

4.1) Explain the process of call progress in a cellular telephone system

The process of a call progress in a cellular system consists of:-

① Mobile unit Initialization:-

→ Each cell site consist of 416 designated channels. Among them 21 channels are used as Setup channels

→ When a Subscriber is moving in a vehicle and wants to make a call, then the mobile unit scans 21 setup channels and locks the strongest ^{signal} channel for a period of time.

② Mobile originated call:-

→ The cell site sent a request to MSC through high-speed data link.

→ With the help of MSC, the cell site connects the Mobile unit

③ Network originated call:-

If a landline Subscriber wants to make a call to a mobile number then the telephone office will recognize it and forward to MTSS/MSC.

④ call Termination:-

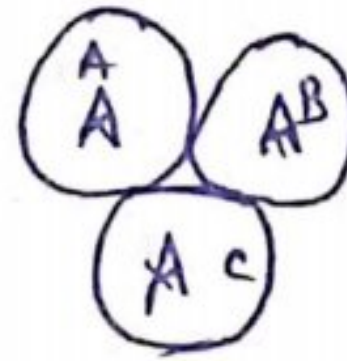
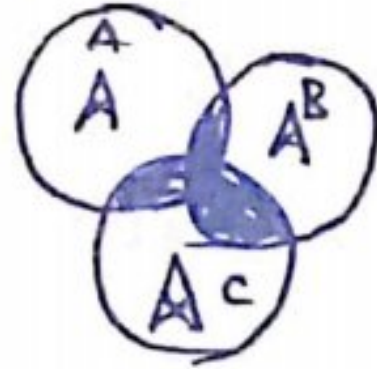
In call termination process, once communication gets over, the respective voice channels are made free.

⑤ Hand-off procedure:-

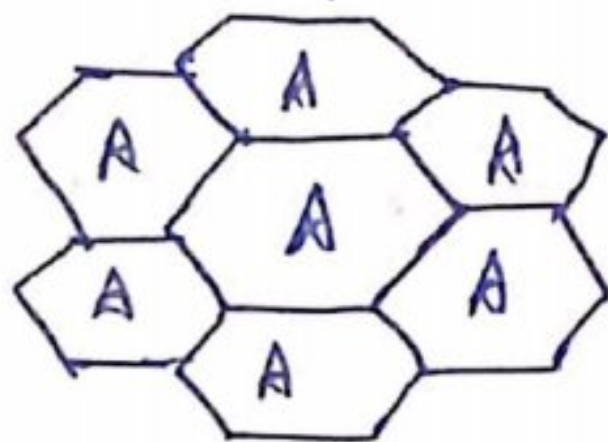
When call is in progress, the transfer of a mobile unit from one base station control to another base station control is called as hand-off procedure.

4-2) State the Need for Hexagonal cell site.

- ① The Base Trans-receiver antenna must radiate 360° to cover the entire cell. So omni-directional antenna is used
- ② Antenna is present at the center of the circle. But the adjacent circles overlaid leaving gaps (or) creating overlapping regions.



- ③ Hence, Hexagon is considered in place of circle because hexagon has largest area and can cover the entire region without overlap and with equal area.



