

MOBILE COMPUTING ARCHITECTURE— AN OVERVIEW

Lesson 01 Cellular Networks

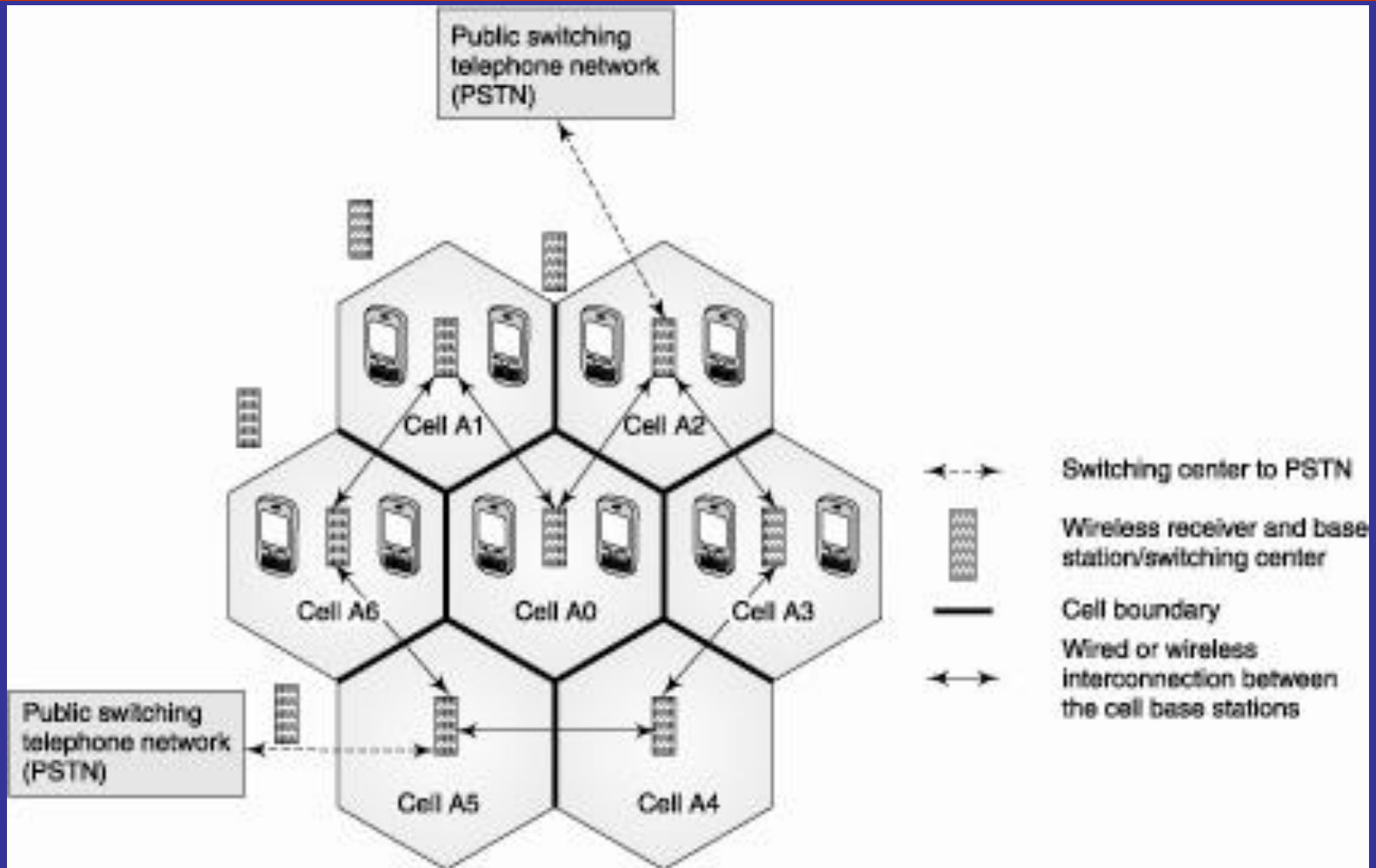
MOBILE NETWORKS

- Cellular networks
- WLAN networks
- Ad Hoc Networks

CELLULAR NETWORK ORGANIZATION

- Areas divided into cells
 - Served by base station consisting of transmitter, receiver, control unit and antenna
 - Each served by its own antenna
 - Band of frequencies allocated
 - Cells set up such that antennas of all neighbors are nearly equidistant (assuming hexagonal pattern)

CELLULAR NETWORK



CELLULAR NETWORK ORGANIZATION

- Use multiple low-power transmitters (100 W or less)

