SNS COLLEGE OF Engineering

Coimbatore – 35

An Autonomous Institution

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

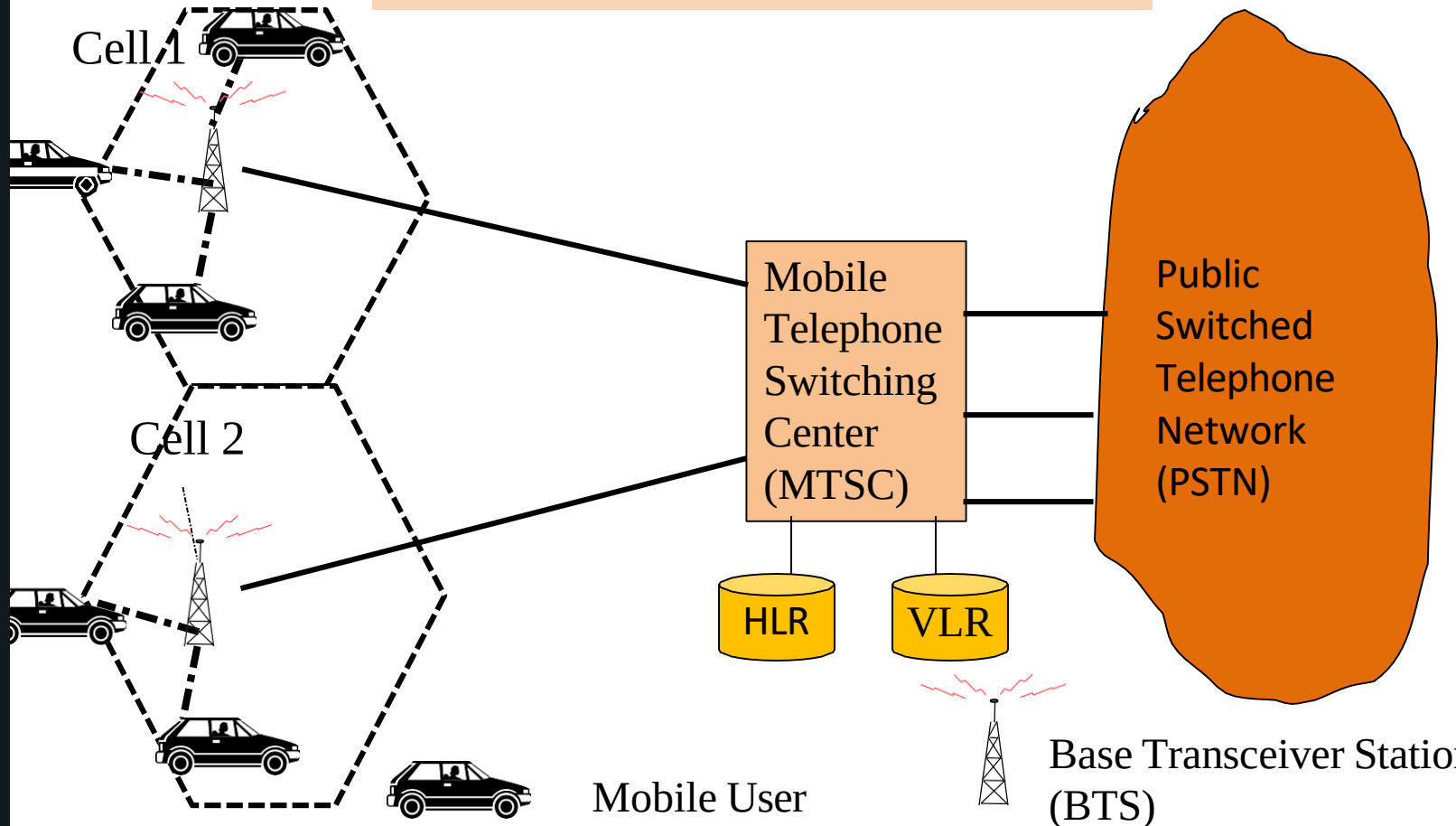
19EC603/ Wireless Communication

III ECE/ VI SEMESTER

Unit I **-FUNDAMENTALS OF WIRELESS COMMUNICATION**

