Chapter 3

A Quick Recap

- We learned about cell and reuse factor.
- We looked at traffic capacity
- We looked at different Earling Formulas
- We looked at channel strategies
- We had a look at Handoff

Interference

- Interference is a major limiting factor in the performance of a cellular radio. It limit capacity and increases the number of dropped calls
  - **Sources**
  - **Another mobile phone**
  - **A call in progress in neighboring cell**
  - **A BS operating at same frequency band**

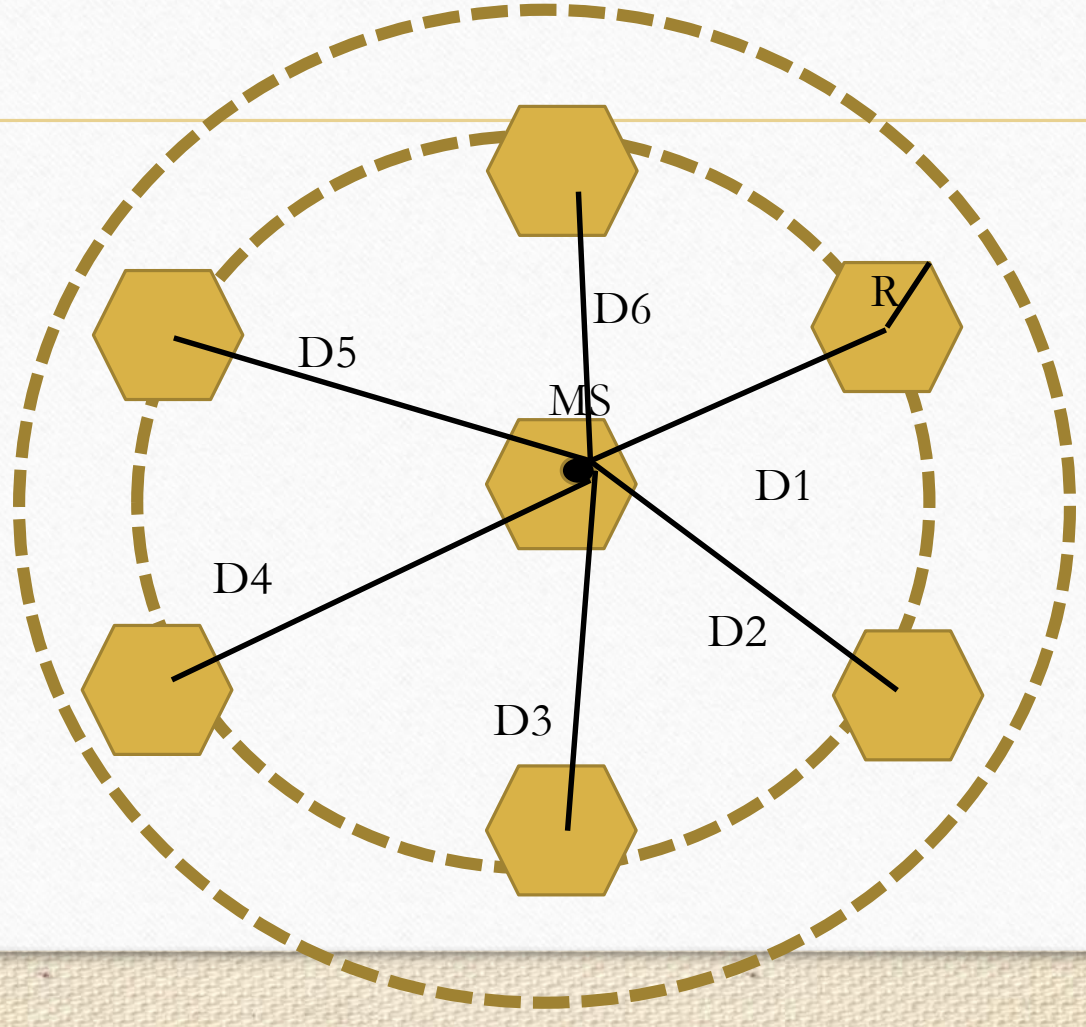
Interference

- Severe in urban areas , due to greater number of RF Noise floor
- In Urban areas normally (with extreme high traffic) we keep N=4
- Interference on voice channel causes
  - Cross Talk
  - Noise in back ground
- Interference on Control channels
  - Miss and blocked calls

