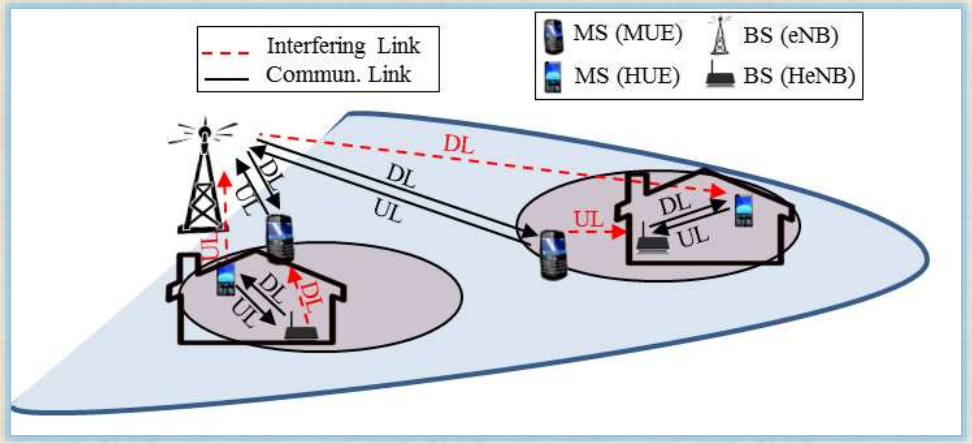
GANDHI INSTITUTE FOR TECHNOLOGY

DEPT. OF ELECTRONICS AND COMMUNICATION ENGINEERING

A SEMINAR ON
INTERFERENCE CANCELLATION FOR CELLULAR SYSTEM



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Content

- Introduction
  - What Is Cellular System?
  - Cellular System Architecture
- Shape Of the Cell
- Cellular Geometric

INTRODUCTION

- Cellular networks today are interference-limited due to the many users that need to share the spectrum to achieve high-rate multimedia communication.
- Cellular concept offered very high capacity in a limited spectrum allocation without any major technological changes.
- Interference is a major limiting factor in the performance of cellular radio systems.
- Interference in voice channel causes cross talk.

What is Cellular System?

- Wireless communication in which several small exchanges(cells)equipped with low-power radio antennas are interconnected through a central exchange.
- A cellular mobile communications system uses a large number of low-power wireless transmitters to create cells—the basic geographic service area of a wireless communications system.

Cellular System Architecture

Cells:-

- A cell is the basic geographic unit of a cellular system.
- Shape of the areas into which a coverage region is divided.
- Cells are base stations transmitting over small geographic areas that are represented as hexagons.
- Each cell size varies depending on the landscape. Because of constraints imposed by natural terrain and man-made structures

Clusters:-

- A cluster is a group of cells No channels are reused within a cluster.

Shapes Of Cells

- **Square**
  - Width of d-cell has four neighbours at distance d and four at distance d better if all adjacent antennas equidistant
- **Hexagon**
  - Provide equidistant antenna
  - Radius defined as radius of circum-circle
    - Distance from centre to vertex equal length of size
  - Distance between centre cell radius R is R.
  - Not always precise hexagon.
    - Topological hexagon
    - Local signal propagation condition
    - Location of antenna.

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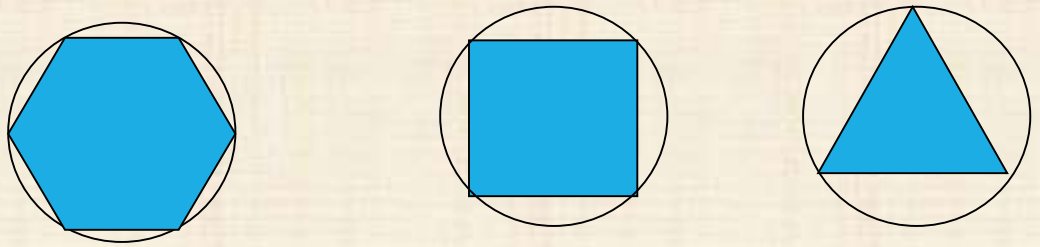
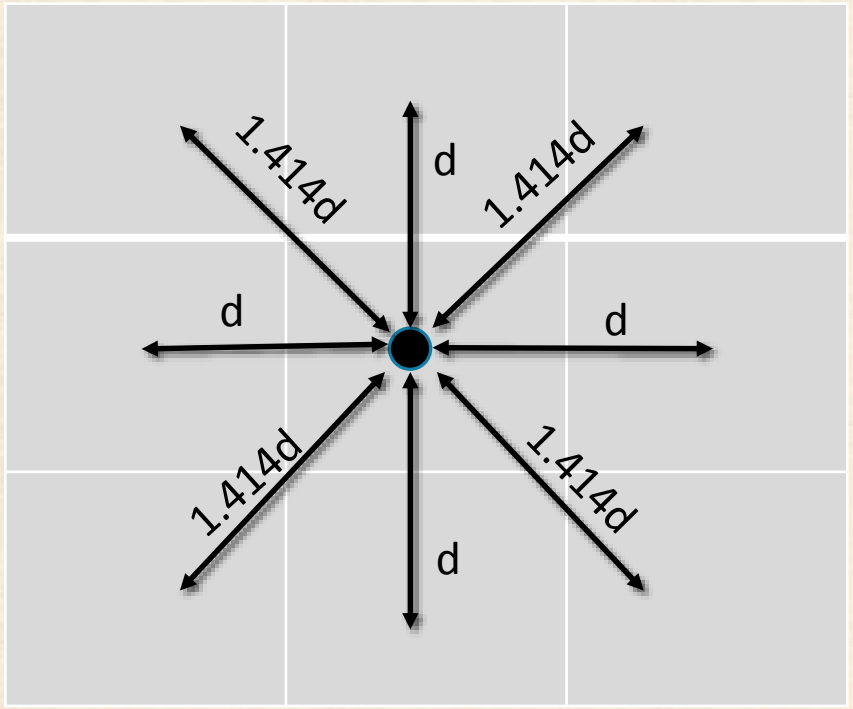
Three possible choices of shapes: square, equilateral triangle and hexagon.