Topic 3,4 : Cellular concepts, Frequency reuse

A Cellular Network

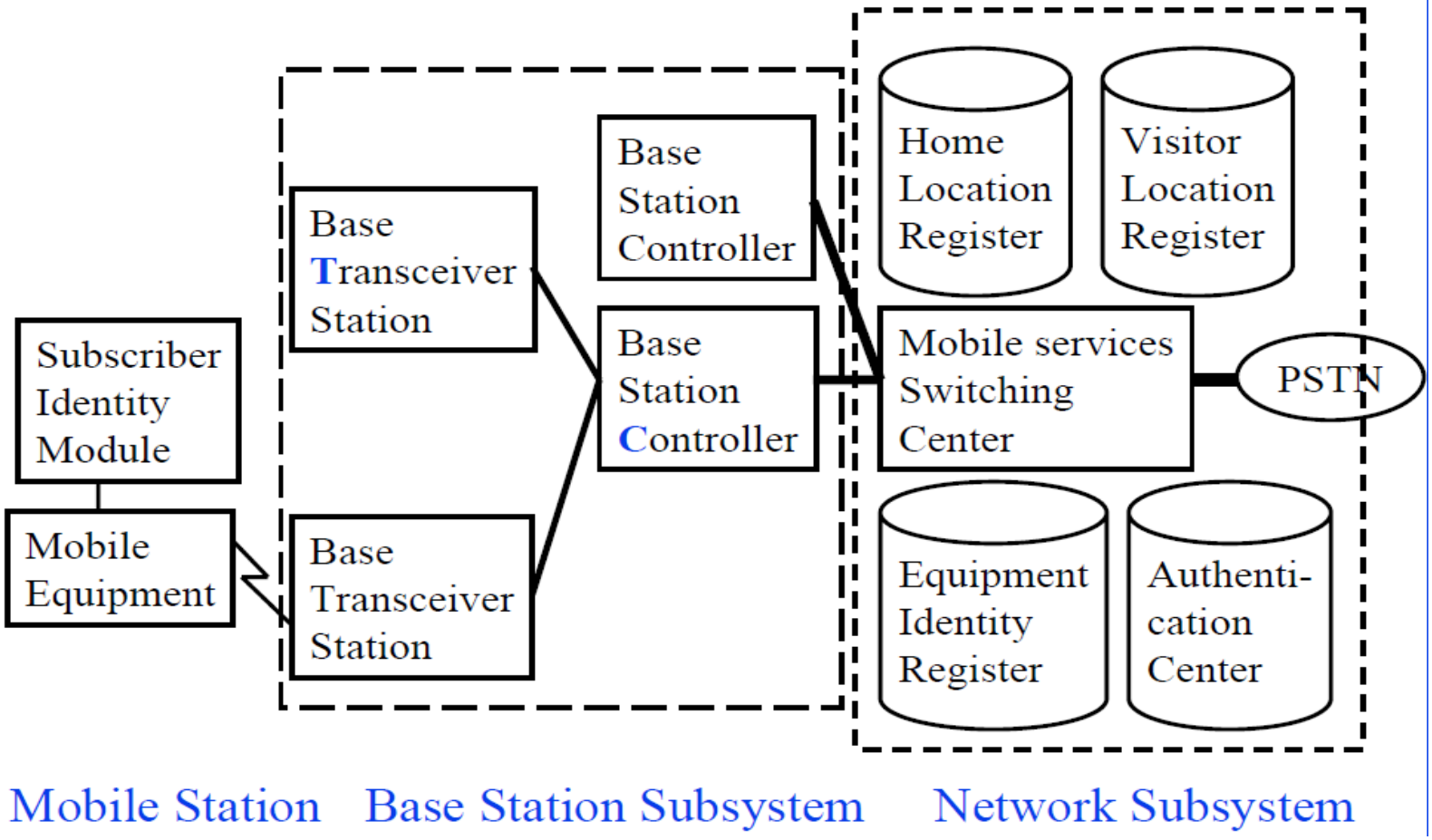


Principles of Cellular Networks

- Underlying technology for mobile phones, personal communication systems, wireless networking etc