Types of Interferences

- There are two interferences
  - Co-Channel Interferences
  - Adjacent channel interference

Co Channel Interference



CCI

- Can not be overcome by increasing SNR
- For similar cells , CCI depends on cell Radius R and co- channel distance D.
- To reduce CCI the co-channels must be physically sepreated
  - We may use different codes as well for different cells (CDMA)
- We know co channel interference is Q=D/R or $\sqrt{3N}$

Calculation to Signal to Interference Ratio

- The signal to interference ratio for a mobile is (S/I o SIR) =

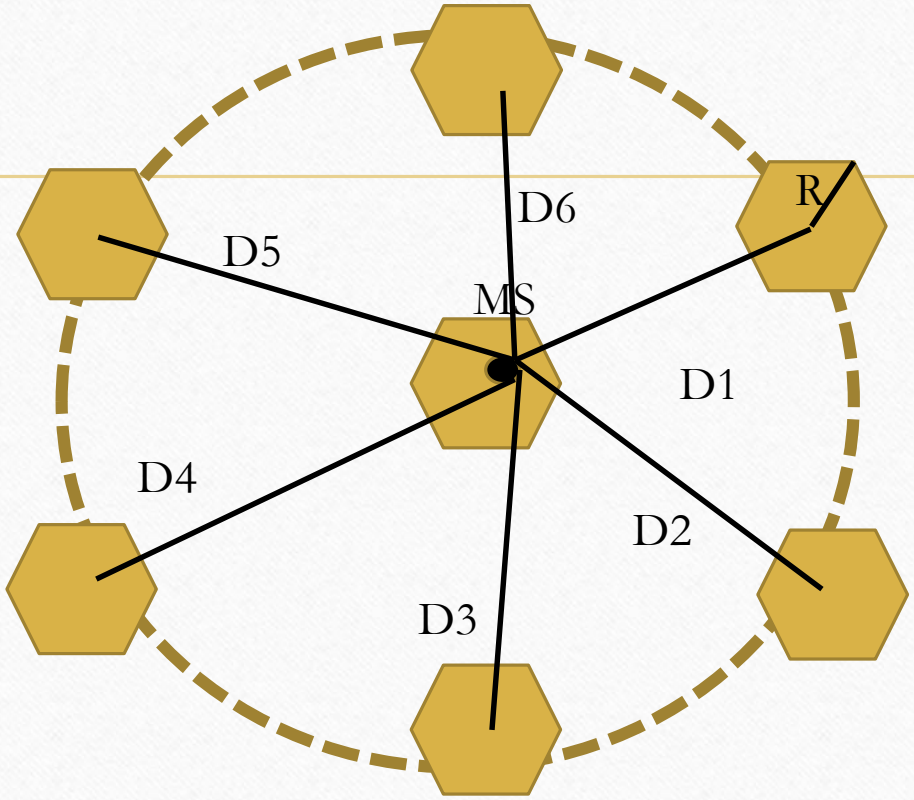
$$\bullet \frac{S}{I} = \frac{S}{\sum_{i=1}^{i0} I_i}$$

- Where S is the desired signal power (desired BS recived power) and Ii is the interference caused by Ith co channel cell

Relation of S/I

- Considering only the first layer of interfering cells, if all BS are at equal distance from desired base station
- $\frac{S}{I} = \frac{\sqrt{3N}}{io}^{n}$
- This equation relates cluster size N to S/I. As N Increases capacity , Capacity Decreases , S/I Improves

- These $\frac{S}{I}=(1/6)\sqrt{3N}^{n}$



Calculations

- S/I (Desired) =15 db
- Path Loss = 4
- Reuse Factor=?
- Step 1: Try N= 4
- Is it Ok
- Step 2 . Try N = 7
- What if path loss =3

