

Wireless Mobile Communication

Lecture 15, 16

- Cell Capacity

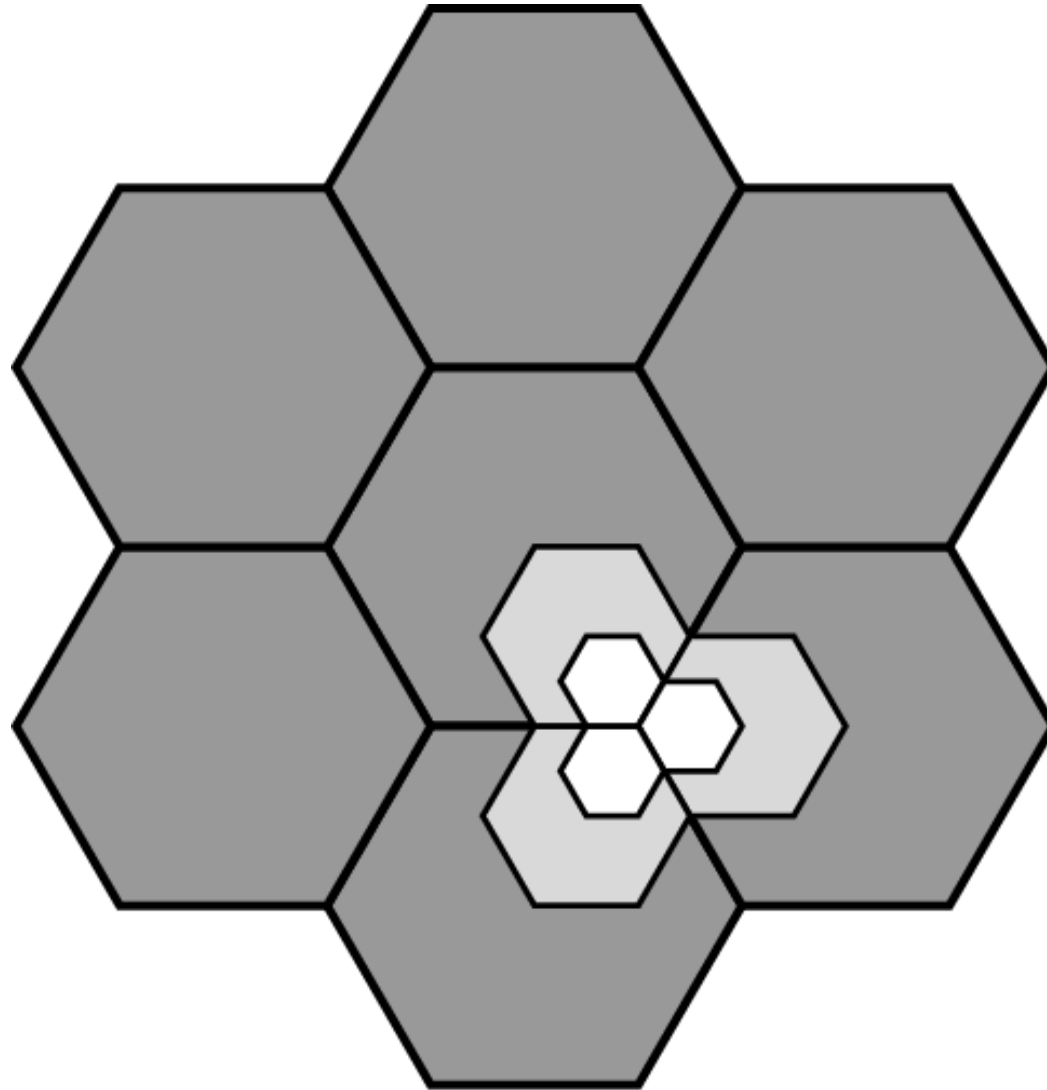
Topics to be Covered

- How to increase capacity
- Cell Splitting
- Mobile Radio Propagation Effect

Increasing Capacity (1)

- Add new channels
 - Not all channels used to start with
- Frequency borrowing
 - Taken from adjacent cells by congested cells
 - Or assign frequencies dynamically
- Cell splitting
 - Non-uniform distribution of topography and traffic
 - Smaller cells in high use areas
 - Original cells 6.5 – 13 km
 - 1.5 km limit in general
 - More frequent handoff
 - More base stations