CELL

- A cell means coverage area of a base station
- Coverage area and its boundaries defines the cell for a given transmitter power of base station
- Signal strength is sufficient for communication within the cell

CELL BASE STATION

- Base station functions as an access point for mobile service
- Each mobile device within a service area connects to base station of cell
- The cell covers area around the current location of device
- All the mobile devices within the range of a given base station, communicate with each other through that base station only

CELLULAR NETWORKS

- Each cell has cells adjoining it in various directions. The cell-boundaries of the cells can also overlap between adjacent cells

FREQUENCY REUSE

- Reuse frequency in nearby cells
 - 10 to 50 frequencies assigned to each cell cluster
 - Transmission power controlled to limit power at that frequency escaping to adjacent cells
 - Determine how many cells must intervene between two cells using the same frequency
 - Number of frequency channels in a given cell can change dynamically

ADJACENT CELLS DISTINCT FREQUENCIES IN CELLULAR NETWORKS

- A cluster of a cell and its neighbouring cells use distinct frequencies
- Avoid interference between the signals in different cells
- Large cells can be divided into smaller cells

FREQUENCY REUSE

- Adjacent cells assigned different frequencies to avoid interference or crosstalk

FREQUENCY REUSE

- Assume each cell has six adjacent cells
- Each cell assigned 3 frequencies, then 3 + 18 (in adjacent neighboring cells) frequencies used and 7 cells form a cluster.

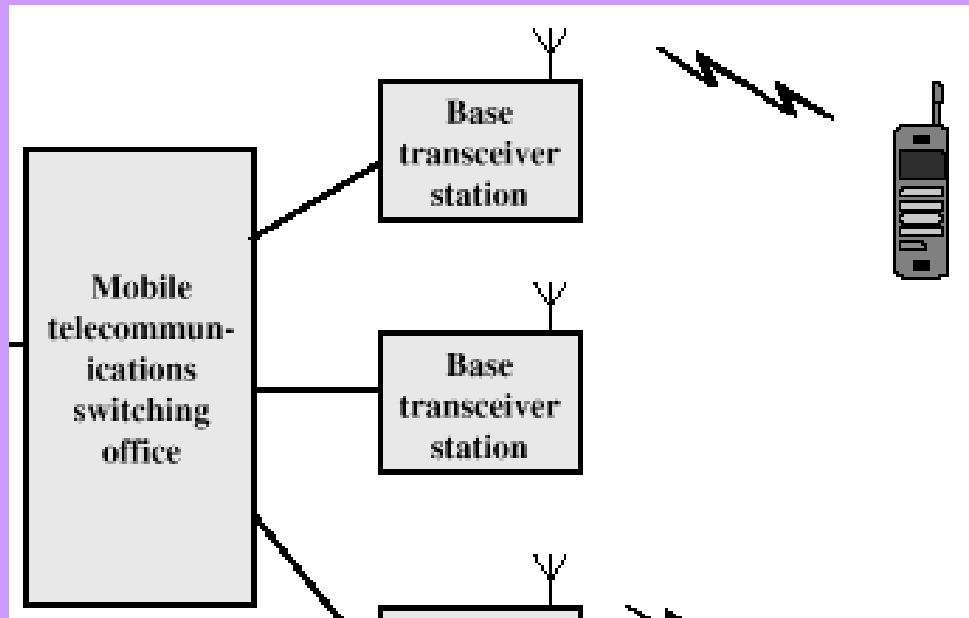
FREQUENCY REUSE

- Adjacent clusters can reuse same frequencies. Same frequency can be used for multiple links as long as they are in different cells
- More capacity than a single large transmitter
- Reuse distance $D = R \cdot \sqrt{3 \times N}$ [R (1 to 30 km) is the cell radius, N number of cells per cluster]

CELLULAR NETWORKS

- Base stations connect among themselves through either guided (wire- or fibre-based), wireless or public switching telephone network (PSTN).
- Multi-cell cellular network entails that when the transceivers (mobile phones) move from place to place, they will also have to switch from cell to cell

