

Lecture 2: 1.2 Basic cellular concept and cellular system

Fundamental of Cellular Communication

DI05011011: Mobile Communication

Agenda for Today

- 1. The Problem with Early Mobile Radios
- 2. What is the Cellular Concept?
- 3. Shape of a Cell (Why Hexagons?)
- 4. Components of a Cellular System
- 5. The Base Station (BS) & Mobile Station (MS)
- 6. Mobile Switching Center (MSC)
- 7. Advantages of the Cellular System
- 8. Summary

The Problem with Early Mobile Radios

- Before cellular systems, Mobile Telephone Systems (MTS) used a single high-power transmitter to cover a large city (e.g., 50 km radius).
- **Limitations:**
 - - **Limited Capacity:** Only a few dozen channels were available. If 50 people were talking, the 51st person couldn't make a call.
 - - **High Power:** Mobile devices needed huge batteries and high transmission power to reach the central tower.
 - - **Inefficient Frequency Use:** A frequency used by one user couldn't be used by anyone else in the entire city.

What is the Cellular Concept?

- Instead of one large area with a high-power transmitter, the city is divided into smaller geographic areas called **Cells**.
- Each cell is served by its own low-power transmitter (Base Station).
- **Key Idea:** Since the transmitter power is low, the radio signal doesn't travel far.
- Therefore, the same frequency channels can be reused in a different cell some distance away without causing interference.

The Shape of a Cell

- In reality, a cell's footprint is irregular, determined by terrain, buildings, and antenna design.
- For mathematical modeling and design, we need a regular geometric shape.
- **Options considered:** Circle, Square, Equilateral Triangle, Hexagon.
- - **Circles:** Leave gaps or overlap too much.
- - **Squares & Triangles:** Don't approximate an omnidirectional antenna's radiation pattern well.
- - **Hexagon:** Best approximation of a circle, covers area without gaps or overlaps.

Visualizing the Hexagonal Grid

- Imagine a honeycomb structure.
- Each hexagon represents one cell.
- At the center (or corners) of the hexagon sits the Base Station antenna.
- The distance from the center to any vertex is the cell radius (R).
- This grid allows engineers to calculate distances between towers and manage interference systematically.

Basic Components of a Cellular System

- A cellular network consists of three main components:
- 1. **Mobile Station (MS)**: The user's device (smartphone).
- 2. **Base Station (BS)**: The cell tower that communicates with the MS via radio waves.
- 3. **Mobile Switching Center (MSC)**: The brain of the network that connects base stations to each other and to the public telephone network.

1. Mobile Station (MS)

- The mobile device used by the subscriber.
- Consists of two parts:
 - - **Mobile Equipment (ME)**: The hardware (radio transceiver, display, processor).
 - - **Subscriber Identity Module (SIM)**: A smart card containing the user's subscription details, security keys, and phone number.
- The MS continuously monitors the signal strength of nearby Base Stations to ensure connection.

2. Base Station (BS)

- Also called Base Transceiver Station (BTS).
- Located at the center or edge of a cell.
- Contains transmitters, receivers, and antennas.
- Functions:
 - - Provides the radio interface to the Mobile Station.
 - - Allocates radio channels to the mobile device for calls.
 - - Monitors signal quality and relays data to the MSC.

3. Mobile Switching Center (MSC)

- The central coordinating element for all Base Stations in a given area.
- Also known as the Mobile Telephone Switching Office (MTSO).
- Functions:
 - - Sets up and routes calls between users.
 - - Connects cellular calls to the PSTN (Public Switched Telephone Network - landlines).
 - - Manages mobility: tracks where the user is and handles handoffs when moving between cells.
 - - Handles billing and authentication.

Advantages of the Cellular System

- **1. Higher Capacity:** Frequency reuse allows millions of users to be supported on a limited spectrum.
- **2. Lower Power Consumption:** Mobile phones only need enough power to reach the nearest cell tower (1-5 km), drastically saving battery life.
- **3. Scalability:** As demand grows, cells can be split into smaller cells to add more capacity.
- **4. Decentralization:** If one Base Station fails, only that small cell goes down, not the whole city.

- Cellular systems replaced single high-power towers with a grid of low-power Base Stations.
- Hexagons are used for theoretical modeling because they cover areas without gaps.
- The core architecture consists of the Mobile Station (MS), Base Station (BS), and Mobile Switching Center (MSC).
- The cellular concept revolutionized mobile capacity and device battery life.

- Are all cells the same size?
- In the next lecture, we will explore:
- **1.3 Cell types: Macro, Micro, Pico, Selective and Umbrella cell**
- - How cell sizes vary based on user density.
- - Different types of cells for rural vs. urban vs. indoor environments.