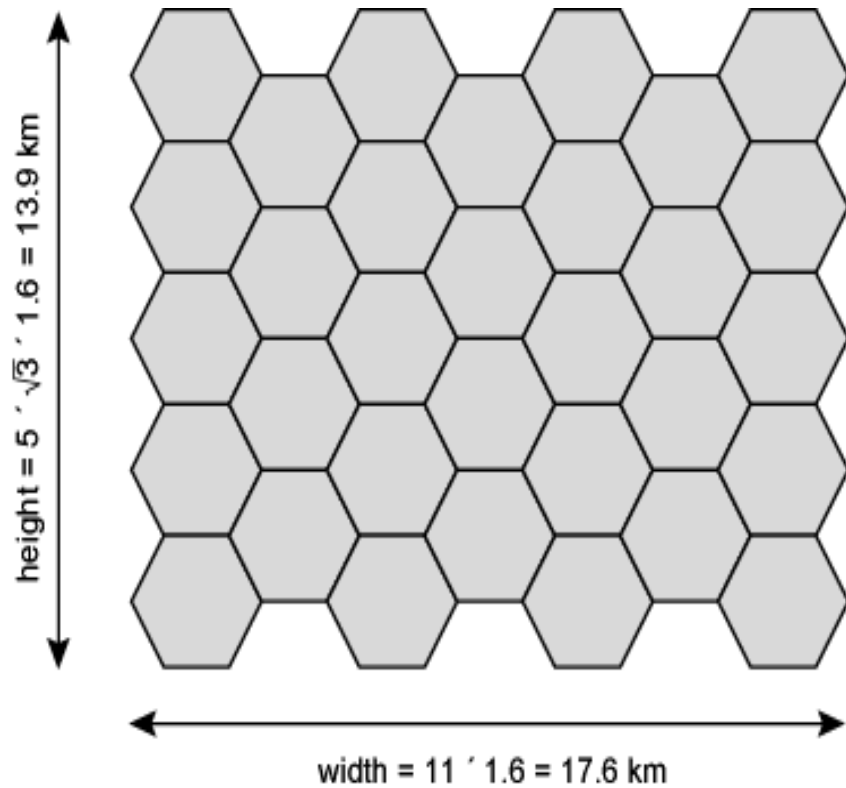
Cell Splitting



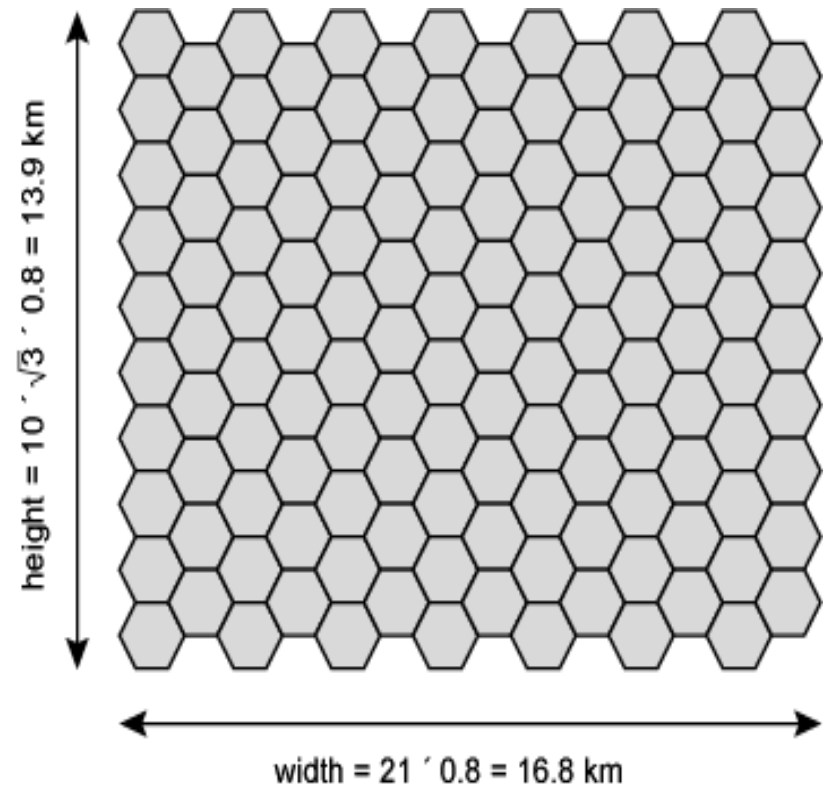
Increasing Capacity (2)

- Cell Sectoring
 - Cell divided into wedge shaped sectors
 - 3 – 6 sectors per cell
 - Each with own channel set
 - Subsets of cell's channels
 - Directional antennas
- Microcells
 - Move antennas from tops of hills and large buildings to tops of small buildings and sides of large buildings
 - Even lamp posts
 - Form microcells
 - Reduced power
 - Good for city streets, along roads and inside large buildings

