MOBILE COMPUTING – ASSIGNMENT PRESENTATION

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CELLULAR ARCHITECTURE

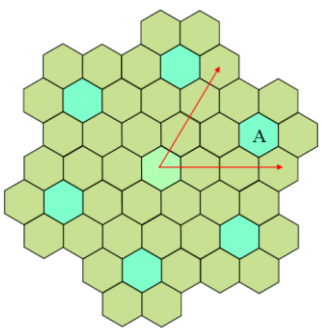
FREQUENCY REUSE

Frequency reuse is the scheme in which allocation and reuse of channels throughout a coverage region is done. Each cellular base station is allocated a group of radio channels or frequency sub-bands to be used within a small geographic area known as a cell. The shape of the cell is **hexagonal**. The process of selecting and allocating the frequency sub-bands for all of the cellular base station within a system is called **Frequency reuse** or **Frequency planning**.

FEATURES

- Frequency reuse improve the spectral efficiency and signal Quality (QoS).
- Frequency reuse classical scheme proposed for GSM systems offers a protection against interference.
- The number of times a frequency can be reused is depend on the tolerance capacity of the radio channel from the nearby transmitter that is using the same frequencies.
- In frequency reuse scheme, total bandwidth is divided into different sub-bands that are used by cells.

COORDINATE SYSTEM



We use (i, j) to denote a particular cell.

Example: Cell A is represented by (2, 1)

i and j are called shift parameters.

- Move i cells along any chain of hexagons.
- Turn counter clockwise 60 degrees.
- Move j cells along the chain that lies on this new heading.

Cell with the same letter uses the same set of channels group or frequencies sub-band.
To find the total number of channels allocated to a cell:

S = Total number of duplex channels available to use

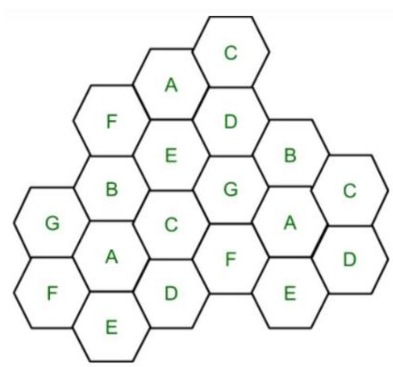
k = Channels allocated to each cell (k<S)

N = Total number of cells or Cluster Size

Then Total number of channels (S) will be,

$S = k * N$

Frequency Reuse Factor = 1/N



In the diagram, cluster size is 7 (A, B, C, D, E, F, G) thus frequency reuse factor is 1/7. N is the number of cells which collectively use the complete set of available frequencies is called a **cluster**. The value of N is calculated by the following formula:

$$N = i^2 + i * j + j^2$$

If a cluster is replicated or repeated M times within the cellular system, then Capacity, C, will be,

$$C = M * k * N = M * S$$

In frequency reuse there are several cells that use the same set of frequencies. These cells are called **co-channel cells**. These co-channel cells result in interference. So, to avoid the interference cells that use the same set of channels or frequencies are separated from one another by a larger distance. The distance between any two co-channels can be calculated by the following formula:

$$D = R * (3 * N)^{1/2}$$

where, R = Radius of a cell and N = Number of cells in a given cluster

	Cluster Size (N)	Co-channel Reuse Ratio (Q)
$i = 1,\ j = 1$	3	3
$i = 1,\ j = 2$	7	4.58
$i = 2,\ j = 2$	12	6
$i = 1,\ j = 3$	13	6.24

$N = i^2 + i * j + j^2$

Where 1/N is the frequency reuse factor

$Q = D/R = (3*N)^{1/2}$

R - radius of the cell

D - distance to the centre of the nearest co-channel cell

N - cluster size

Example 3.1

If a total of 33 MHz of bandwidth is allocated to a particular FDD cellular telephone system which uses two 25 kHz simplex channels to provide full duplex voice and control channels, compute the number of channels available per cell if a system uses (a) four-cell reuse, (b) seven-cell reuse, and (c) 12-cell reuse. If 1 MHz of the allocated spectrum is dedicated to control channels, determine an equitable distribution of control channels and voice channels in each cell for each of the three systems.

Solution

Given:

Total bandwidth = 33 MHz

Channel bandwidth = 25 kHz × 2 simplex channels = 50 kHz/duplex channel

Total available channels = 33,000/50 = 660 channels

(a) For $N = 4$,
total number of channels available per cell = 660/4 ≈ 165 channels.

(b) For $N = 7$,
total number of channels available per cell = 660/7 ≈ 95 channels.

(c) For $N = 12$,
total number of channels available per cell = 660/12 ≈ 55 channels.

A 1 MHz spectrum for control channels implies that there are 1000/50 = 20 control channels out of the 660 channels available. To evenly distribute the control and voice channels, simply allocate the same number of voice channels in each cell wherever possible. Here, the 660 channels must be evenly distributed to each cell within the cluster. In practice, only the 640 voice channels would be allocated, since the control channels are allocated separately as 1 per cell.

(a) For $N = 4$, we can have five control channels and 160 voice channels per cell. In practice, however, each cell only needs a single control channel (the control channels have a greater reuse distance than the voice channels). Thus, one control channel and 160 voice channels would be assigned to each cell.

(b) For $N = 7$, four cells with three control channels and 92 voice channels, two cells with three control channels and 90 voice channels, and one cell with two control channels and 92 voice channels could be allocated. In practice, however, each cell would have one control channel, four cells would have 91 voice channels, and three cells would have 92 voice channels.

(c) For $N = 12$, we can have eight cells with two control channels and 53 voice channels, and four cells with one control channel and 54 voice channels each. In an actual system, each cell would have one control channel, eight cells would have 53 voice channels, and four cells would have 54 voice channels.