Lecture 8: 1.8 Cell splitting and sectoring

Fundamental of Cellular Communication

DI05011011: Mobile Communication

Agenda for Today

- 1. The Need for Capacity Expansion
- 2. Concept of Cell Splitting
- 3. Mechanics of Cell Splitting
- 4. Advantages and Drawbacks of Splitting
- 5. Concept of Sectoring
- 6. Antenna Configurations in Sectoring (120° and 60°)
- 7. Impact of Sectoring on Interference (SIR)
- 8. Comparing Splitting and Sectoring
- 9. Summary and Next Steps

The Need for Capacity Expansion

- As cellular systems mature, traffic demand increases.
- Eventually, all available channels in a given cell will be occupied, leading to high call blocking rates.
- Adding new frequency spectrum is often impossible or prohibitively expensive.
- Solution: We must reuse the existing spectrum more frequently in the same geographical area.

What is Cell Splitting?

- Cell splitting is the process of subdividing a congested cell into smaller cells (microcells).
- Each new smaller cell has its own base station with a reduced antenna height and reduced transmitter power.
- By making cells smaller, the same number of channels is available over a smaller geographical area.
- This drastically increases the number of channels available per square kilometer (capacity).

Mechanics of Cell Splitting

- Original cell radius: R.
- New split cell radius is typically: R / 2.
- Since Area is proportional to R squared, the new cell area is 1/4th the original area.
- Therefore, one original cell is replaced by four smaller cells.
- Capacity increases theoretically by a factor of 4 in that area.

Adjusting Power in Cell Splitting

- When a cell is split, the transmission power must be reduced to avoid co-channel interference with neighboring cells.
- If radius is reduced from R to R/2, the transmit power is reduced.
- Assuming a path loss exponent of n=4, the new power is roughly 1/16th of the original power.
- Formula: P_new = P_old * (R_new / R_old)^n

Pros and Cons of Cell Splitting

- **Advantages:**
- - Massive increase in system capacity.
- - Solves severe congestion in urban hotspots.
- **Disadvantages:**
- - Very high cost: requires purchasing new real estate and installing new base stations.
- - Handoff issues: smaller cells mean mobiles cross boundaries more often, requiring more handoffs and processing.

What is Sectoring?

- Sectoring increases capacity by keeping the cell radius the same but replacing a single omni-directional antenna with several directional antennas.
- A single cell is divided into sectors (e.g., 3 sectors of 120° or 6 sectors of 60°).
- Each sector acts like a distinct cell and uses a portion of the cell's allocated channels.
- Primary goal: Reduce co-channel interference to allow for a smaller cluster size (N).

How Sectoring Reduces Interference

- Recall that with an omnidirectional antenna, a mobile receives interference from all 6 surrounding co-channel cells.
- With 120° sectoring, the antenna only 'looks' in one direction.
- The mobile now only receives interference from 2 of the 6 co-channel cells (those facing the same direction).
- With 60° sectoring, interference is reduced to just 1 co-channel cell.

Sectoring and Capacity (The Catch)

- Sectoring improves the Signal-to-Interference Ratio (SIR).
- Higher SIR allows network planners to use a smaller cluster size (e.g., reducing N from 7 to 4 or 3).
- A smaller cluster size means frequencies are reused more often across the network.
- More frequent reuse = Higher overall system capacity.

Pros and Cons of Sectoring

- **Advantages:**
- - Improves SIR significantly.
- - Cheaper than cell splitting (no new real estate needed, just new antennas).
- **Disadvantages:**
- - Decreases trunking efficiency (channels are partitioned into smaller pools per sector).
- - Increases handoffs (mobiles now handoff between sectors of the same cell).

Comparison: Splitting vs Sectoring

- — Feature — Cell Splitting — Sectoring —
- — :— — :— — :— —
- — Mechanism — Reduces cell radius (R) — Uses directional antennas —
- — Number of Base Stations — Increases — Remains the same —
- — Cost — Very High (New sites) — Low to Medium (New antennas) —
- — Primary Effect — Direct capacity increase — Improves SIR, leading to smaller N —
- — Handoffs — Increased (Inter-cell) — Increased (Intra-cell and Inter-cell) —

Lecture Summary

- When networks run out of capacity, we must manipulate geometry to reuse frequencies more often.
- Cell splitting reduces cell radius, massively increasing capacity but requiring expensive new base stations.
- Transmit power must be carefully reduced when splitting cells.
- Sectoring uses directional antennas to reduce co-channel interference.
- Reduced interference allows for smaller cluster sizes, which increases overall capacity.
- Both methods increase the frequency of handoffs.

Next Lecture Preview

- In the next lecture, we will dive into Handoffs:
- 1. What exactly happens when you move from one cell to another?
- 2. Soft vs. Hard handoffs.
- 3. How the network ensures your call doesn't drop while driving.