N=7, 32 cells, R=1.6km, in total 336 channels



(a) Cell radius = 1.6 km

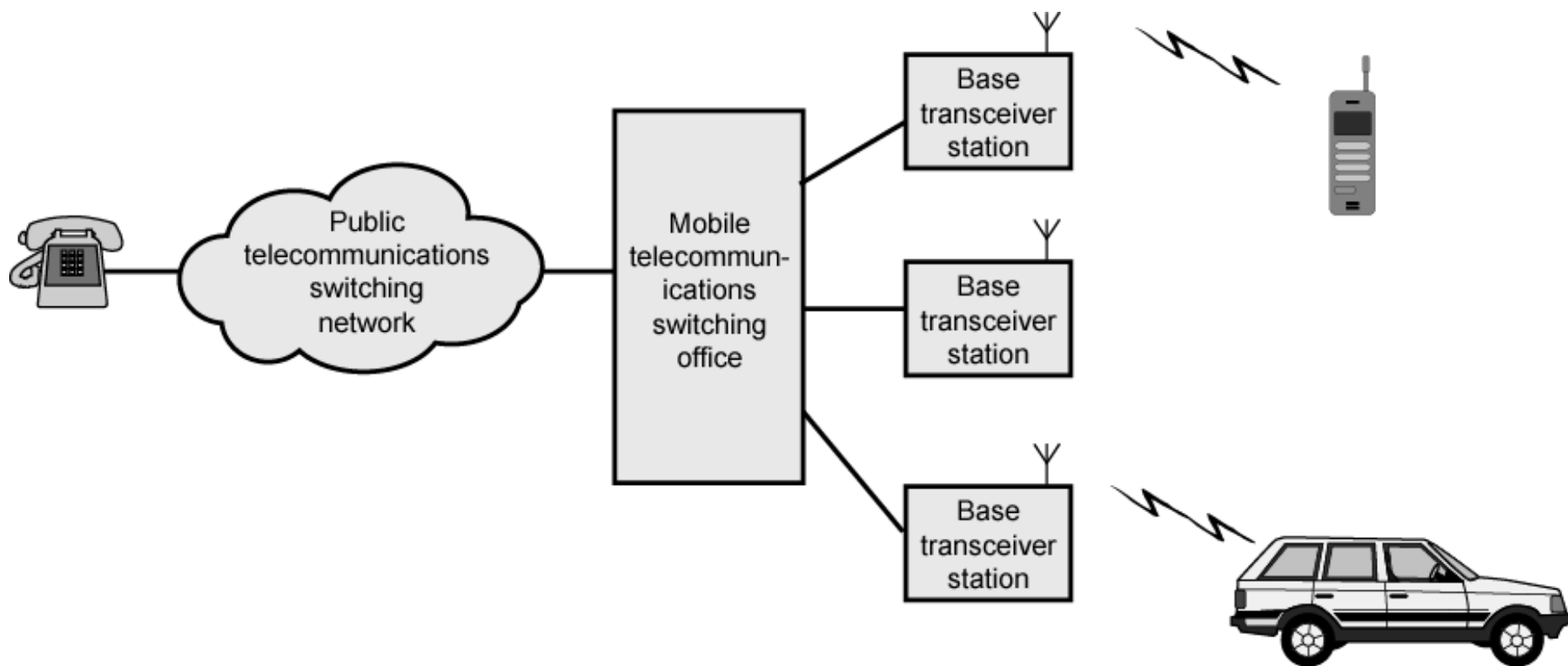


(b) Cell radius = 0.8 km

Operation of Cellular Systems

- Base station (BS) at center of each cell
 - Antenna, controller, transceivers
- Controller handles call process
 - Number of mobile units may in use at a time
- BS connected to mobile telecommunications switching office (MTSO)
 - One MTSO serves multiple BS
 - MTSO to BS link by wire or wireless
- MTSO:
 - Connects calls between mobile units and from mobile to fixed telecommunications network
 - Assigns voice channel
 - Performs handoffs
 - Monitors calls (billing)
- Fully automated

