



SNS COLLEGE OF TECHNOLOGY

Coimbatore – 35

An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

19ECT311 / Wireless Communication

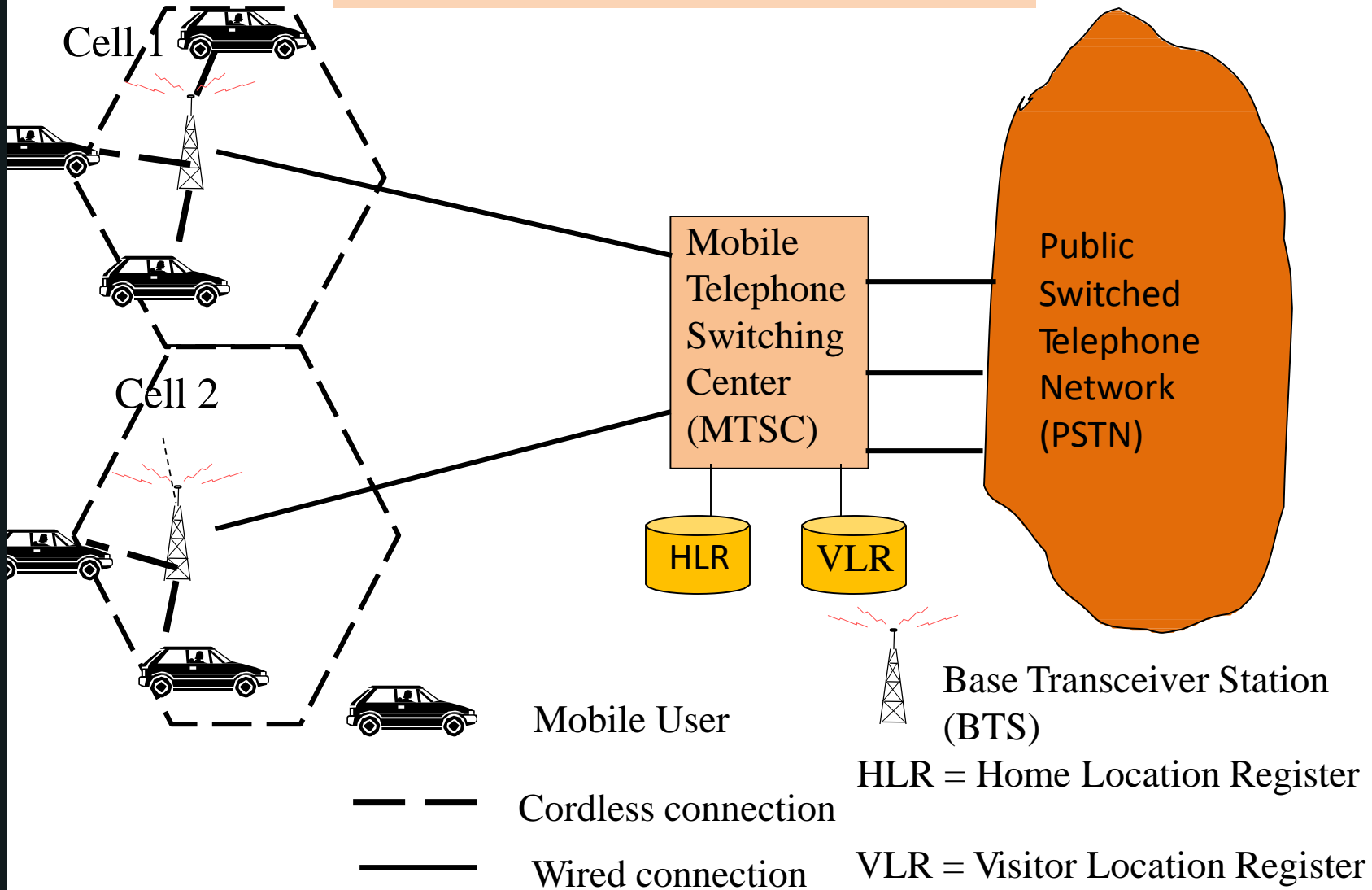
III ECE/ VI SEMESTER

Unit I - **FUNDAMENTALS OF WIRELESS COMMUNICATION**

