lec 4

outlines

- Cellular sys. infrastructure
- Multiple access technique
- Cell Capacity
- Frequely Reuse

Cell → area Coverd by transimitting station → Base station (BS)

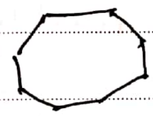
→ radius equal to reachable range of transimitted signal

→ each Cell Serve multiple mobile subscribers (MS) by Connecting them to single (BS)

→ Shape → Circle → overlab ✗

→ Square → No Cover ✗

octagon
decagon (,1) → hexagonal → large Region ✓
→ No overlab ✓ }



→ triangle → less frequently used Cover area

Review

MS $\xrightarrow{\text{wireless}}$ BS $\xrightarrow{\text{wired}}$ BSC $\xrightarrow{\text{wired}}$ MSC

MS: mobile subscriber
BS: Base station
BSC: Base station Controller
MSC: mobile switching Center

MSC $\xrightarrow{\text{wired}}$ PSTN

PSTN: public switched telephone network

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ATM
asynchronous transfer mode

Scanned with CamScanner

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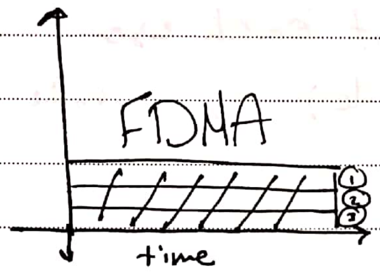
عشان استغل ال band width → Multiple access technique

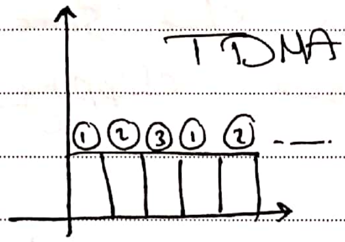
(1)



Frequency division multiple Access

All users Can use divided Frequency all the time

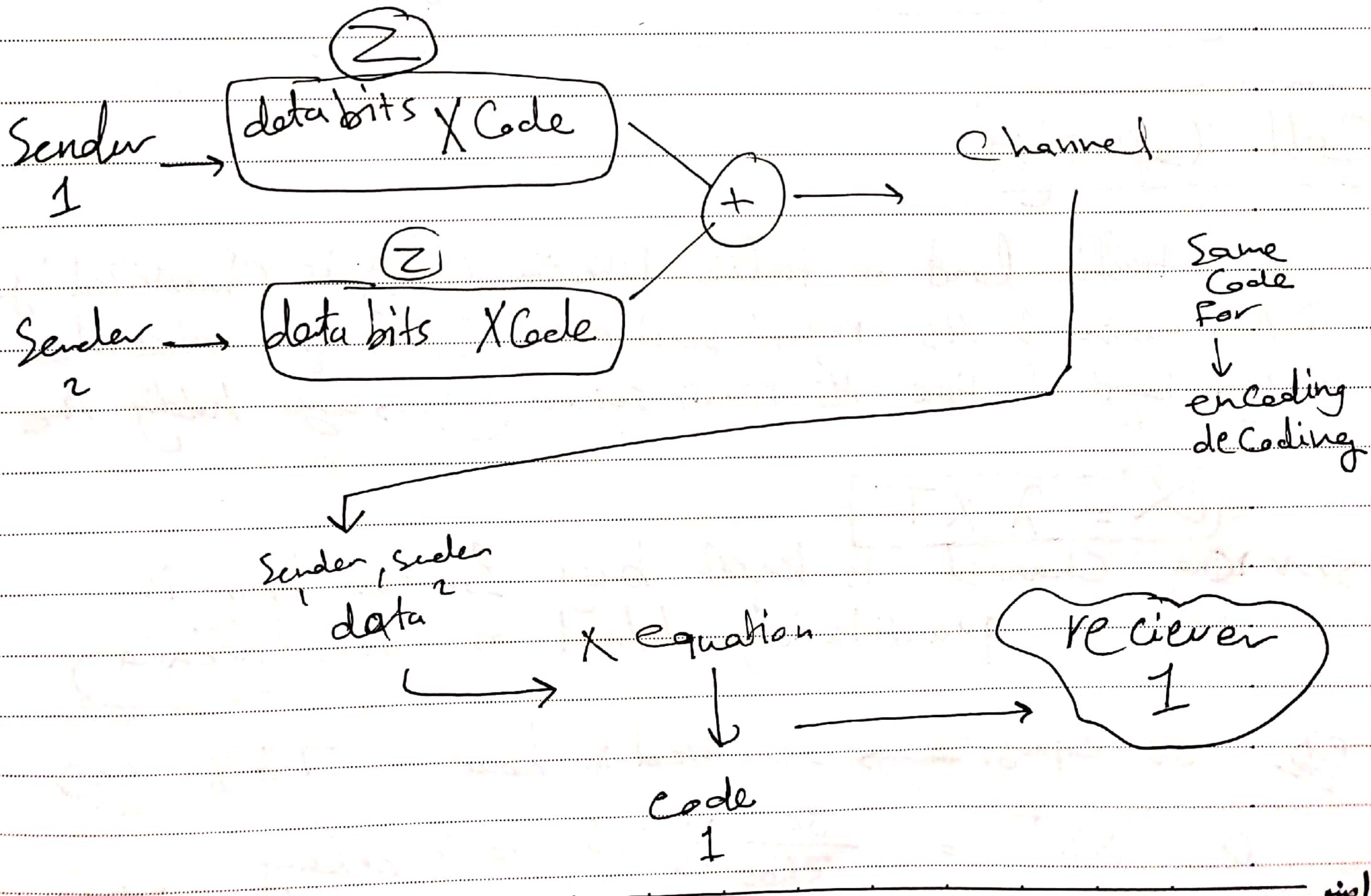
(2)