For a give distance between the center of a polygon and its farthest perimeter points, the hexagon has the largest area of the three

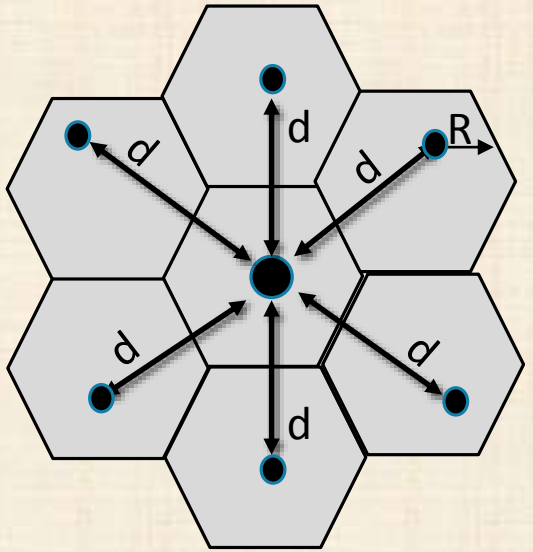


Thus by using hexagon geometry, the fewest number of cells can cover a geographic region and it closely approximates circle.

Cellular Geometric



a)Square Pattern



b)Hexagonal Pattern

Capacity of System

When using hexagon to model coverage areas

- Center-excited Cell: BS depicted as being either in the center of the cell
  - Omni-directional antenna is used
- Edge-excited Cell: on three of the six cell vertices
  - Sectored direction antenna is used

Consider a cellular system

- which has S duplex channels available for reuse.
- Each cell allocated group of k channels ($k < S$)
- S channels divided among N cells (unique and disjoint) then

$$S = kN$$

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Cluster: N cells, which collectively use the complete set of available frequencies

If a cluster is replicated M times in the system, the number of duplex channels C as a measure of capacity is

$$C = MkN = MS$$

So capacity is directly proportional to the replication factor in a fixed area.

Factor N is called cluster size and is typically equal to 4, 7, 12.

Contd.

If cluster size N is reduced while cell size is kept constant

- more clusters are required
- More capacity is achieved

Large cluster size indicates that co-channel cells are far from each other

Conversely, small cluster size means co-channel cells are located much closer together

The value of N is a function of how much interference a mobile or BS can tolerate

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Clusters are inversely proportion to N

- Capacity is directly proportional to Clusters
- Thus frequency reuse factor is given by 1/N.

In last fig, each hexagon has exactly six equidistant neighbors and that the lines joining the centers of any cell and its neighbors are separated by multiple of 60 degrees.

- There are only certain cluster sizes and layouts possible

Interference Defined

- **Unwanted signals**

either entering your equipment

or

getting into equipment of other parties but generated by you.

Interference

- It is a major limiting factor in the performance of cellular radio systems. (In comparison with wired comm. Systems, the amount and sources of interferences in Wireless Systems are greater.)
- Creates bottleneck in increasing capacity
- Sources of interference are:

1.Mobile Stations 2. Neighboring Cells 3. The same frequency cells

4. Non-cellular signals in the same spectrum

- Interference in Voice Channels: Cross-Talk
- Urban areas usually have more interference, because of: a)Greater RF Noise Floor, b) More Number of Mobiles

Interference Types

1. CO-CHANNEL INTERFERENCE

2. ADJACENT CHANNEL INTERFERENCE

Co-channel Interference and System Capacity

- Frequency reuse - there are several cells that use the same set of frequencies
  - co-channel cells
  - co-channel interference
- To reduce co-channel interference, co-channel cell must be separated by a minimum distance.
- When the size of the cell is approximately the same
  - co-channel interference is independent of the transmitted power
  - co-channel interference is a function of
    - *R*: Radius of the cell
    - *D*: distance to the center of the nearest co-channel cell
- Increasing the ratio $Q=D/R$, the interference is reduced.
- *Q* is called the co-channel reuse ratio