- Developed for mobile radio telephon
  - Replace high po transmitter/receiver systems
    - Typical support for 25 chan over 80km
  - Use lower power, shorter range, more transmitters

Cellular Architecture



Cellular Architecture (Cont)

- Base station controller (BSC) and Base transceiver station (BTS)
- One BTS per cell.
- One BSC can control multiple BTS.
  - Allocates radio channels among BTSs.
  - Manages call handoffs between BTSs.
  - Controls handset power levels
- Mobile Switching Center (MSC) connects to PSTN and switches calls between BSCs. Provides mobile registration, location, authentication. Contains Equipment Identity Register.

Cellular Architecture (Cont)

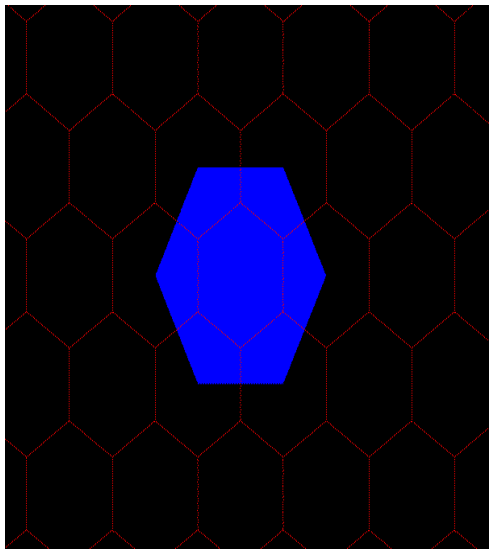
- Home Location Register (HLR) and Visitor Location Register (VLR) provide call routing and roaming
- VLR+HLR+MSC functions are generally in one equipment
- Equipment Identity Register (EIR) contains a list of all valid mobiles.
- Authentication Center (AuC) stores the secret keys of all SIM cards.
- Each handset has a International Mobile Equipment Identity (IMEI) number.

ACTIVITY

Find the difference between two images

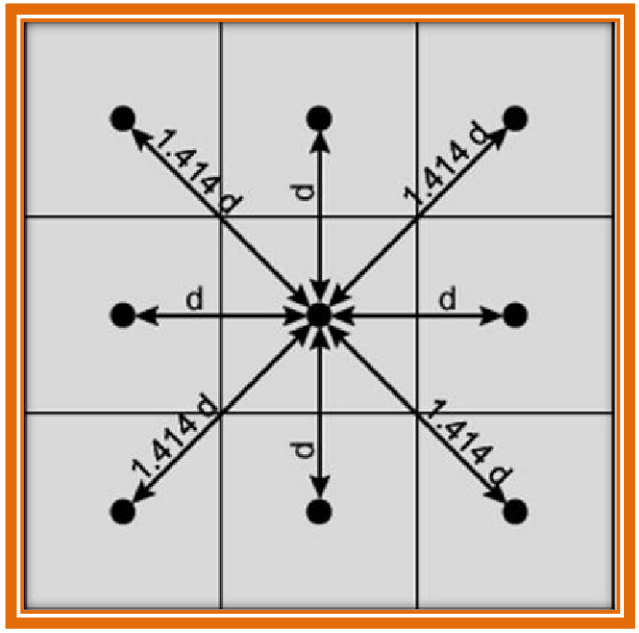
Cellular Network Organization

- Multiple low power transmitters
  - 100w or less
- Area divided into cells
  - Each with own antenna
  - Each with own range of frequencies
  - Served by base station
    - Transmitter, receiver, control unit
  - Adjacent cells on different frequencies to avoid crosstalk