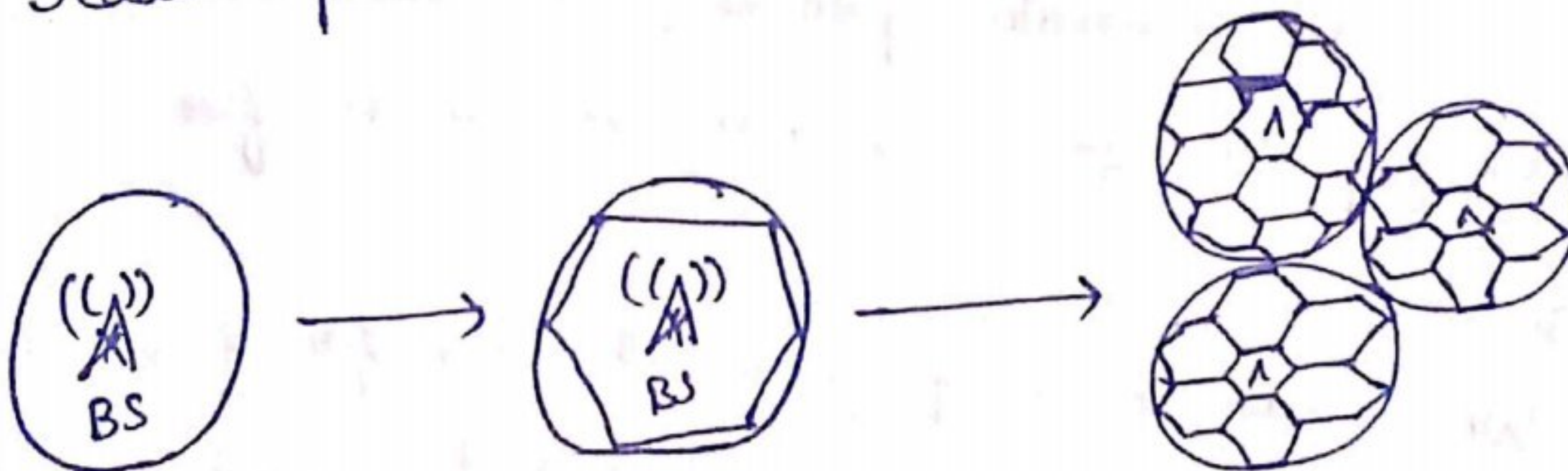
→ Group of Hexagonal cell sites



Hexagon cell site

→ The main reasons for the need of Hexagonal cell site is

- ① It is more Economical
- ② It has largest area
- ③ It provides best approximation to circular omni-directional radio patterns.



circle to Hexagonal cell shape approximation

4.3) Explain the concept of Frequency Reuse?

Cell: Each Base Station (BS) is allocated a group of radio channels to be used within a small geographic area called cell.

→ The same group of channels may be used to cover different cells that are separated from one another by distances

large enough to keep the interference level within tolerable limits.

→ The design process of selecting and allocating channel groups for all of the cellular BS's is called Frequency Reuse.

→ Neighbouring cells cannot use the same frequency.



Cellular frequency re-use concept

4.4) Define the terms cell and cluster related to mobile communication

Cell: Each cellular BS is allocated a group of radio channels to be used within a small geographic area called Cell.

Cluster: It is defined as a group of cells that use a different set of frequencies in each cell.

Thus, A cluster is a group of cells with no reuse of channels within it.

4.5) Explain the capacity of a cellular system?

① Consider a cellular system which has a total of S ~~duplex~~ ^{radio} channels available for use

② If each cell is allocated a group of k channels ($k < S$), and if S channels are divided among N cells, then Total number of available radio channels can be expressed as,

$$\boxed{S = kN}$$

③ N cells which collectively use complete set of available frequencies is called a cluster.

④ Hence a cluster is defined as a group of cells that use a different set of frequencies in each cell.

⑤ Thus a cluster is a group of cells with no reuse of channels within it.

⑥ If a cluster is replicated M times within the system, the total number of duplex channels C , can be used as a measure of capacity and is given by,

$$C = MKN$$

$$\Rightarrow \boxed{C = MS}$$

⑦ So the capacity of a cellular system is directly proportional to the number of times a cluster is replicated in fixed service area.

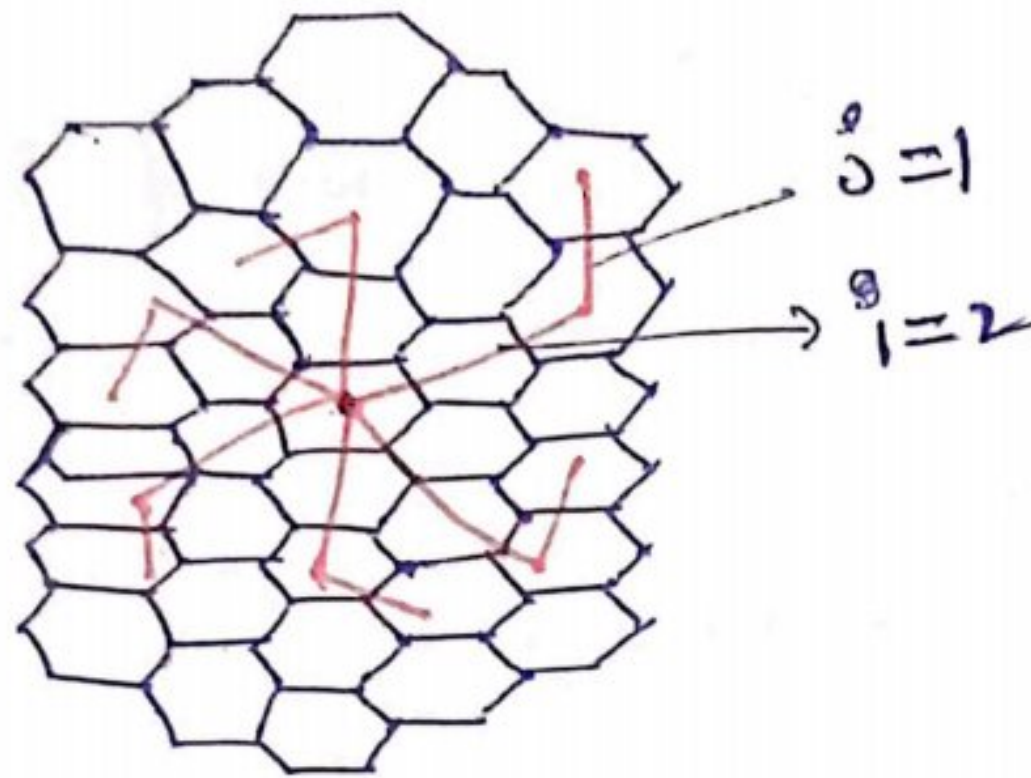
⑧ The cluster size N is given by the equation.