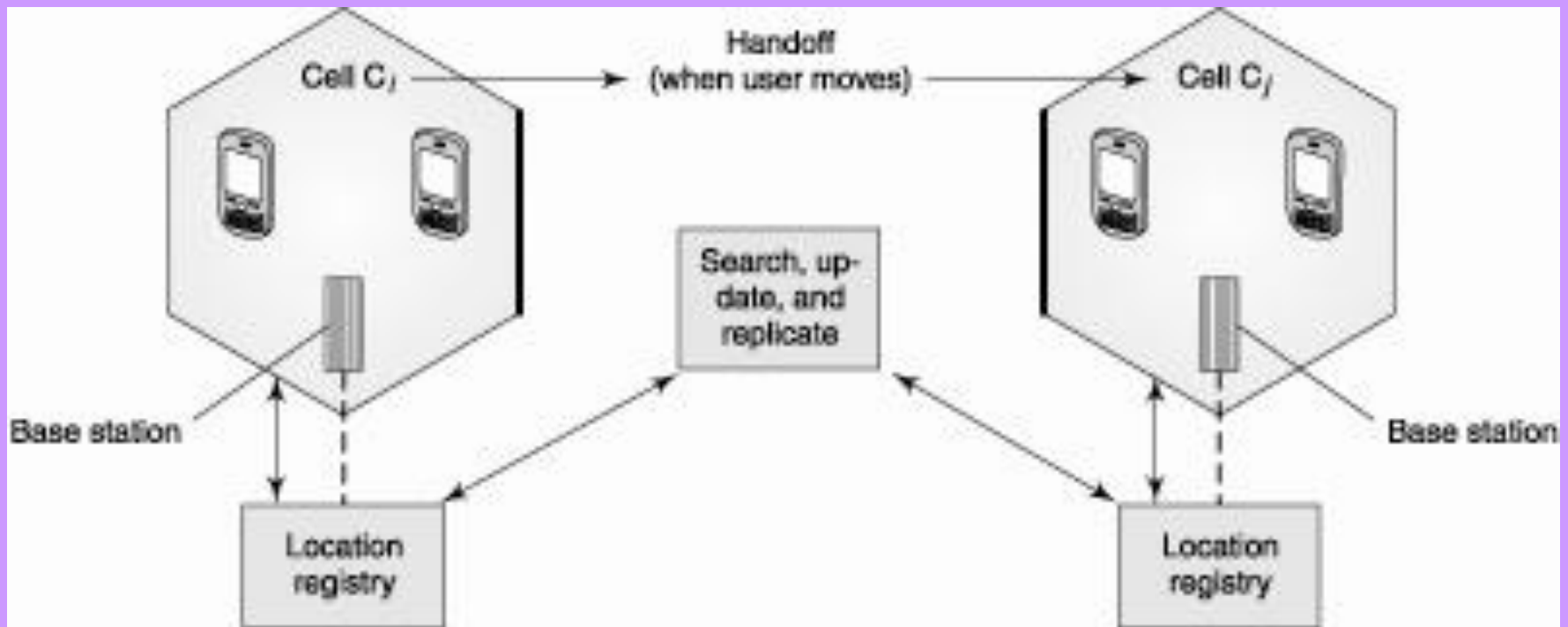
CELLULAR SYSTEM OVERVIEW



HANDOFF AND HANDOVER

- When a mobile device moves and reaches a cell boundary
- Switching on to next cell occurs by handover of the device connection to another neighbouring base station

CELLULAR NETWORKS FOR MOBILE PHONES



APPROACHES TO COPE WITH INCREASING CAPACITY

- Adding new channels
- Frequency borrowing by congested cells— frequencies are taken from adjacent cells
- Cell splitting – cells in areas of high usage can be split into smaller cells

APPROACHES TO COPE WITH INCREASING CAPACITY

- Cell sectoring – cells are divided into a number of wedge-shaped sectors, each with their own set of channels
- Microcells – antennas move to buildings, hills, and lamp posts

GSM MOBILE SERVICE NETWORKS

- Uses a reuse pattern of $\frac{3}{4}$ (for 3-sector antenna and when 4 cells cannot use same frequencies out of 1 cell) $u = 4$
- Each sector using SDMA (Space Division Multiple Access) can use bandwidth b_s

TDMA DESIGN CONSIDERATIONS

- Number of logical channels per physical channel (number of time slots in TDMA frame): 8
- Maximum cell radius (R): 35 km
- Frequency: region around 900 MHz
- Maximum vehicle speed (V_m): 250 km/hr

DESIGN CONSIDERATIONS

- Maximum coding delay: approx. 20 ms
- Maximum delay spread (Δ_m): 10 μ s
- Bandwidth: Not to exceed 200 kHz (25 kHz per channel)

CDMA

- Same spectrum used in the adjacent cell but the codes that are used for the chipping frequencies or frequency hopping sequences different in the adjacent cells. Frequency reuse factor $u = 1$ for each sector and each cell

4G

- Each cell sector can be divided into picocells
- Pre-4G services use the concept of picocells for further divisions into narrow regions

4G

- One picocell may correspond to one floor of a building
- Femto-cells for further division of picocells

SUMMARY

- Cells
- Cellular Network
- Frequency Reuse

...

End of Lesson 01 Cellular Networks