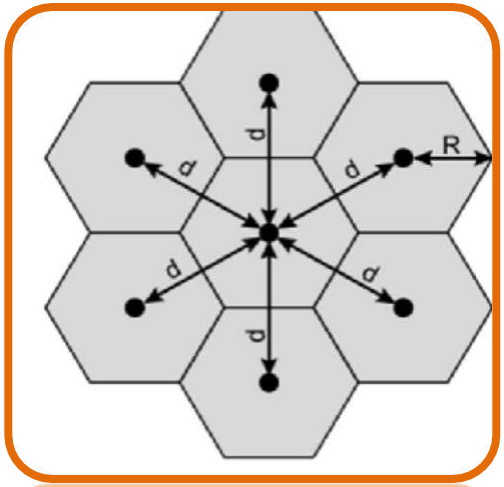
Shape of Cells

- Square
  - Width *d* cell has four neighbours at distance *d* and four at distance $\sqrt{2}\,d$
  - Better if all adjacent antennas equidistant
    - Simplifies choosing and switching to new antenna



Cellular Geometries

- Hexagon
  - Provides equidistant antennas
  - Radius defined as radius of circum-circle
    - Distance from center to vertex equals length of side
  - Distance between centers of cells radius R is $\sqrt{3}R$
  - Not always precise hexagons
    - Topographical limitations
    - Local signal propagation conditions
    - Location of antennas



Frequency Reuse

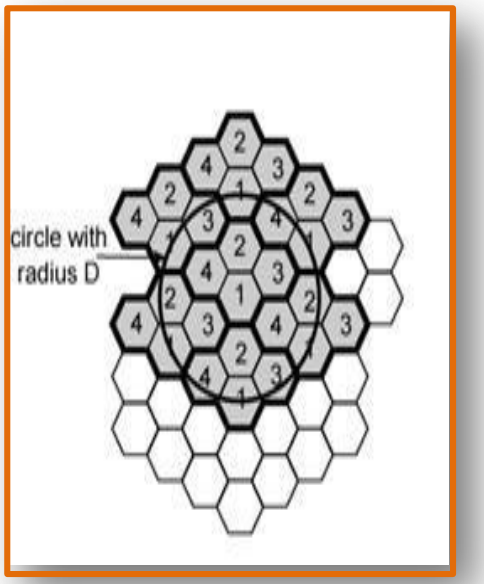
- Frequency reusing is the concept of using the same radio frequencies within a given area, that are separated by considerable distance, with minimal interference, to establish communication.

Benefits

- Allows communications within cell on a given frequency
- Limits escaping power to adjacent cells
- Allows re-use of frequencies in nearby cells
- Uses same frequency for multiple conversations
- 10 to 50 frequencies per cell

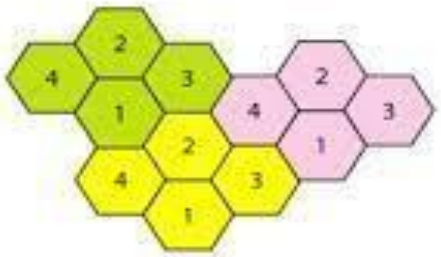
Frequency Reuse

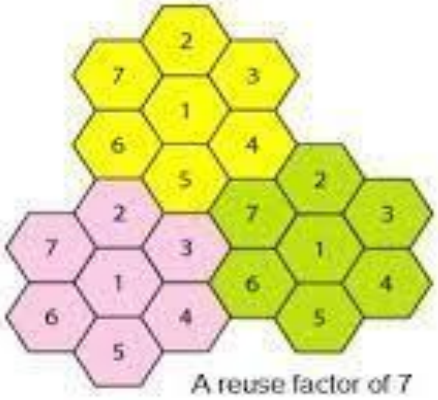
- Power of base transceiver controlled
  - Allow communications within cell on given frequency
  - Limit escaping power to adjacent cells
  - Allow re-use of frequencies in nearby cells
  - Use same frequency for multiple conversations
  - 10 – 50 frequencies per cell
  - *N* cells all using same number of frequencies
  - *K* total number of frequencies used in systems
  - Each cell has *K/N* frequencies
  - Advanced Mobile Phone Service (AMPS) *K*=395, *N*=7 giving 57 frequencies per cell on average