Overview of Cellular System



Channels

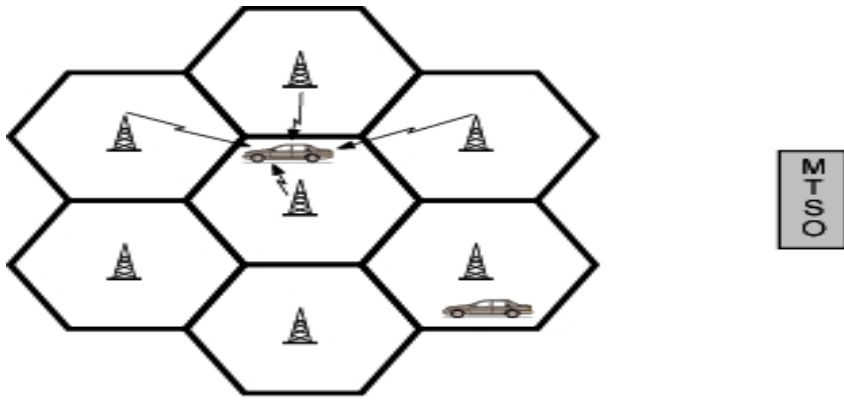
- Control channels
 - Setting up and maintaining calls
 - Establish relationship between mobile unit and nearest BS
- Traffic channels
 - Carry voice and data

Typical Call in Single MTSO Area (1)

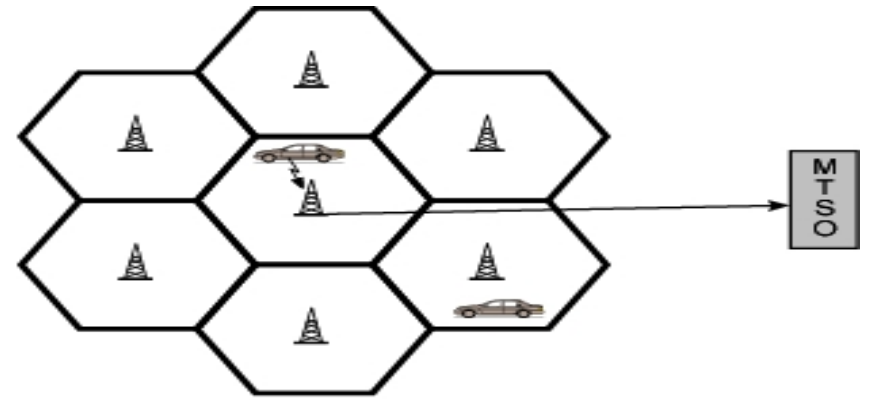
- Mobile unit initialization
 - Scan and select strongest set up control channel
 - Automatically selected BS antenna of cell
 - Usually but not always nearest (propagation anomalies)
 - Handshake to identify user and register location
 - Scan repeated to allow for movement
 - Change of cell
 - Mobile unit monitors for pages (see below)
- Mobile originated call
 - Check set up channel is free
 - Monitor forward channel (from BS) and wait for idle
 - Send number on pre-selected channel
- Paging
 - MTSO attempts to connect to mobile unit
 - Paging message sent to BSs depending on called mobile number
 - Paging signal transmitted on set up channel

Typical Call in Single MTSO Area (2)

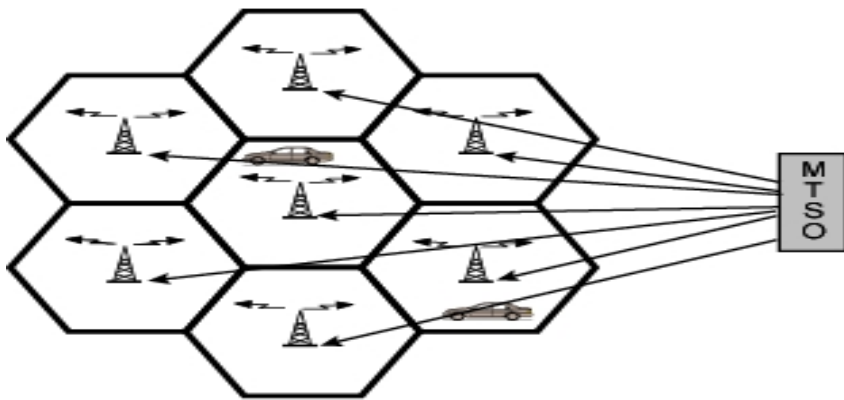
- Call accepted
 - Mobile unit recognizes number on set up channel
 - Responds to BS which sends response to MTSO
 - MTSO sets up circuit between calling and called BSs
 - MTSO selects available traffic channel within cells and notifies BSs
 - BSs notify mobile unit of channel
- Ongoing call
 - Voice/data exchanged through respective BSs and MTSO
- Handoff
 - Mobile unit moves out of range of cell into range of another cell
 - Traffic channel changes to one assigned to new BS
 - Without interruption of service to user