$$\boxed{N = i^2 + i + j^2}$$

where $i \geq 0$, $j \geq 0$

→ To find nearest co-channel neighbours of a cell, one must do the following:-

- a) Move i cells along any chain of hexagons and then
 b) Turn 60° counter clockwise and move j cells.
 let $i=2$ and $j=1$



4.6) Define Hand-off in Mobile communication?

Hand-off: When call is in progress, the transfer of a mobile unit from one base station to another base station is called hand-off (or) hand-over.

There are 2 types of Hand-off's, they are:-

① Hard Hand-off:-

It is a "Break-before-make process" i.e., the mobile unit breaks its connection with one base station before establishing voice communication with a new base station.

② Soft Hand-off:-

It is a "make-before-break process" i.e., a mobile unit establishes contact with a new base station before giving up its current radio channel.

4.7) Explain the frequency of Analog cellular System (AMPS) :-

- ① Advanced mobile phone service (AMPS) is a standard system for analog signal cellular telephone service.
- ② AMPS allocates frequency ranges within 800 to 900 MHz spectrum to cellular telephone.
- ③ Each service provider can use half of 824-849 MHz range for receiving signals and half of 869-894 MHz for transmitting to cellular phones.
- ④ The bands are divided into 30KHz sub-bands called channels. The receiving channels are called reverse channels and sending channels are called forward channels.

4.8) List the drawbacks of Analog cellular System :-

- ① Low calling capacity
- ② Limited spectrum
- ③ poor data communications
- ④ Minimum privacy
- ⑤ Inadequate fraud protection.

4.9) State the need for multiple access techniques :-

- Multiple access techniques are needed because:-
- ① wireless communication provides services with limited resources (eg. power, time, spectrum). These limited spectrum need to be shared among large number of users.
 - ② In mobile communication, all the users are not active at all times. Hence bandwidth allocated to a particular user remains idle and cannot be used by other users.

→ Here these limited resources need to be shared among large number of users. So multiple access techniques permits multiple users to access and share the common resources.

4.10) List the three types of multiple access techniques.

Multiplexing can create channels in frequency, time, code etc...

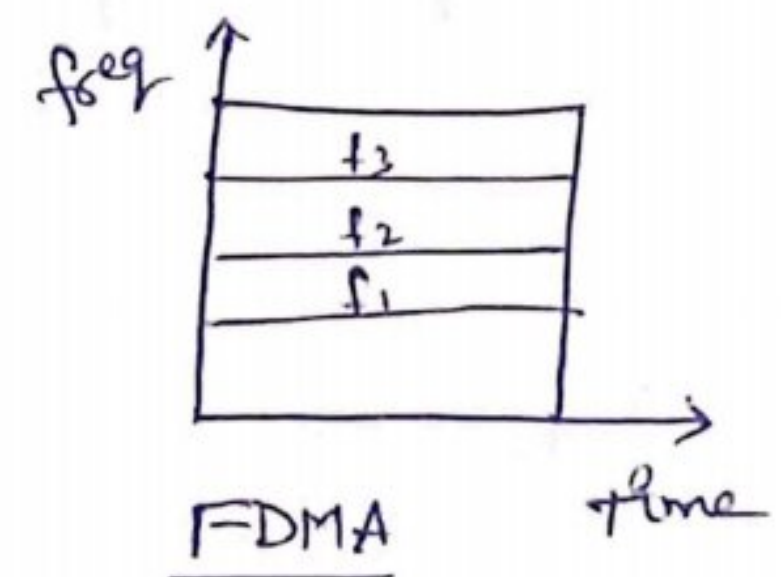
Types of multiple access techniques are:

- ① Frequency Division Multiple access (FDMA)
- ② Time Division Multiple access (TDMA)
- ③ Code Division Multiple access (CDMA)

4.11) List the features of FDMA and TDMA.