Frequency reuse N=4

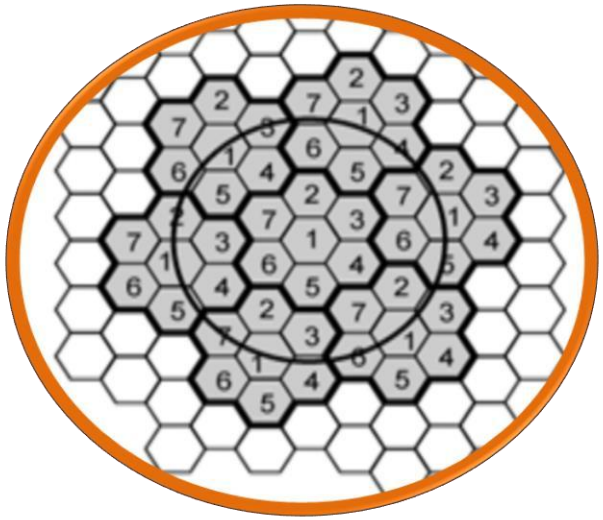
Frequency Reuse Pattern

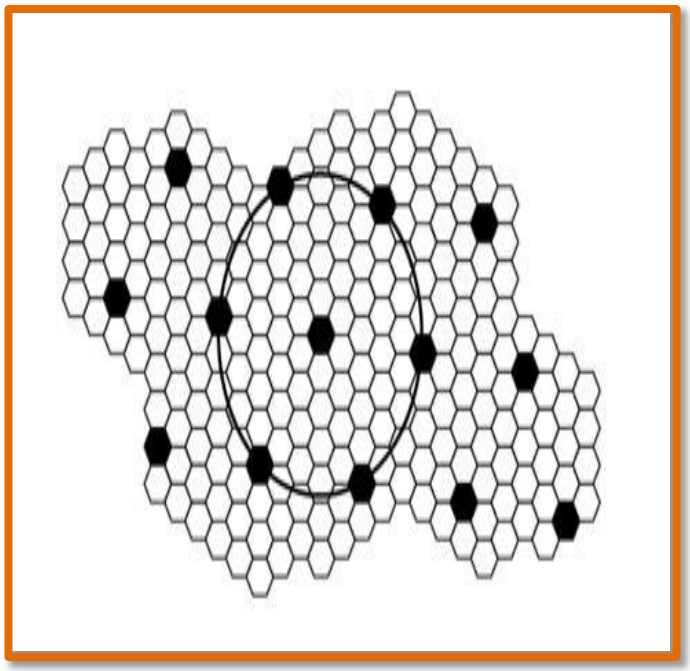




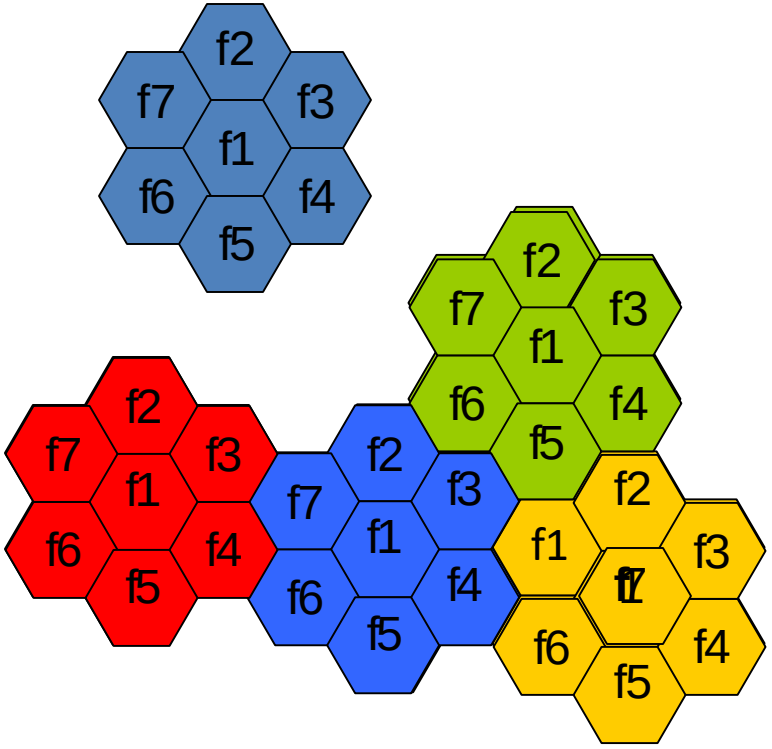
Frequency reuse N=19