- For a hexagonal geometry

$$Q = \frac{D}{R} = \sqrt{3N}$$

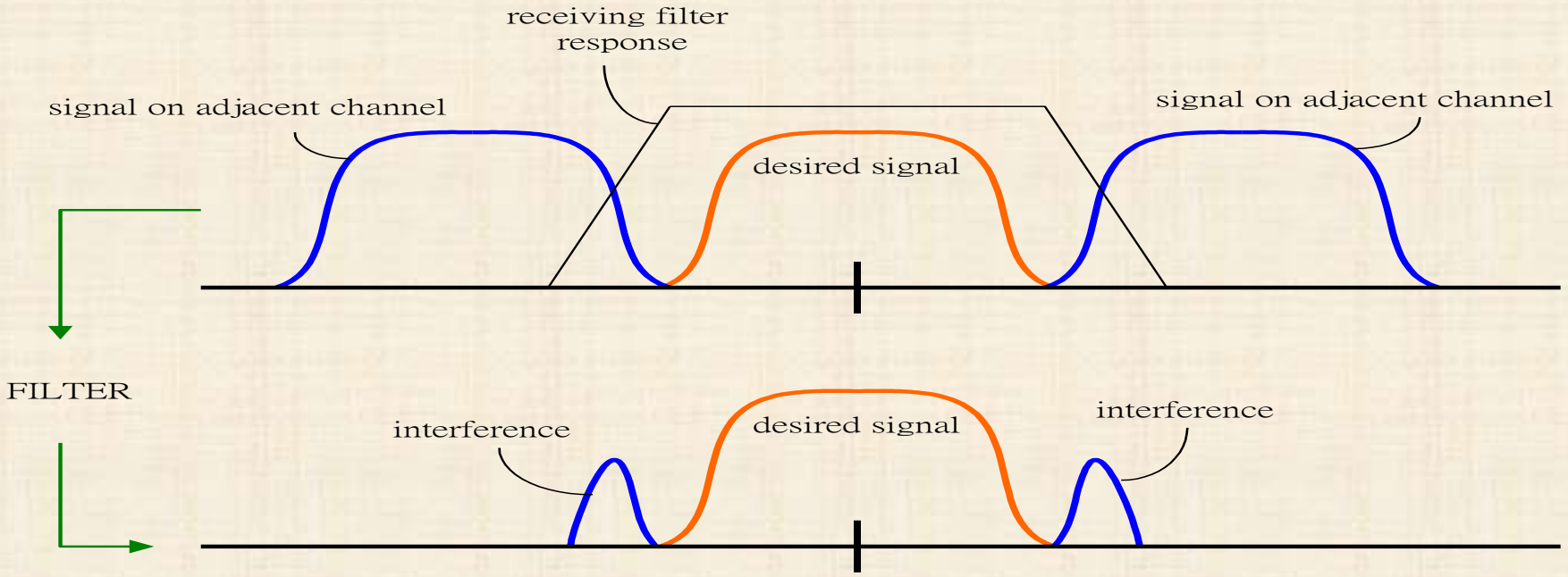
- A small value of Q provides large capacity
- A large value of Q improves the transmission quality - smaller level of co-channel interference
- A tradeoff must be made between these two objectives

Table 2.1 Co-channel Reuse Ratio for Some Values of N

	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

Adjacent Channel Interference

- Adjacent channel interference: interference from adjacent in frequency to the desired signal.
  - Imperfect receiver filters allow nearby frequencies to leak into the passband
  - Performance degrade seriously due to *near-far* effect.



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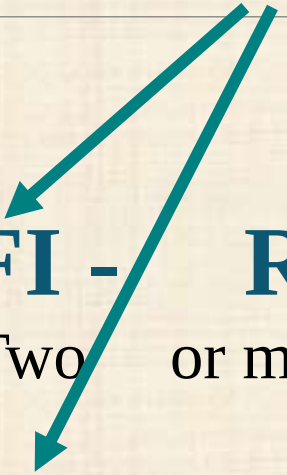
- Adjacent channel interference can be minimized through careful filtering and *channel assignment*.
- Keep the frequency separation between each channel in a given cell as large as possible
- A channel separation greater than six is needed to bring the adjacent channel interference to an acceptable level.

Power Control for Reducing Interference

- Ensure each mobile transmits the smallest power necessary to maintain a good quality link on the reverse channel
  - long battery life
  - increase SIR
  - solve the near-far problem

Interference : Flavours



- **RFI - Radio Frequency Interference**

- - - Two or more signals competing for the same channel

- **EMI - Electromagnetic Interference**

- - - Appliances that are overloaded by strong EMI from nearby RF sources

Solving RFI Problems

- - - Disconnect components to localize problem area

- - - Check cable connections

- - - Check for grounded polarized plugs

- - - Ferrite cores around power cables

- - - Hipass filter on 300 ohm TV feedline

Solving EMI Problems

- Hard to track down appliance causing interference

- Microprocessors often generate EMI

- Enclose in grounded box

- Ferrite cores on cables

REFERENCE

- Wireless Communication by *T.S. RAPPAPORT*
- http://www.slideshare.net/ajal4u/interference-and-system-capacity
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QUERIES ???

(if any..)