General Discussion CDMA

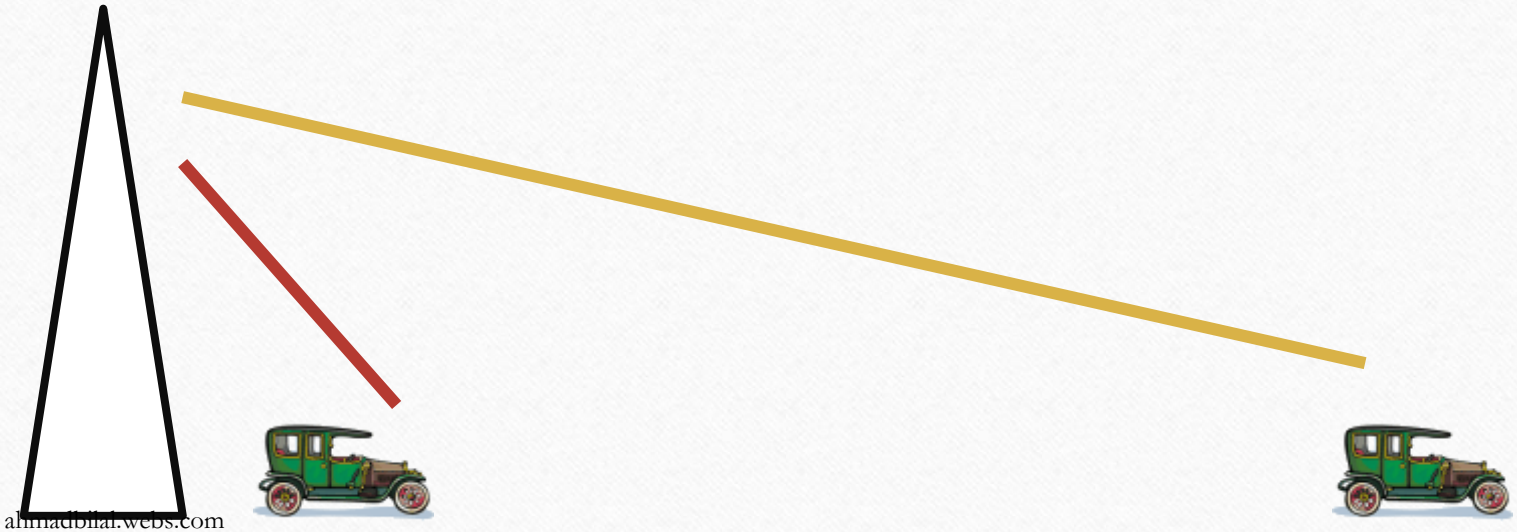
- Breathing Cell Concept
- Advantages
- Disadvantage

Adjacent ChannelInterference

- Results from Signals that are adjacent in frequency to the desired signal
- Results from imperfect receiver filters (Pass band)
- Problem increases , When users near by are assigned near by frequency
  - May give rise to Cross Talk
  - Blocked Call

ACI 2

- Near Far Effect .
  - When an interferer close to the BS radiates in adjacent channel , while the subscriber is far away from BS



ACI

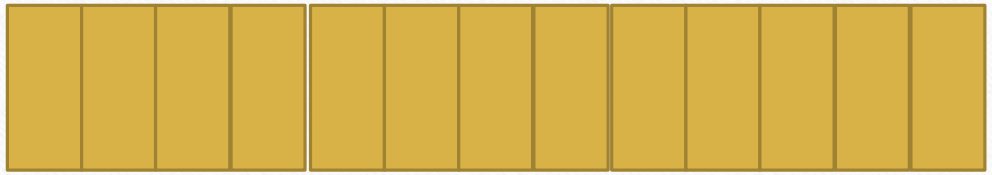
- Can be reduced by
  - Careful channel Assignment
  - Filtering
- Guard band

S/I Ratio

- If the subscriber is at distance d1 and the interferer is at d2, than Signal to interference ratio is (prior to filtering)
- $\frac{S}{I}=(\frac{d1}{d2})^n$

ACI

- More Reduction Techniques: Frequency Separation



Reducing Interference And Power Control

- In practical system, the level of every subscriber is under constant control by serving BS
- Power Control not only reduces interference , but also prolongs battery life