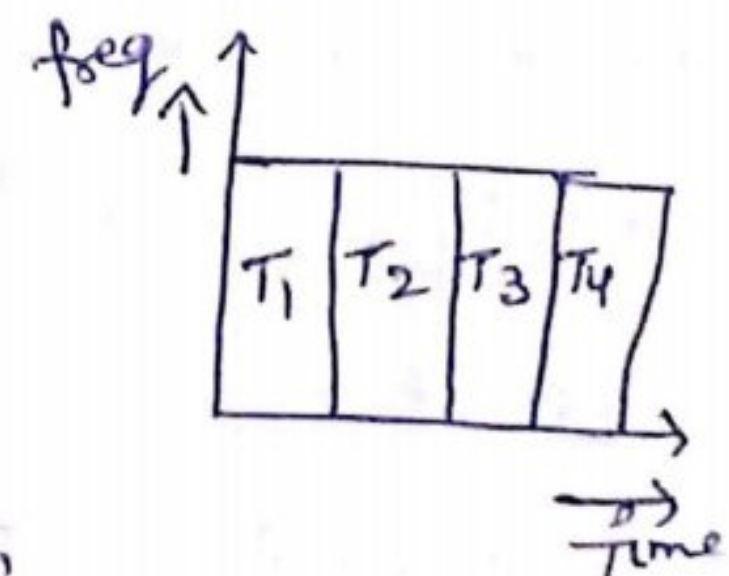
Features of FDMA are:-

- ① Complexity is less
- ② Narrow Bandwidth
- ③ There is a chance of resource wastage
- ④ It can handle one phone circuit at a time



⑤ Features of TDMA are:-

- ① TDMA shares a single carrier frequency with several users
- ② Transmission rates are very high
- ③ Can allocate different number of slots to different users
- ④ Guard time should be minimized



4.12) Explain the frame structure of TDMA?

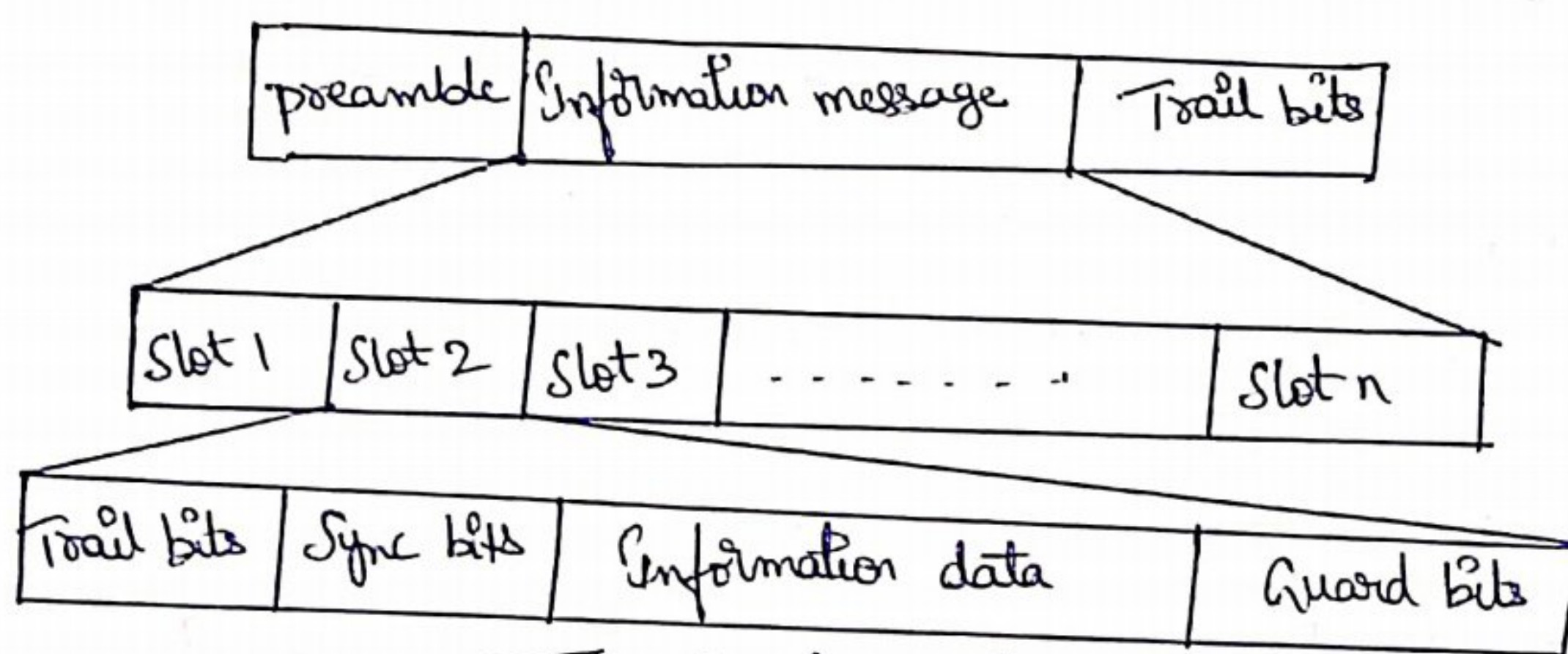
TDMA Frame Format

① In a TDMA System, time is divided into equal time intervals called Slots.

② User data is transmitted in the Slot

③ Several Slots make up a frame

④



TDMA frame format

① preamble - It consists of address and Synchronization information used by BS and MS to identify each other.