Topic 3,4 : Cellular concepts, Frequency reuse



A Cellular Network





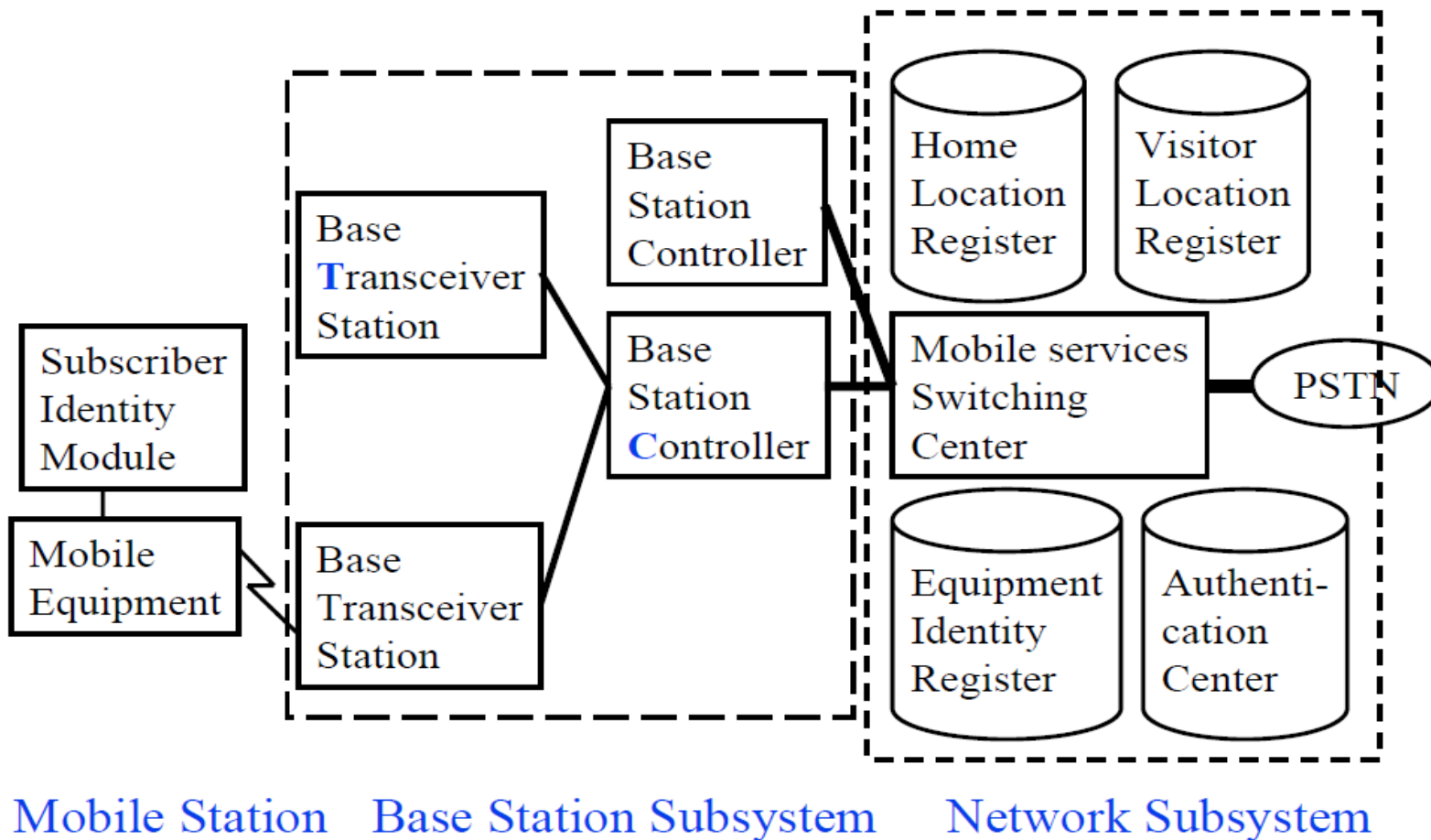
Principles of Cellular Networks

- Underlying technology for mobile phones, personal communication systems, wireless networking etc
