

Lecture 17: 2.11 Comparison: GSM vs CDMA

GSM and CDMA Systems

DI05011011: Mobile Communication

Agenda for Today

- 1. Recap of GSM and CDMA Principles
- 2. Multiple Access: TDMA/FDMA vs CDMA
- 3. Spectrum Utilization and Capacity
- 4. Call Quality and Handoff Types
- 5. Security and Encryption
- 6. Global Adoption and Roaming
- 7. Comparison Summary Table
- 8. Introduction to Limitations
- 9. Summary and Next Steps

- **GSM (Global System for Mobile Communications):**

- - Originally a European standard.
- - Uses a combination of TDMA (Time Division) and FDMA (Frequency Division).
- - Defines specific time slots on specific frequencies for users.
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- **CDMA (Code Division Multiple Access):**

- - Developed by Qualcomm (IS-95 standard).
- - Uses spread spectrum technology (DSSS).
- - All users transmit on the same frequency at the same time, separated by unique PN codes.

Multiple Access Technique Comparison

- **GSM Approach:**

- - Like a dinner party where people take turns speaking (Time slots) in different rooms (Frequencies).
- - Hard limit on the number of users per channel (e.g., 8 time slots per 200 kHz carrier).
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- **CDMA Approach:**

- - Like a dinner party where everyone speaks at once in the same room, but in different languages (Codes).
- - Soft limit on capacity; as more users join, the background noise (interference) gradually increases.

- **GSM:**

- - Requires careful frequency planning to avoid co-channel interference.
- - Frequency reuse factor is typically 3, 4, or 7 (cluster size).
- - Lower spectral efficiency compared to CDMA.



- **CDMA:**

- - Universal frequency reuse (Reuse factor = 1). Every cell uses the same frequency.
- - Much higher spectral efficiency.
- - Can support 4 to 5 times more users than GSM in the same spectrum.

- **GSM (Hard Handoff):**

- - Break-before-make. The mobile disconnects from the old base station before connecting to the new one.
- - Can result in dropped calls if the transition isn't perfect.
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- **CDMA (Soft Handoff):**

- - Make-before-break. The mobile connects to multiple base stations simultaneously during the transition.
- - Results in fewer dropped calls and better voice quality at cell edges.
- - Requires a RAKE receiver to combine signals.

- **GSM Security:**

- - Uses A5/1 (and later A5/3) encryption algorithms.
- - Security is mostly confined to the SIM card and network authentication.
- - Easier to intercept using IMSI catchers (Stingrays).



- **CDMA Security:**

- - Inherently more secure due to spread spectrum (signal looks like noise without the code).
- - Additionally uses built-in encryption.
- - Historically much harder for eavesdroppers to intercept than early GSM.

- **GSM (SIM Cards):**

- - Separates subscriber identity (SIM) from the handset hardware.
- - Easy to switch phones, highly adopted globally (over 80% of the global 2G/3G market).
- - Seamless international roaming.
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- **CDMA (Device Bound):**

- - Subscriber identity was historically tied directly to the phone's ESN (Electronic Serial Number).
- - Harder to switch devices (required carrier intervention).
- - Mostly adopted in North America (Verizon, Sprint) and parts of Asia.

Summary Comparison Table

- — Feature — GSM — CDMA —
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- — **Access Method** — TDMA + FDMA — Spread Spectrum (CDMA) —
- — **Frequency Reuse** — Cluster (3, 4, 7) — Universal (1) —
- — **Handoff** — Hard Handoff — Soft Handoff —
- — **Subscriber ID** — SIM Card — Handset (ESN/MEID) —
- — **Capacity** — Lower — Higher (4x - 5x) —
- — **Global Roaming** — Excellent — Limited —

- While GSM and CDMA revolutionized mobile voice communication, they both eventually hit technological roadblocks.
- **The Shift in Demand:** Networks designed primarily for voice (circuit-switched) struggled with the rise of the internet and packet-data (IP).
- **Common Bottlenecks:**
 - - Limited data rates (Bandwidth).
 - - Scalability issues in dense urban areas.
 - - Inefficiencies in handling bursty IP traffic.

Engineering Example: The Cost of Upgrades

- **The GPRS/EDGE patch for GSM:**

- - GSM introduced GPRS (2.5G) and EDGE (2.75G) to handle packet data.
- - However, it still had to steal time-slots from voice calls, leading to poor data performance during peak voice hours.



- **The EV-DO patch for CDMA:**

- - CDMA introduced EV-DO to provide high-speed data.
- - It required a separate dedicated carrier frequency just for data, complicating spectrum management for operators.

- GSM utilizes TDMA/FDMA, requires frequency planning, and uses hard handoffs, but excels in global roaming via SIM cards.
- CDMA utilizes spread spectrum, allows universal frequency reuse, supports soft handoffs, and offers higher capacity, but historically lacked easy device swapping.
- While GSM won the global market share battle, CDMA's core technology (spread spectrum) proved superior for capacity and was adopted for 3G (WCDMA/UMTS).
- Both systems ultimately faced severe limitations when mobile internet demand surged.

- In the next lecture, we will dive deep into the specific limitations of these technologies:
- **1. Limitations of GSM Technology.**
- **2. Technical bottlenecks of TDMA.**
- **3. Why 2G GSM is being shut down globally.**