② Each Slot consist of :-

a) Trail Bits :- helps in power control mechanism for transmission of signal

b) Sync Bits - helps in synchronizing of Transmitter and Receiver at time of communication

c) Information Data :- It consists of information about the user of that particular slot.

d) Guard bits :- this is needed in order to avoid adjacent channel interference



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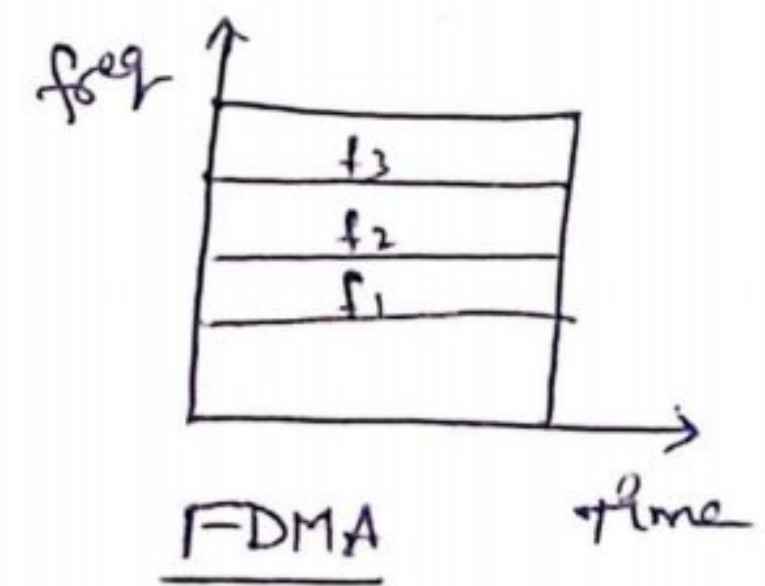
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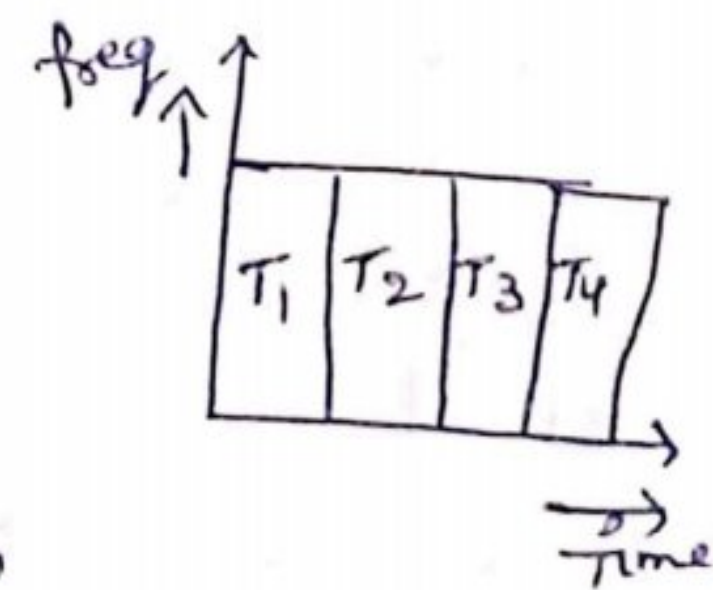
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4.13)