- Developed for mobile radio telephony
 - Replace high power transmitter/receiver systems
 - Typical support for 25 channels 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.



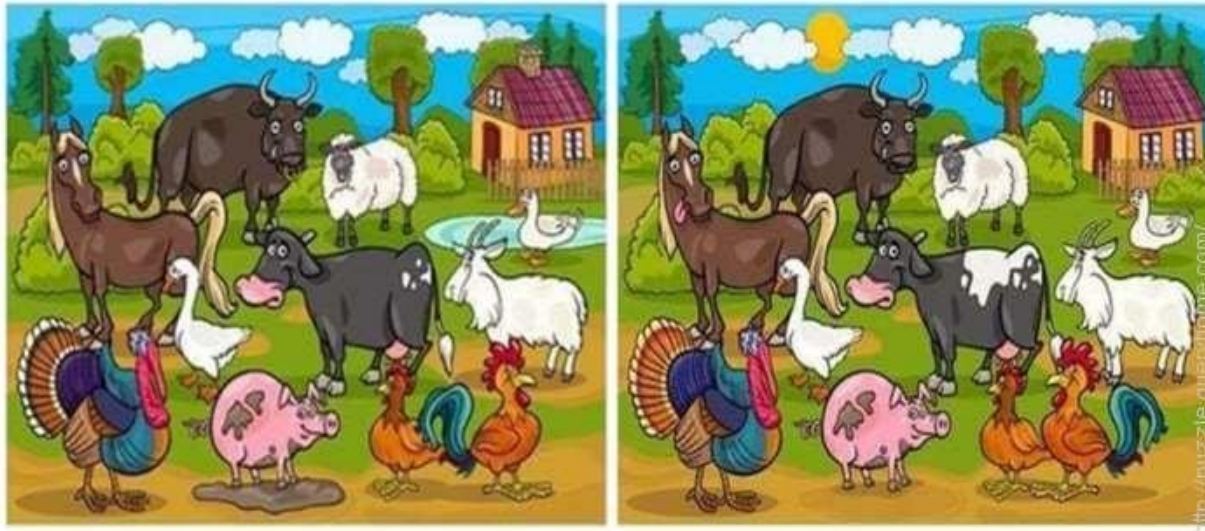
Cellular Architecture (Cont)

