Cellular Communications

- Performance measure: with limited spectral width support maximum number of users
- Poor signal to interference ratio, higher transmission BER due to channel impairment result in a reduction of usable spectral width
- Parameters: wider spectrum, powerful transmitter, larger geographical coverage, high antenna, cell size, frequency reuse
- Cellular communications: dividing the total large geographical coverage area into many small contiguous area and using a low power transmission with low antenna in each small area

Terminology

- BS: small area is served by a transmit/receive unit
- user access the base station so called access point (AP)
- radio coverage by one base station is referred to as a cell or called a footprint
- forward channel (downlink) BS to user
- reverse channel (uplink) user to BS
- cells arrangement: square, triangular, hexagonal - no dead spot and no overlap
- due to difference in terrain and population densities, cells are amorphous in nature
- irregular structure or topology result into inefficient and limited growth

Other Issues

- support user roaming: continuous operation of an ongoing session and preserve end-to-end QoS; effective and efficient handoff management
- handoff operation: identification of a new base station, allocation of channel to support data and control signal
- MSC having larger computing power handles handoff operation
- MH (MS) is assigned a home network
- MH is identified by address, called home address
- An agent in home network, called home agent keeps track of MH's current location to facilitate delivery of messages destined for MH
- foreign territory and foreign network

- As MH migrates away from its home network, the association between MH and its home agent must be maintained so that the home agent can keep track of MH's current location for message delivery
- MH has to register with its home agent, through the foreign agent, to let the home agent know its current location
- When MH powers on, it registers with its home agent so when it moves to a foreign network, it has to register with its home agent via foreign agent
- requires association between the home agent and the foreign agent
- home agent needs to ensure the registration process through the foreign agent is the correct MH called as authentication process

Cell Cluster

- forward channel and reverse channel separated in time or in frequency for duplexing
- channel capacity is the total number of channels available which are finite
- also depends on how the available channels are deployed
- reuse for additional traffic and expand the system capacity
- different cells can reuse radio channels if cells are separated and minimum interference between cells; called cochannel cells and cochannel interference
- a group of cells that use a different set of frequencies in each cell is called a cell cluster
- N cluster size (number of cells) and K total number of available channels without frequency reuse

- N cells utilize all K available channels
- each cell in the cluster contains one-Nth of the total number of available channels
- N is referred to as the frequency reuse factor of the cellular system
- Let, each cell is allocated J channels and if K channels are divided among the N cells into unique and disjoint channel group $K = JN$
- decrease in the cluster size $N \rightarrow$ increase in the number of channels J per cell; increase capacity per cell
- cluster replicated say M times and C the total number of channels used in the entire cellular system with frequency reuse
- System capacity $C = MJN$

- replicate smaller cluster more times to cover the same geographical area with $K = JN$ constant and M is increased then C is increased
- when N is minimized, C is maximized
- minimizing N will increase cochannel interference
- Say 1001 radio channel available, area of a cell is $A_{cell} = 6$ km^2 and the entire system is $A_{sys} = 2100$ km^2
- Say if cluster size is $N = 7$ and $K = 1001$; $J = 1001/7 = 143$ channels/cell
- $A_{cluster} = N \times A_{cell} = 7 \times 6 = 42$km^2 so $M = A_{sys}/A_{cluster} = 2100/42 = 50$
- $C = MJN = 50 \times 143 \times 7 = 50,050$ channels

- Now, $N = 4$ $A_{cluster} = 4 \times 6 = 24$ km^2
- $M = A_{sys}/A_{cluster} = 2100/24 = 87.5$
- $J = 1001/4 \approx 250$ channels/cell
- Channel capacity $C = 87 \times 250 \times 4 = 87,000$ channels
- $N : 7 \rightarrow 4 \rightarrow M : 50 \rightarrow 87$
- results into $C : 50,050 \rightarrow 87,000$ channels
- decreasing the cluster size does increase the system capacity