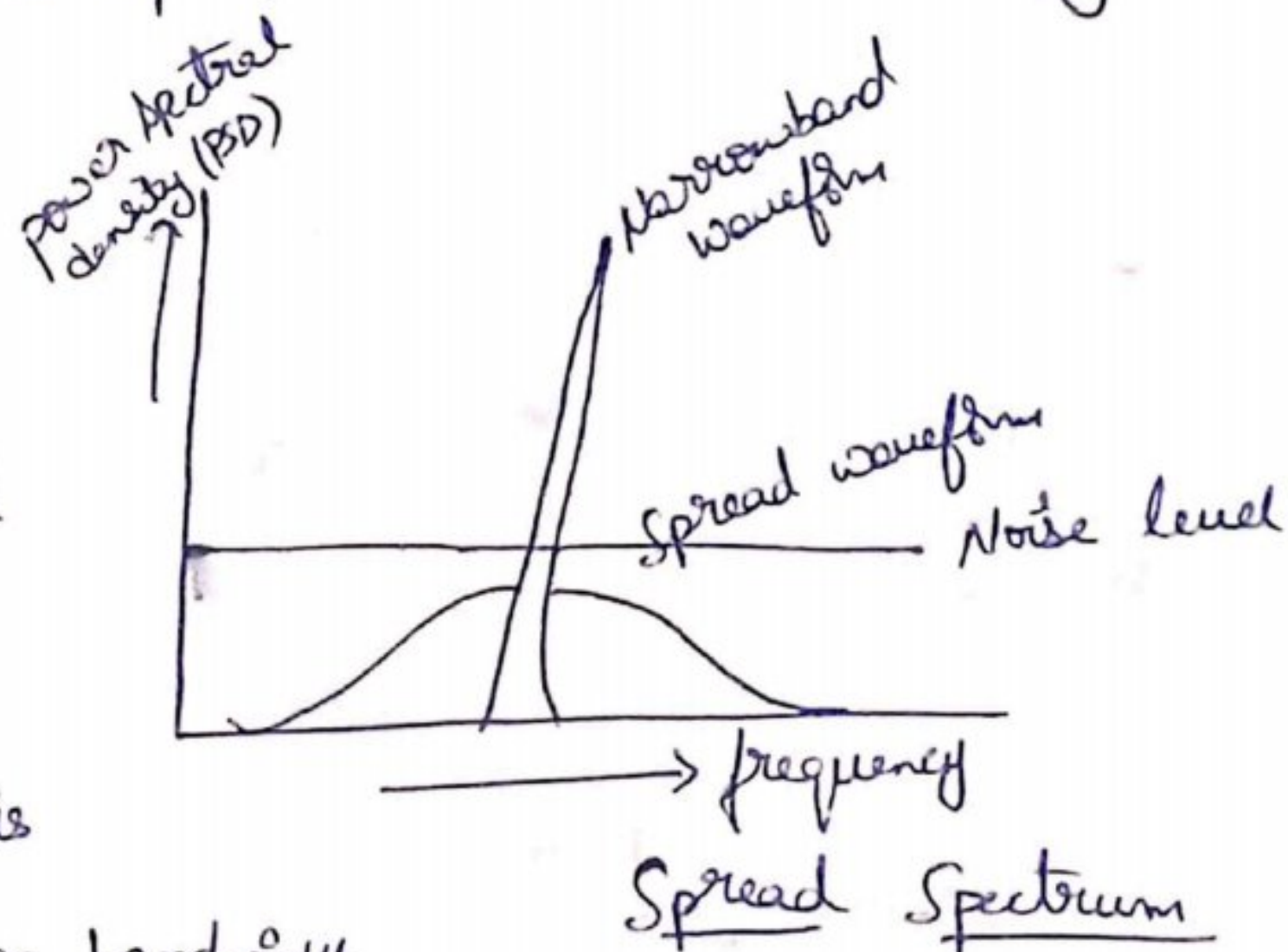
Explain the concept of Spread Spectrum technique:-

① In a conventional transmission system, the information is modulated with a carrier signal and then transmitted through a medium with a particular frequency.

② This frequency represents a specific channel and has very narrow band.

③ In Spread Spectrum, the transmitted power is spread over the complete band.

④ In Spread Spectrum, the transmitted signal bandwidth is much higher than the information bandwidth.



⑤ Steps in Spread Spectrum system is,

① Data to be transmitted is modulated

② Carrier is modulated by spreading code, causing it to spread over a large bandwidth.

4.14)

Explain CDMA and list its features?

① CDMA stands for "Code Division Multiple Access".

② In this technique, a unique code is assigned to each user for communication in the spectrum. Hence it is called as "Code Division Multiple access".