- ❑ 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

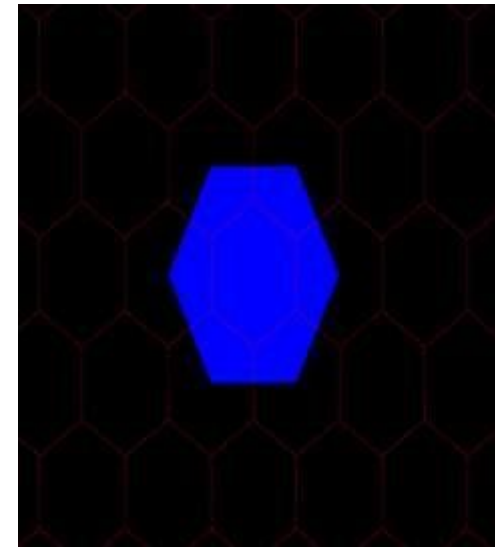
Find the difference between two images





Cellular Network Organization

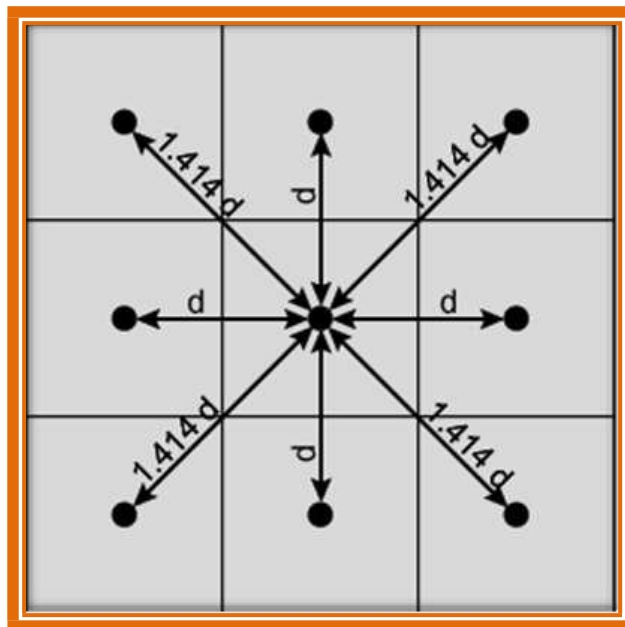
- Multiple low power transmitters
 - 100w or less
- Area divided into cells
 - Each with own antenna
 - Each with own range of frequencies
 - Served by base station
 - Transmitter, receiver, control unit
 - Adjacent cells on different frequencies to avoid crosstalk





Shape of Cells

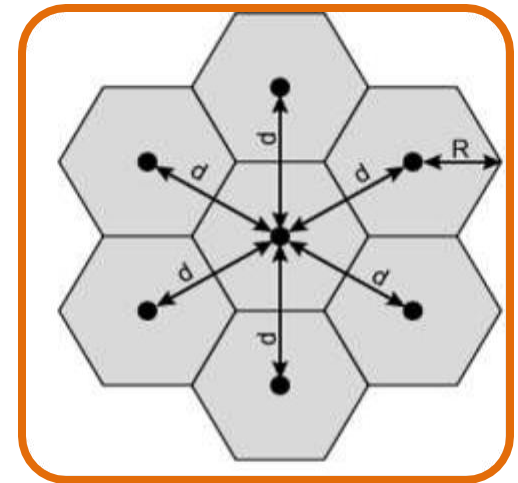
- Square
 - Width d cell has four neighbours at distance d and four at distance $\sqrt{2} d$
 - Better if all adjacent antennas equidistant
 - Simplifies choosing and switching to new antenna





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.

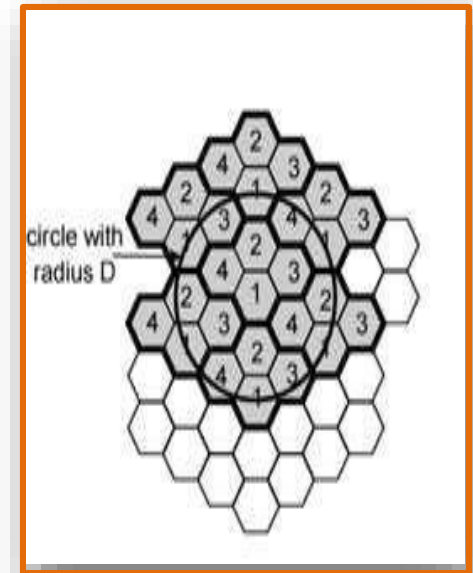
Benefits

- 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

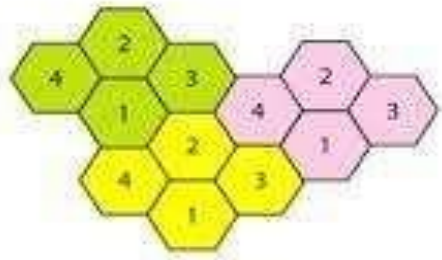
- Power of base transceiver controlled
 - Allow communications within cell on given frequency
 - Limit escaping power to adjacent cells
 - Allow re-use of frequencies in nearby cells
 - Use same frequency for multiple conversations
 - 10 – 50 frequencies per cell
 - N cells all using same number of frequencies
 - 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



