

Lecture 9: 1.9 Define handoff and differentiate various Handoff techniques

Fundamental of Cellular Communication

DI05011011: Mobile Communication

Agenda for Today

- 1. Definition of Handoff
- 2. Why Handoffs are Necessary
- 3. Handoff Initiation (When to handoff?)
- 4. Signal Strength and Thresholds
- 5. Hard Handoff ('Break before make')
- 6. Soft Handoff ('Make before break')
- 7. Mobile Assisted Handoff (MAHO)
- 8. Practical Handoff Problems (Ping-pong effect)
- 9. Summary and Next Steps

What is a Handoff (Handover)?

- A handoff (or handover) is the process of transferring an active call or data session from one cell (or base station) to another.
- It occurs without disconnecting the ongoing session.
- It is required when a mobile user travels out of the coverage area of one cell and enters another.
- The system must allocate a new voice/data channel in the new cell for the call to continue.

Handoff Initiation Parameters

- How does the network know when to trigger a handoff?
- It constantly monitors the Received Signal Strength Indicator (RSSI) from the mobile.
- **Threshold 1 (Minimum Acceptable):** The minimum signal level required to maintain a call (e.g., -100 dBm). If it drops below this, the call drops.
- **Threshold 2 (Handoff Threshold):** A level slightly above the minimum acceptable level. When signal hits this, the handoff process begins.

The Handoff Margin (Delta)

- The difference between the Handoff Threshold and the Minimum Acceptable Signal is called the Margin (Delta).
- **$\Delta = P_{\text{handoff}} - P_{\text{minimum_acceptable}}$**
- - If Delta is too large: Handoffs occur too early, burdening the MSC with unnecessary processing.
- - If Delta is too small: Handoffs occur too late, and calls drop before the handoff completes.
- Engineers must carefully tune this margin based on user speeds (highway vs. pedestrian).

- Also known as '**Break before make**'.
- The connection to the current base station is completely broken before the connection to the new base station is established.
- There is a brief, unnoticeable interruption in the call.
- Typically used in systems where different cells use different frequencies (like FDMA/TDMA in GSM).
- A mobile cannot tune to two different frequencies simultaneously with a standard receiver.

- Also known as '**Make before break**'.
- The connection to the new base station is established before the connection to the old base station is broken.
- The mobile is simultaneously connected to two (or more) base stations for a brief period.
- Used primarily in CDMA (and 3G) systems where all cells share the same frequency band.

- A specialized version of Soft Handoff.
- Occurs when a mobile moves from one sector of a cell to another sector of the *same* cell.
- The handoff is handled entirely by the single Base Station, without needing the MSC's involvement.
- Highly efficient and fast.

Mobile Assisted Handoff (MAHO)

- In older systems (1G), the Base Station measured the mobile's signal and initiated the handoff.
- In modern systems (2G onwards), we use MAHO.
- The mobile handset continuously measures the signal strength of neighboring base stations.
- It periodically sends these reports back to its current base station.
- The network uses the mobile's measurements to decide when and where to handoff.

Handoff Problems: The Ping-Pong Effect

- Occurs when a user is on the boundary between two cells.
- Due to fading and environmental obstacles, the signal strength fluctuates rapidly.
- The system might repeatedly hand the call back and forth between Cell A and Cell B.
- This causes massive signaling overhead and can degrade call quality.

Mitigating the Ping-Pong Effect

- **Solution:** Hysteresis.
- Instead of just handing off when Cell B is stronger than Cell A, the system requires Cell B to be stronger by a certain margin (Hysteresis Margin) for a specific duration.
- Example: Handoff only if $(\text{Signal_B} \geq \text{Signal_A} + 3\text{dB})$.
- This prevents handoffs based on momentary signal spikes.

- Handoffs allow mobile users to maintain connections while crossing cell boundaries.
- Initiated based on signal strength dropping below a specific threshold (plus a margin).
- Hard handoff breaks the old connection before making the new one (FDMA/TDMA).
- Soft handoff makes the new connection before breaking the old one (CDMA).
- MAHO utilizes the handset to measure neighboring signals, improving efficiency.
- Hysteresis is used to prevent the ping-pong effect at cell boundaries.

- In the next lecture, we conclude Unit 1 by looking at Multiple Access Techniques:
- How do hundreds of users share the same cell tower simultaneously?
- 1. FDMA (Frequency Division)
- 2. TDMA (Time Division)
- 3. CDMA (Code Division)
- 4. SDMA (Space Division)