Frequency reuse N=7



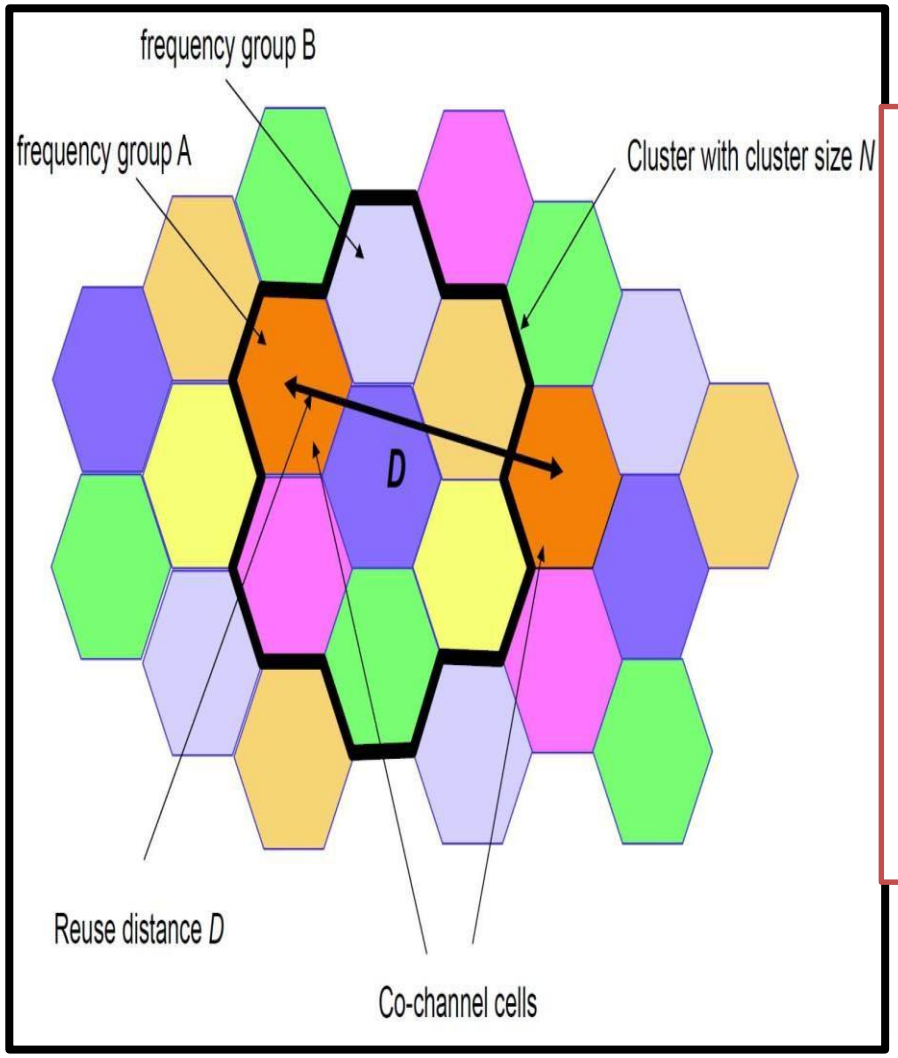


Frequency Reuse using 7 frequencies allocations



Each cell is generally 4 to 8 miles in diameter with a lower limit around 2 miles.