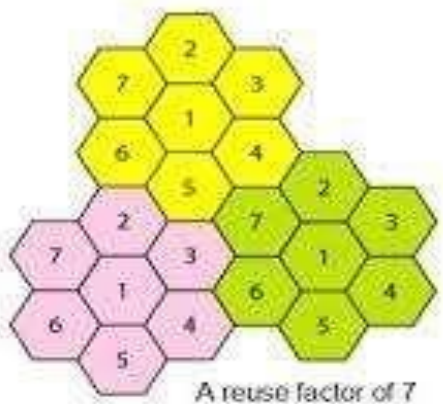
Frequency reuse $N=4$



Frequency Reuse Pattern



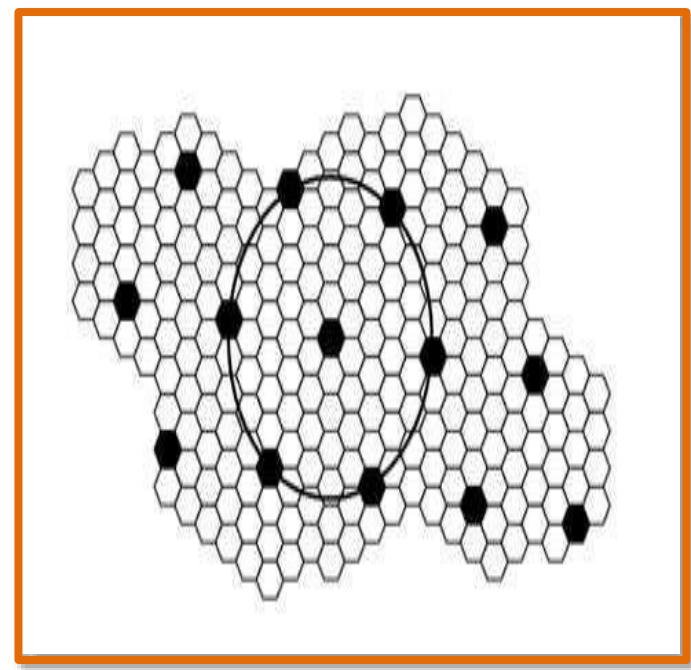
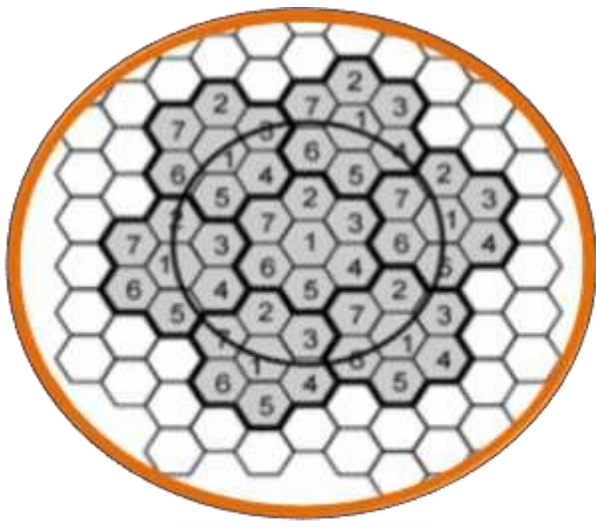
A reuse factor of 4



