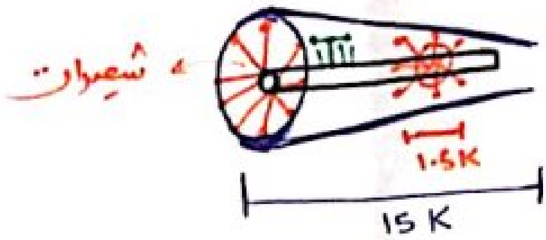
$$R_1 = \frac{1}{2} \log_2(100) + R_2$$

$$\boxed{R_1 = 3.32 + R_2}$$

* MP3 :- Audio signal not speak signal.

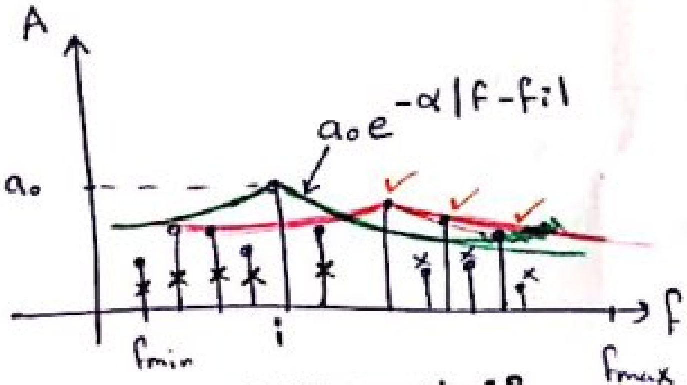
↳ layer 3

* بنسمع عن frequency domain مش في time domain لأنو كل شعيرة الها طول مختلف .



1.5 K * 15K = 22.5 M

Psychoacustic Model :

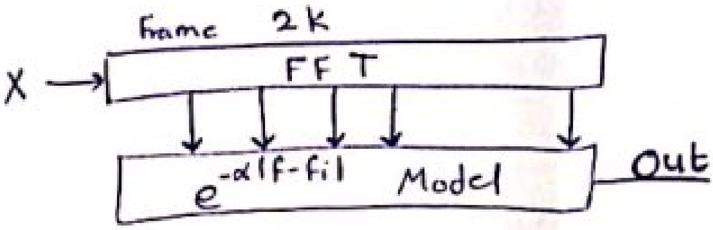


⟵ 2024 sample *8 ⟶ 16 K bit

$\alpha \equiv$ سرعة نزول المنحنى

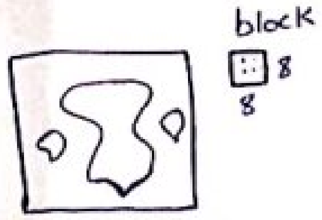
$20 \uparrow * (11 \text{ bits} + 11) = 420$

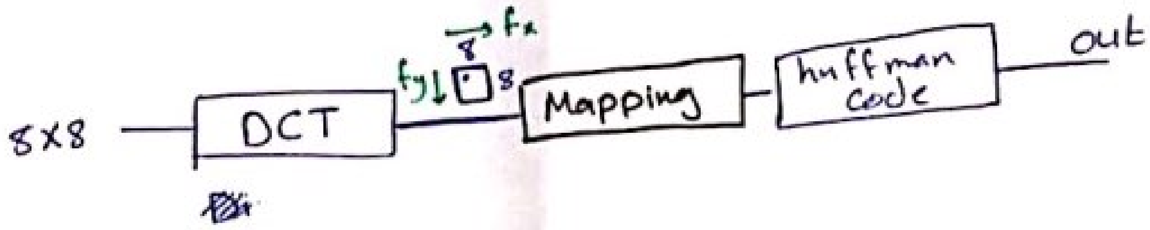
↳ location



MPEG-2: video compression

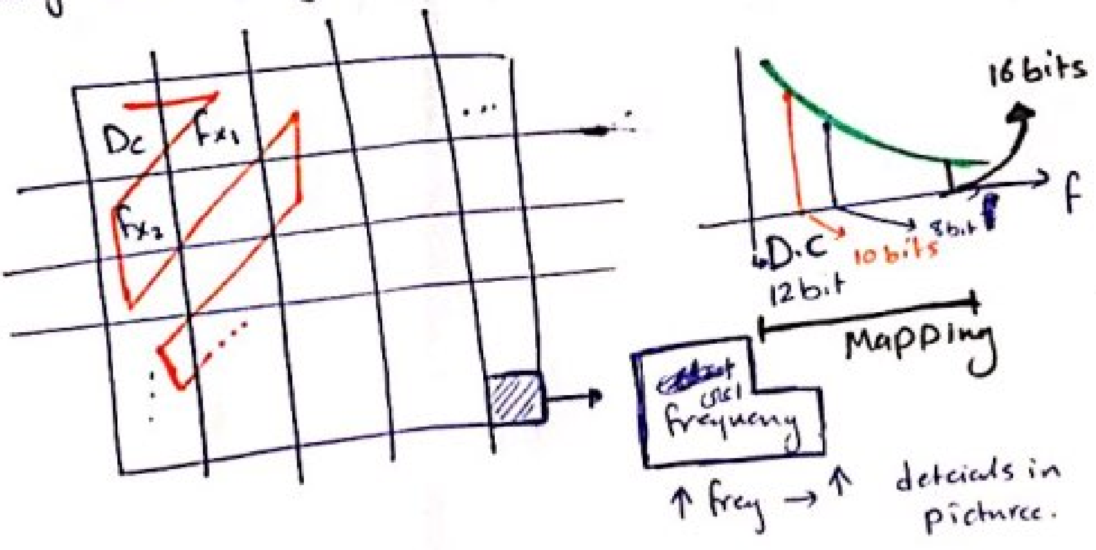
JPEG

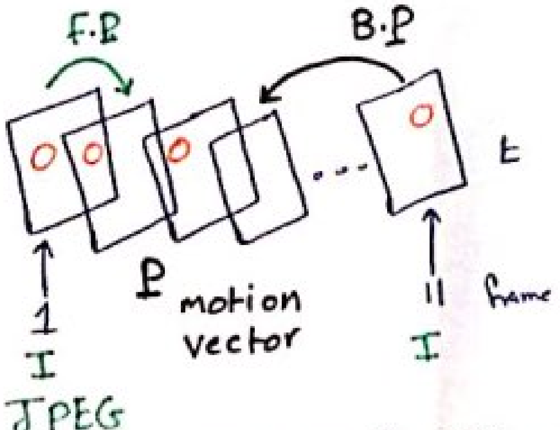




DCT ≡ Discrete cosine transform

frequency ⇒ changinig تغير





P ≡ Preduction

F ≡ forward preduction

B·P ≡ Backward "

K-L transformer ⇒ optimal transformer and the best transformer.

DCT ⇒ fast ⇒ FFT and take real part

" The End "