Trunking

- Cellular System rely on trunking to accommodate large number of users in a limited radio spectrum
- The Concept of trunking allow a large number of users to share a small number of channels in a cell by providing access to each user on demand , from a pool of available channels
- In trunk radio system, each user is allocated channel on a per call basis.
- Upon termination of call previously occupied channel is immediately returned to pool of available channels

Types of Trunking

- Lost call Cleared System (LCC)
- Lost Call Delayed System

Lost call Cleared System (LCC)

- No queue
- Minimal call set sup
- Immediate access
- If all channels busy call is blocked
- Measured by Earling B

Lost Call Delayed System

- Queues are used to hold call requests that are initially blocked
- Call request may be delayed in resources not available
- Measured Via Earling C

Trunking Efficiency

- Measure of number of users which can be offered a particular GoS with a particular configuration of fixed channel

Improving Capacity

- Capacity is total number of users that can be supported in system, and translates directly into N
- As the demand increases , system designers have to *provide more channels per unit coverage area (/ square km)*
- Common methods are
  - Cell Splitting. – Increase number of BS . Allows growth
  - Sectoring – Use directional antenna to control interference and frequency reuse
  - MicroCell Zoning : Distributes coverage , and extend the cell boundaries to provide coverage to hard to reach areas

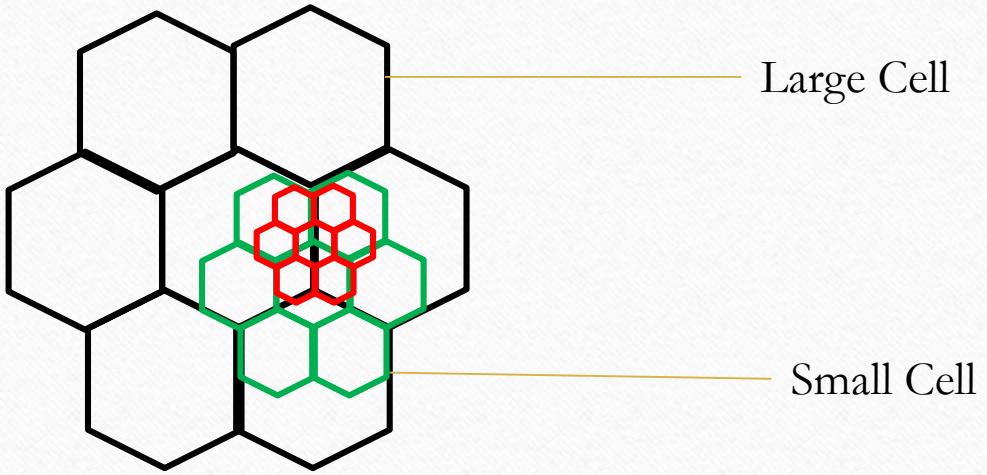
Cell Splitting 1

Cell Splitting is a process of subdividing a congested cell into a smaller cell with