A reuse factor of 7

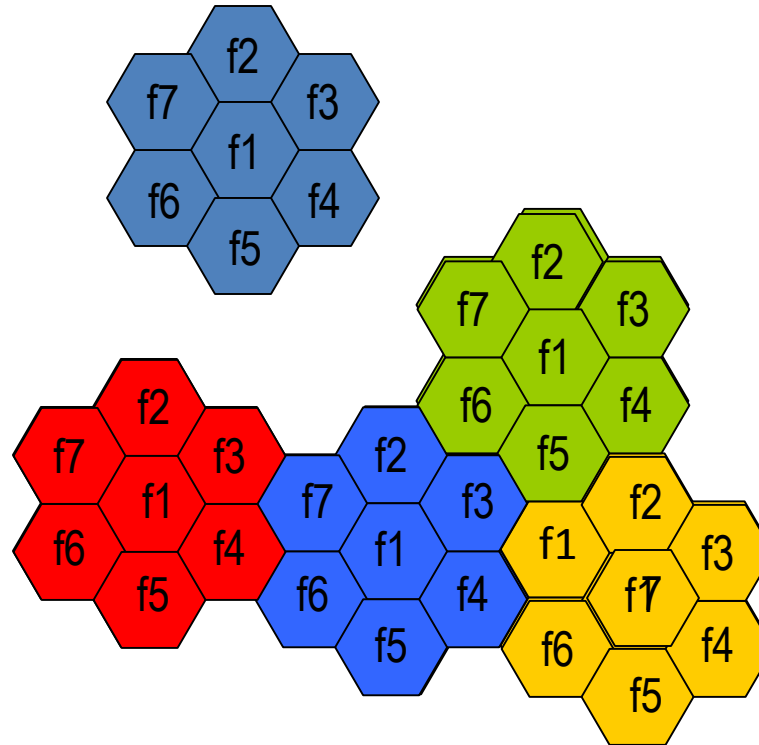
Frequency reuse N=19

Frequency reuse N=7





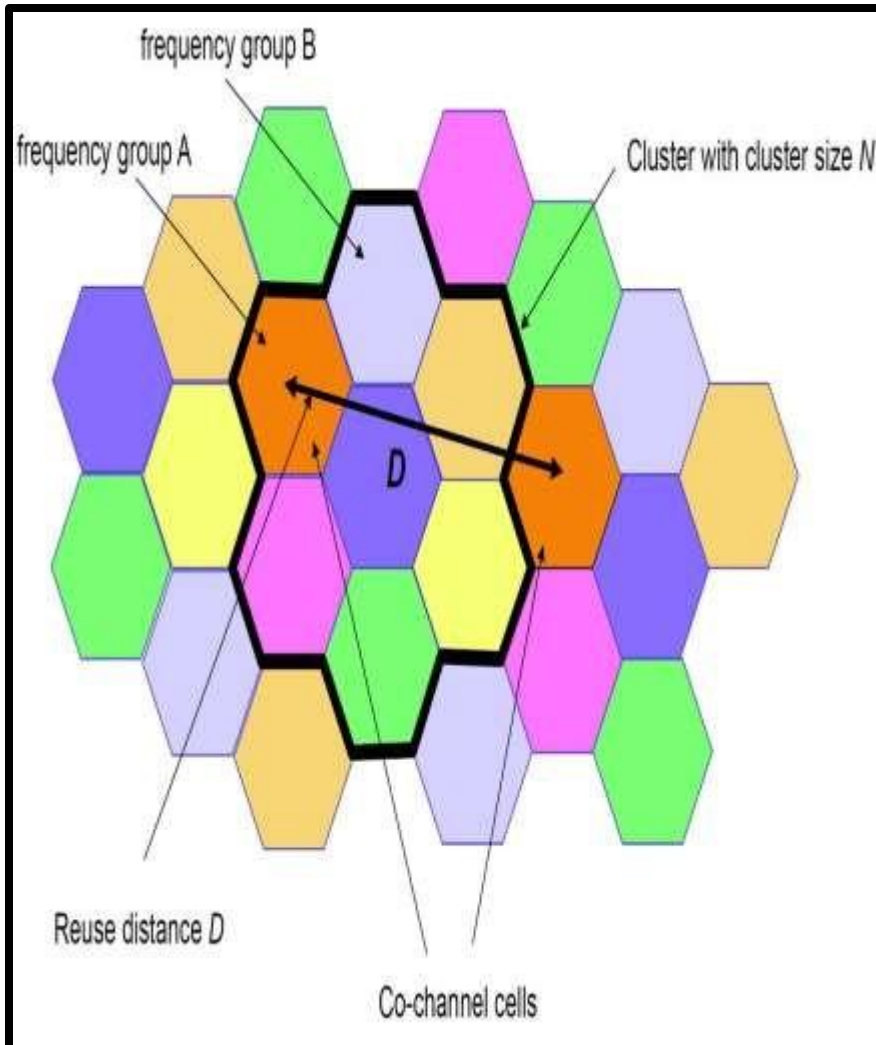
Frequency Reuse using 7 frequencies allocations