Time division multiple access

Users Can use full Frequency but In divided time

(3) CDMA → Code division multiple access



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CDMA

- used in severall wireless broadcast channel
- unique code assigned to each user
- all uses share same frequency but each user have own chipping sequence (code) to encode data

encoded signal = original signal X chipping sequelle

decoded signal = inner-product of encoded signal and chipping sequence

⇒ allow multiple users to coexist and transmit with minimal interface → code = orthogonal

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Cell Capacity

traffic load or traffic intensity (α) is chactrized by.

1. Avg. number of MS request service (λ) → avg. arrival rate
2. Avg. length of time MS request service (T) → avg. holding time

$$\boxed{\alpha = \lambda \times T}$$

serving channel is kept busy for an hour is quantitavely defined as one Erlang

ex 30 request → Generated in hour $T = 360$ sec

$$\alpha = \lambda \times T = \frac{30}{3600} \times 360 = 3 \text{ Erlang}$$

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Cells → channels, users, control

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Erlang B (B_c) → blocking probability, probability of loss, probability of rejection for an arriving call

Call → block → all n channels are occupied when the call arrives

$$\boxed{P_{os} = 1 - B_c}$$

Erlang C → probability of an arriving call being delayed

channel

$$B_c = Erl(n, \alpha) = \boxed{\frac{\alpha^n / n!}{\sum_{i=0}^{n} \frac{\alpha^i}{i!}}}$$

traffic intensity

Capacity (n) → number of channels required for the cell based on its traffic load and given blocking prob.

$$n(\alpha) = \min\{i = 1, 2, \mid Erl(i, \alpha) < B_{c\,max}\}$$

Ex offered traffic is $\alpha = 2.0$ erlang   blocking prob = 1%

↓ Sol

$$n(2) = \min\{i = 1, 2, \mid Erl(i, 2) < 0.01\}$$

channel, traffic

$$B_c = Erl(4, \overset{2}{\alpha}) = \frac{2^4/4!}{1 + 2 + \frac{2^2}{2!} + \frac{2^3}{3!} + \frac{2^4}{4!}}$$

trial and error

$\alpha^i / i!$

$2^0/0!$

ALADIB

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[4] Frequency reuse
↓
Frequency band or Channel in Cell can be reused in other Cell
if these Cells are apart → will be no inference

Real world ⇒ Electromagnetic waves → Path loss and link budgets are Computed from terrain features and antena data

this determine Coverage of each base Station and interface between Cells

Path loss → model that describe signal attenuation between T_x and R_x antenas as function of Probagation distance

$$L(dB) = 10\,n\log_{10}(d) + C$$

C → Constant for sys. loss

n → pathloss exponent
2 : 4 → free space
4 : 6 → indoor

d → distance between Tx, Rx

Reuse Distance → closest distance between Centers of 2 Cells using Same Frequency

Determined by clustersize → Cells using diff Frequency band

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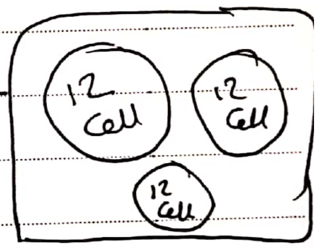
if we have $N \rightarrow$ number of Cells in a Cluster
$R \rightarrow$ Cell radius

Reuse distance $= \sqrt{3N}\ R$

Cluster size (N) $\longrightarrow$ 1, 3, 4, 7, 9
$= i^2 + ij + j^2$

i: number of Cells (along direction)
j: number of Cells in direction (60°) of i



Example
(1) Find reuse distance if:
radius of each Cell is 2 km
channel multiplixed by (8) users
(2) how many Calls Can be processed by each Cell
if only 10 Channels / Cell reserved for Control
bw = 30 MHZ
simplex Channel = 25 kHZ → No Calls on simplex duplex رقم

—— Selution ——

(1)
Reuse distance $= \sqrt{3N}\ R = \sqrt{3 \times 12} \times 2 = 12$ km

(2) one duplex Channel $= 2 \times 25 = 50$ kHZ

number of Channels $= \left(\dfrac{30 \times 10^3}{50}\right) - \underbrace{10}_{\text{Controll}} \times \underbrace{12}_{\text{cell}} = 480$ Channel

number of Channel / Cell $= 480 / 12 = 40$ Channel / Cell
Total number of Calls $= 8 \times 40$ Call