- Their on BS
- Reduction in antenna height
- Reduction in transmitter power

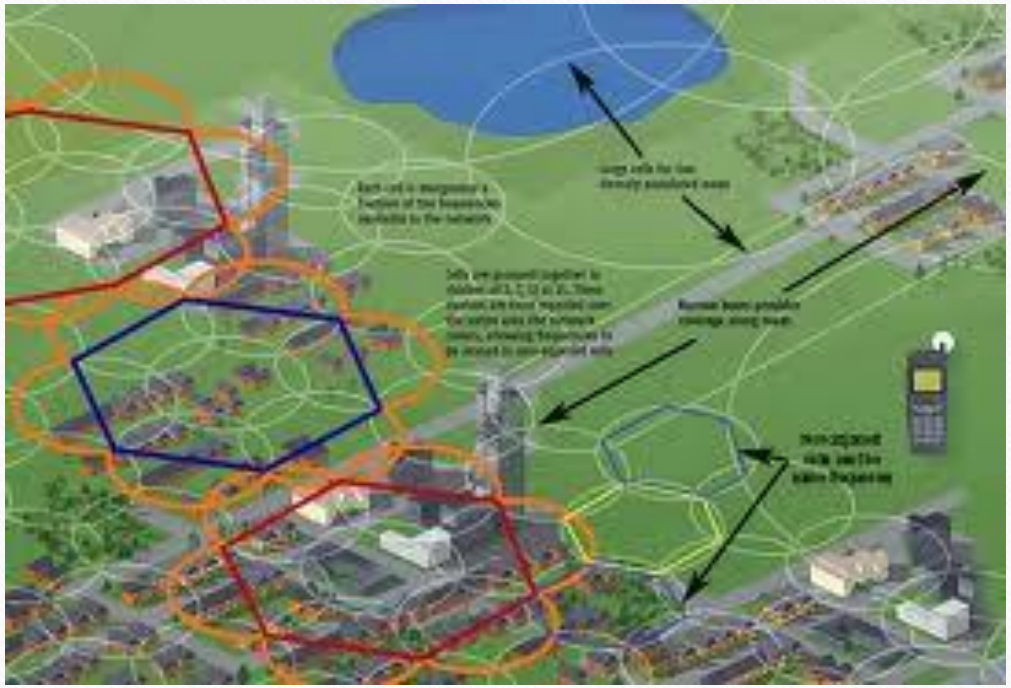
Splitting cells ~ reduces cell size (microcell) thus we get more number of cells, which eventually leads to more number of cluster , and we get more capacity

Cell Splitting



- Please Keep in mind, Cell are split to add more channels with no new spectrum
- Depending on traffic pattern, these small cells cab be activated and deactivated

A Pictorial Represent



Practical Splitting Considerations

- Different Cells sizes of microcell, due to geographic conditions
- Channel assignments become more complicated
- Hand off Issues
- Larger cells are normally used for high speed

Cell Splitting VS Sectoring

- Capacity is achieved by rescaling the system .
- D/R ratio is kept constant while decreasing R
- Increases number of channels per unit area
  - VS
- Keep cell radius unchanged .

- ***<u>Suppose the microcells are of the half size of old cell. What should be the transmitted power</u>***

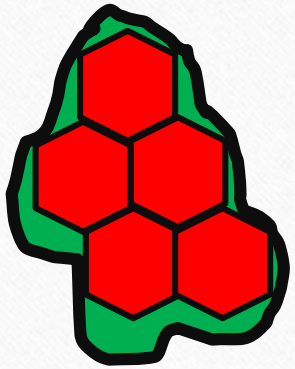
- We have Pr receiver (old cell) = $Pt_1 R^{-n}$

- Pr received (new) = $Pt_2(\frac{R}{2})^{-n}$
- $Pt_{2=} \frac{Pt_1}{2^n}$
- Lets suppose the path loss for area at Sheik Zayed hospital is 3. What should be the transmitting power of new microcells
  - For n=3
  - $Pt2= \frac{Pt1}{8}$

- Power need to be reduced by 9 DB

Cell Splitting

- Suppose the congested service are is covered as
  - 5 cells
  - Each cell with 80 Channels
  - Capacity = 5x80= 400
  - These 5 cells have been spitted in to 24 cells
  - Sow now the new capacity is 24 *80 =1920
- **Issues**
  - More hand off
  - More BS



Repeaters for Range Extension

Coverage for hard to reach pages

Like buildings, valleys and Tunnels

Radio Retransmitted know as repeater are used .

Bidirectional in natures and can send and receive at same time.