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

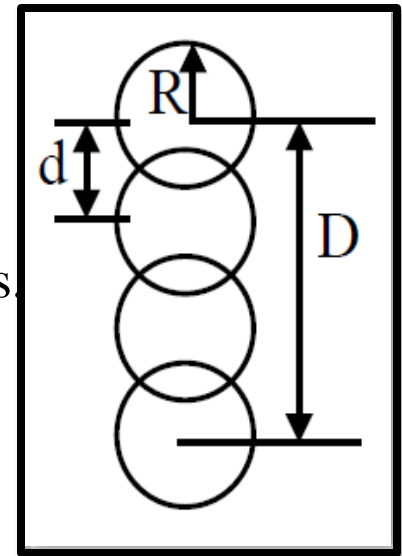
Reuse distance: Minimum distance between two cells using same channel

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



Characterizing Frequency Reuse

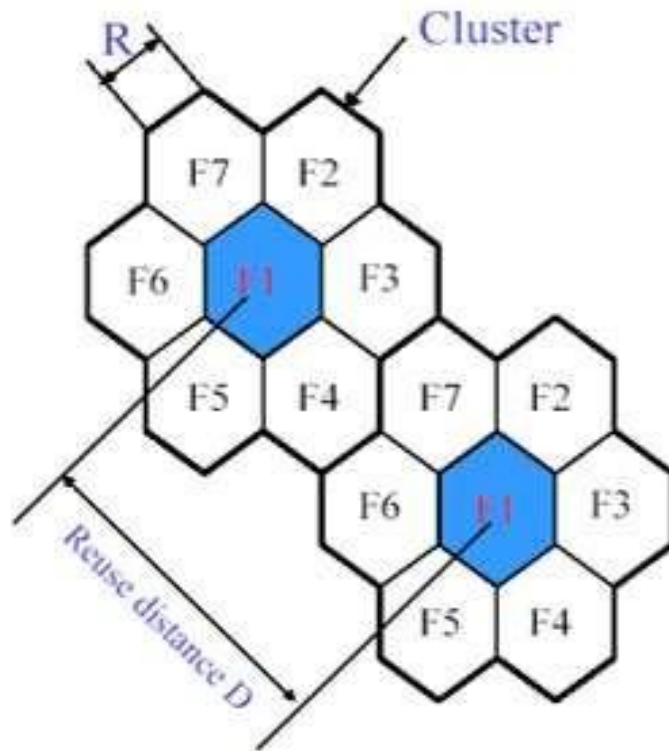
- D = Minimum distance between centers of cells that use the same band of frequencies (Co-Channels)
- R = Radius of a cell
- d = Distance between centers of adjacent cells ($d = R\sqrt{3}$)
- N = Number of cells in repetitive pattern (Cluster)
 - Reuse factor
 - Each cell in patterns uses unique band of frequencies
- Hexagonal cell pattern, following values of N possible
$$N = I^2 + J^2 + (I \times J), I, J = 0, 1, 2, 3, \dots$$
- 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?





Thank you