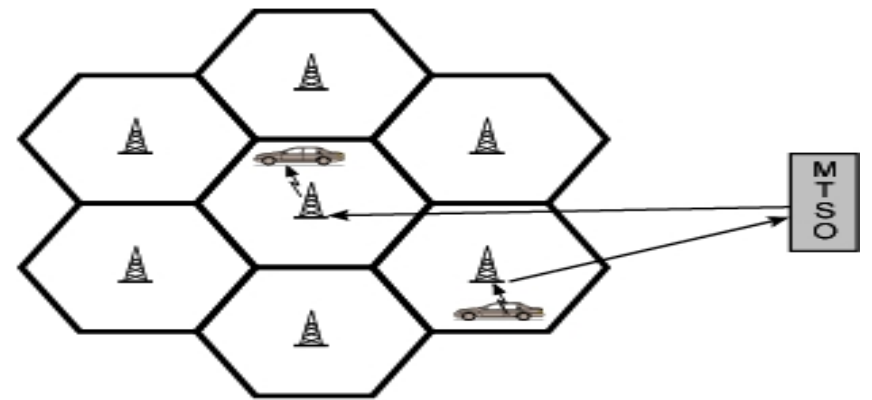
(a) Monitor for strongest signal



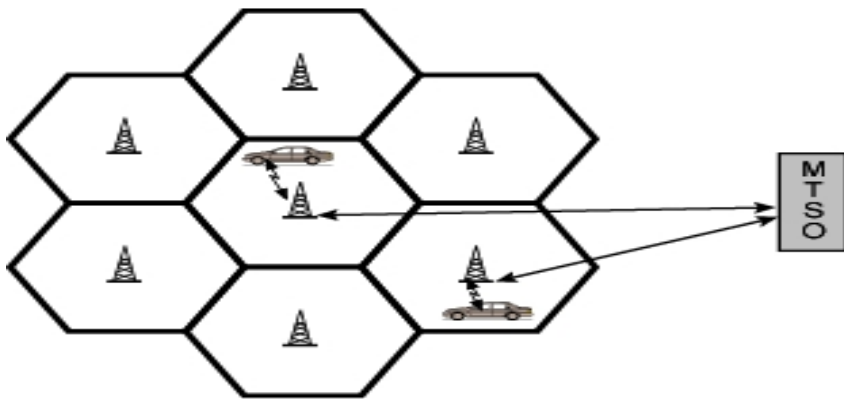
(b) Request for connection



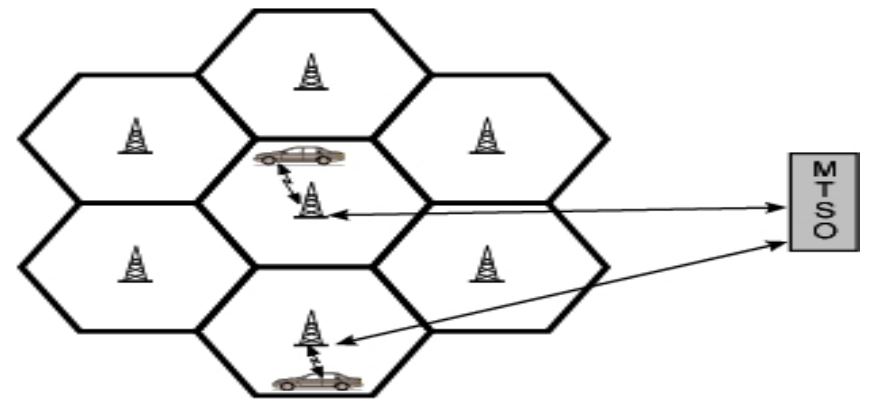
(c) Paging



(d) Call accepted



(e) Ongoing call



(f) Handoff

Other Functions

- Call blocking
 - During mobile-initiated call stage, if all traffic channels busy, mobile tries again
 - After number of fails, busy tone returned
- Call termination
 - User hangs up
 - MTSO informed
 - Traffic channels at two BSs released
- Call drop
 - BS cannot maintain required signal strength
 - Traffic channel dropped and MTSO informed
- Calls to/from fixed and remote mobile subscriber
 - MTSO connects to PSTN
 - MTSO can connect mobile user and fixed subscriber via PSTN
 - MTSO can connect to remote MTSO via PSTN or via dedicated lines
 - Can connect mobile user in its area and remote mobile user

Mobile Radio Propagation Effects

- Signal strength
 - Strength of signal between BS and mobile unit strong enough to maintain signal quality at the receiver
 - Not strong enough to create too much cochannel interference
 - Noise varies
 - Automobile ignition noise greater in city than in suburbs
 - Other signal sources vary
 - Signal strength varies as function of distance from BS
 - Signal strength varies dynamically as mobile unit moves
- Fading
 - Even if signal strength in effective range, signal propagation effects may disrupt the signal