Frequency Reuse



Reuse Cluster:
Each cell uses totally the different set of channels with the others in the same

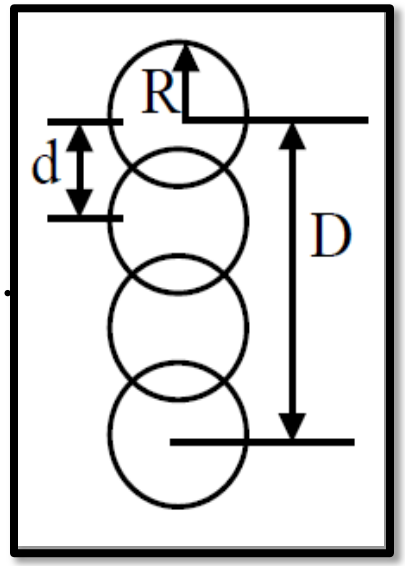
Reuse distance: Minimum distance between two cells using same channel

Co-channel interference:
Interference for satisfactory signal quality caused by transmissions of co-channel cells

Characterizing Frequency Reuse

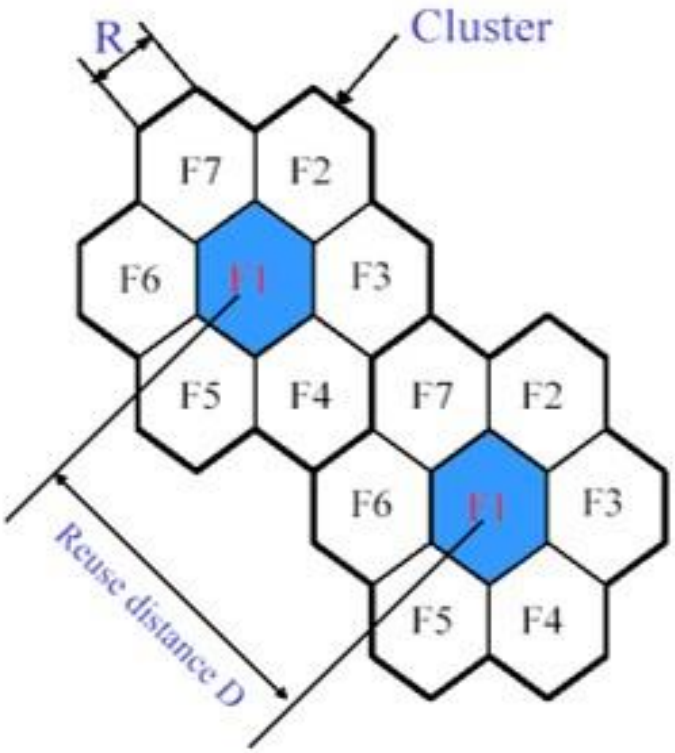
- D=Minimum distance between centers of cells that use the same band of frequencies(Co-Channels)
- R=Radius of a cell
- d = Distance between centers of adjacent cells($d=R\sqrt{3}$)
- N= Number of cells in repetitious pattern(Cluster)
  - Reuse factor
  - Each cell in patterns uses unique band of frequencies.
- Hexagonal cell pattern, following values of N possible

  $N=I^2+J^2+(I \times j)$, I,J =0,1,2,3,….
- Possible values of N are 1,3,4,7,9,12,13,16,19,21,…
- $D/R=\sqrt{3N}$
- $D/d=\sqrt{N}$



Frequency Reuse

- Cells with the same number have the same set of frequencies



For hexagonal cells, the reuse distance is given by

$$D = \sqrt{3N} \times R$$

where R is cell radius and N is the reuse pattern (the cluster size or the number of cells per cluster)

Reuse factor is

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

Assessment

1. What is Cell?
2. What is frequency reuse or frequency planning?
3. What is hard and soft handoff?