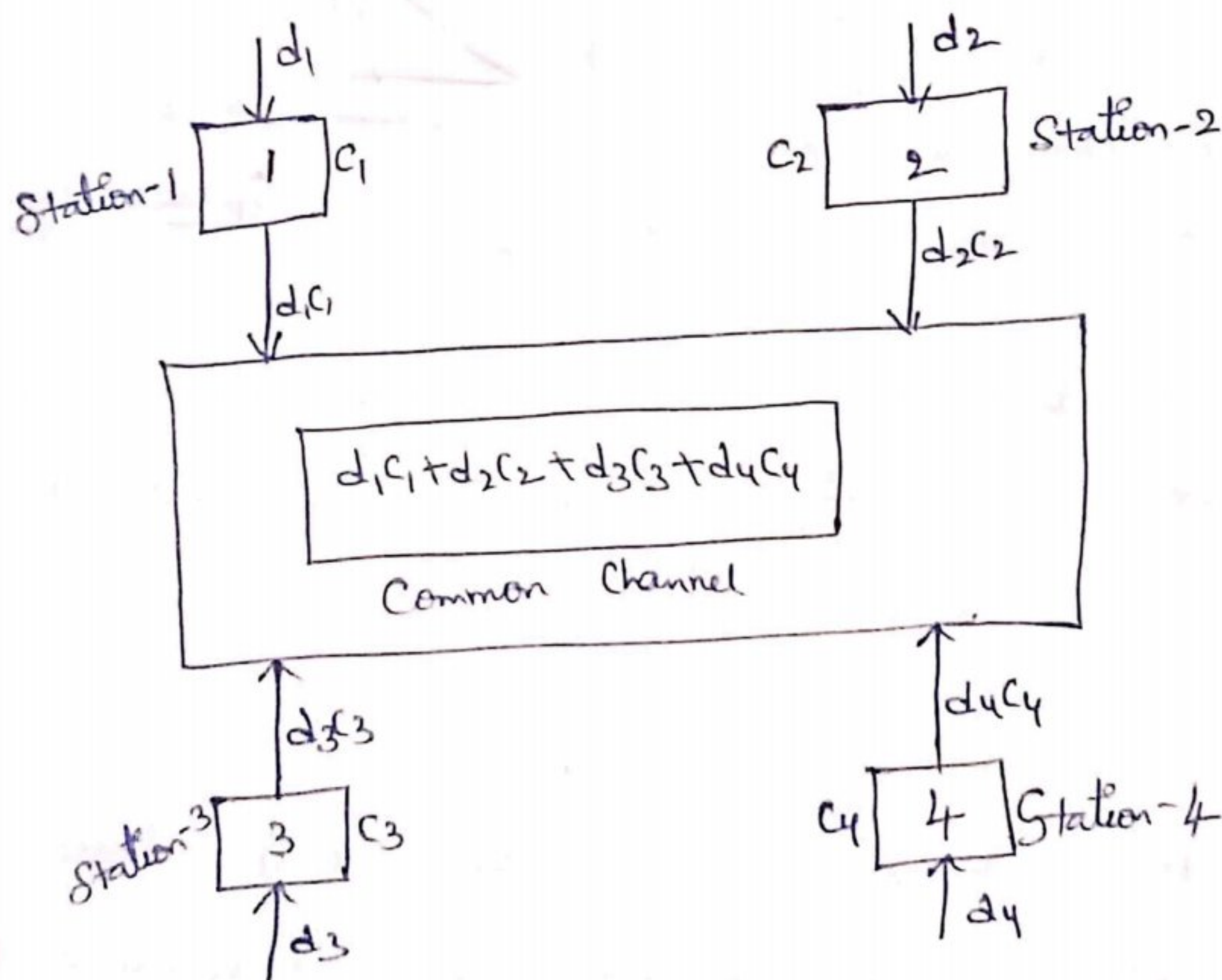
③ It allows each user to transmit over the entire frequency spectrum for all times.

④ CDMA is a Spread Spectrum technique.

⑤ The principle of Spread Spectrum communication system is that the bandwidth of transmitted signal is much higher than the information bandwidth.

⑥ At the transmitter, different codes (PN - pseudo random sequence) are assigned to the baseband signals of different users.

⑦ These transmitted signals are received only by authorized users and these signals appear as noise for unauthorized users.



Concept of CDMA

⑧ In CDMA, one channel carries all the transmissions simultaneously.

⑨ We have 4 stations i.e., Station 1, Station 2, Station 3 and Station 4.

(10) Each and every station will be having one unique code i.e., C_1, C_2, C_3 and C_4

(11) Data Signals D_1, D_2, D_3, D_4 are given to stations

(12) The product $D_1C_1, D_2C_2, D_3C_3, D_4C_4$ are given to the common channel

(13) All these products are added in the common channel.