Can repeat exact cell pattern or a single band

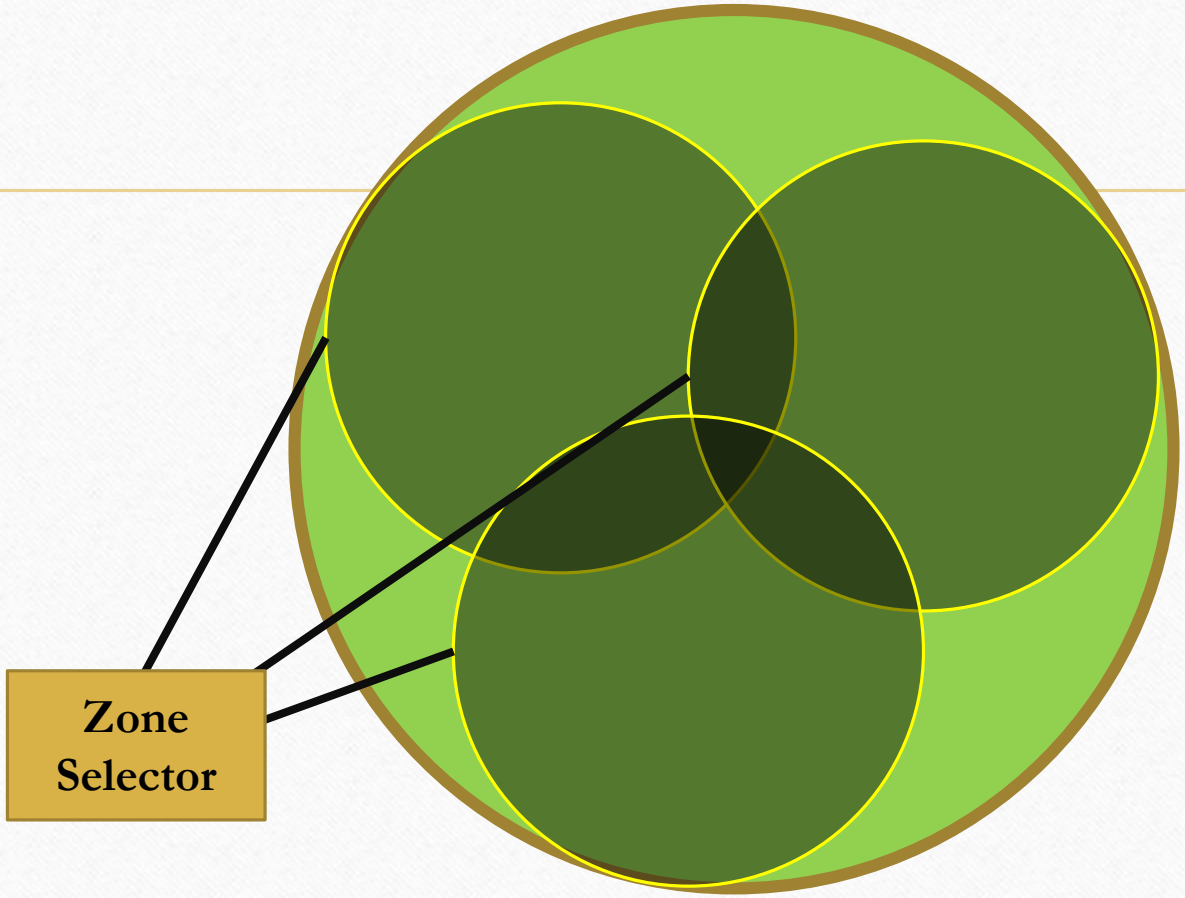
The antenna which is connected for input and output of repeater for lovalized spot coverage is call DAS (distributed antenna system)

Micro Cell Zones

- A cell is divided in to micro cell or zones
- Each micro zone is to same BS connect
- Each zone uses a directional antenna
- As mobile travels from one zone to another , it retains same channel.
- BS simply switches the channel to next BS

Micro Zone Cell

- Overlapping
- No BS
- Directional
- Passive transmitters
- No load in MSc
- Useful in High way



- CCI reduced due to
  - Low power transmitters
  - Directional antennas
- Help us to design smaller cluster .

Cell Sectoring 2

- Its is done by increasing frequency reuse .
- Increase Interference

Cell Sectoring

- CCI may be decreased by replacing the single Omni-directional antenna by several directional antennas , each radiating within a specified sector
- The directional antenna transmits to and receives from only a fraction of the total number of co-channel cells . Thus CCI is reduced .
- A cell is normally divided in to , three , four or six sectors .
- As we increase sectors, CCI is reduced.

Issues

- Handoff
- Antennas

- Does not add capacity
- Just help signal to reach hard coverage areas.
- Typically Large building are provided with coverage of microcells, and than the building is provided coverage via DAS networks