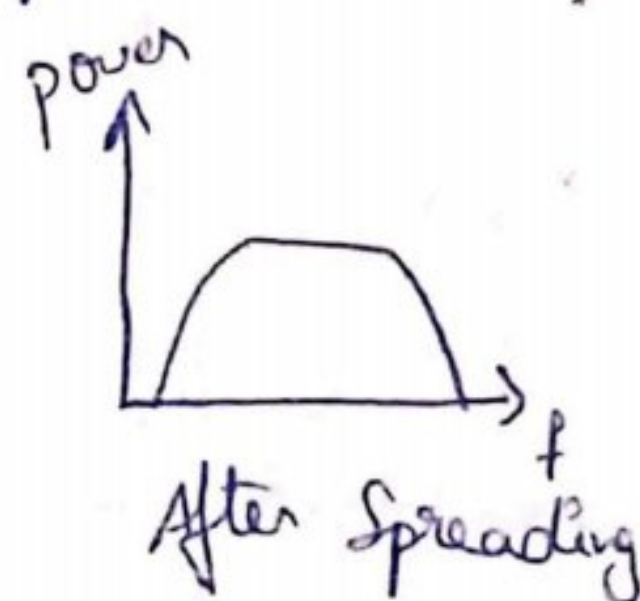
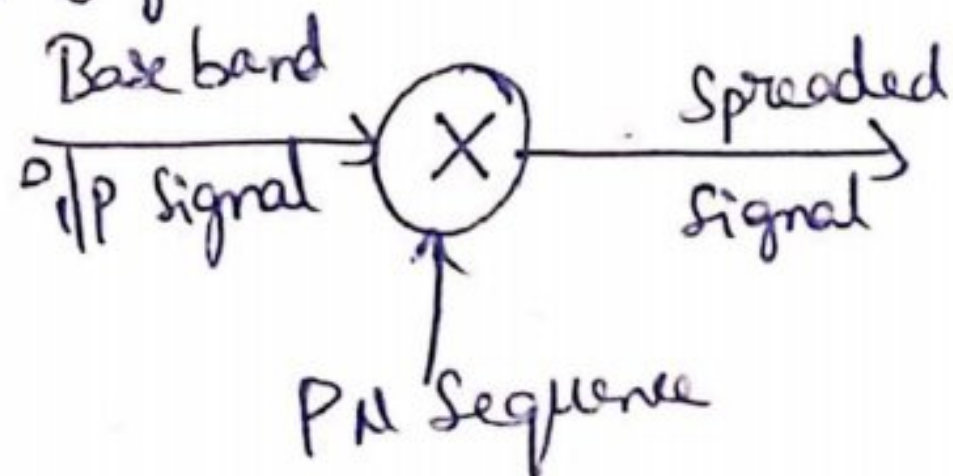
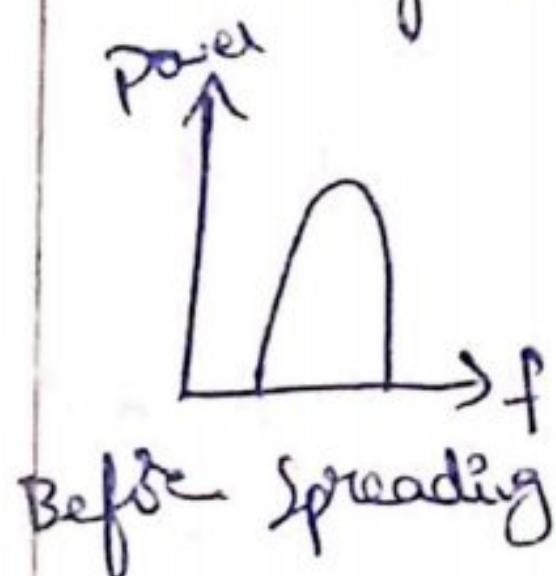
(14) Thus, one channel carries all the transmissions simultaneously.

(15) pseudo random Noise (PN) :- There are 2 types of spreading signals. They are:

(1) Direct Sequence - Code Division Multiple Access (DS-SS)

In DS-SS, Spreading signal is achieved by

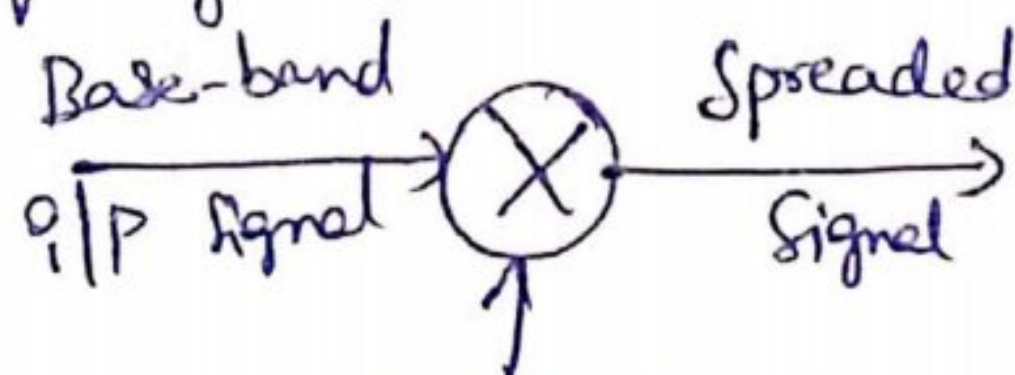
Directly multiplying the users base band signal with PN-Sequence



DS-SS

(2) Frequency Hopping - Spread Spectrum CDMA

A PN Sequence is used to change the radio signal frequency across a broad frequency in random fashion



Freq Synthesizer

PN Sequence

FH-SS

Features of CDMA

- ① High Immunity to Interference
- ② High Security
- ③ privacy
- ④ channel data rates are very high
- ⑤ Soft hand-off is provided.

4-15)

Compare FDMA, TDMA and CDMA

parameters	FDMA	TDMA	CDMA
① Concept	The radio frequency Spectrum is divided into several frequency bands & each user transmits or receives in their respective band	The radio Spectrum is divided into slots & each user is allowed to either transmit or receive in each time slot	The same radio frequency is used by all the users and each user has its own PN code word
② Signal Separation	Filtering in the frequency domain	Synchronization in the time domain	Code plus special receivers
③ Guard bands	Guard bands are required	Guard time slots are required	Guard bands and time slots, both are required
④ Application	used in 1G analog AMPS	used in 2G digital cellular network for GSM	used in 2G CDMA