

Lecture 14: GSM Identifiers and Spread Spectrum Concept

GSM and CDMA Systems

DI05011011: Mobile Communication

Agenda for Today

- 1. Why do we need Identifiers?
- 2. IMSI (Subscriber Identity)
- 3. TMSI (Temporary Identity)
- 4. IMEI (Equipment Identity)
- 5. MSISDN (Phone Number)
- 6. LAI & BSIC (Location/Cell Identities)
- 7. Introduction to Spread Spectrum
- 8. Why spread the spectrum?
- 9. Summary

Why do we need Identifiers?

- A cellular network must track millions of users and devices seamlessly.
- Identifiers are required to:
 - - Route calls to the correct user.
 - - Bill the correct account.
 - - Prevent stolen devices from accessing the network.
 - - Maintain user privacy over the airwaves.
 - - Distinguish between different network operators and cell towers.

IMSI: International Mobile Subscriber Identity

- **What is it?** The permanent, unique identifier for a mobile subscriber.
- **Where is it?** Stored securely on the SIM card and in the HLR.
- **Structure (up to 15 digits):**
 - - **MCC (Mobile Country Code):** 3 digits (e.g., 404 for India).
 - - **MNC (Mobile Network Code):** 2 or 3 digits (identifies the operator, e.g., Airtel, Jio).
 - - **MSIN (Mobile Subscriber Identification Number):** Unique serial number for the user.
- **Usage:** Internal network routing and authentication. Rarely transmitted over the air to prevent tracking.

TMSI: Temporary Mobile Subscriber Identity

- **What is it?** A temporary alias for the IMSI.
- **Where is it?** Assigned by the VLR and stored in the SIM and VLR.
- **Purpose:**
 - - Protects user privacy.
 - - If the IMSI is constantly broadcast, eavesdroppers could track a user's physical location.
 - - Instead, the network assigns a TMSI. Only the VLR knows which TMSI maps to which IMSI.
 - - The TMSI is changed frequently (e.g., after every call or location update).

- **IMEI (International Mobile Equipment Identity):**

- - Identifies the *hardware* (the phone itself), not the user.
- - 15-digit number.
- - Used by the EIR (Equipment Identity Register) to block stolen phones.
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- **MSISDN (Mobile Station International Subscriber Directory Number):**

- - The actual 'phone number' dialed by other people.
- - Includes Country Code (e.g., +91), National Destination Code, and Subscriber Number.
- - The network maps the MSISDN to the IMSI to route the call.

- **LAI (Location Area Identity):**

- - Identifies a specific Location Area (a group of cells) within a network.
- - Used for paging. When a call comes in, the network pages the MS in its last known LAI.
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- **BSIC (Base Station Identity Code):**

- - Allows the MS to distinguish between neighboring cells using the same frequencies (co-channel cells).
- - Broadcast on the SCH (Synchronization Channel).
- - Prevents the MS from connecting to the wrong tower during handoff.

Introduction to Spread Spectrum

- Let's shift gears from GSM to the foundational theory of CDMA.
- **What is Spread Spectrum?**
- - A transmission technique where the signal occupies a bandwidth much wider than the minimum required for information transmission.
- - In standard AM/FM or GSM, we try to compress signals into the smallest bandwidth possible.
- - In Spread Spectrum, we intentionally *spread* the signal over a massive frequency band.

Why Spread the Spectrum?

- It seems counter-intuitive to waste bandwidth. However, spreading offers massive advantages:
- **1. Interference Resistance:** Highly immune to narrow-band jamming and interference.
- **2. Low Intercept Probability:** The signal power is spread so thin it looks like background noise. Hard to detect (originally designed for military).
- **3. Multiple Access (CDMA):** Multiple users can share the *exact same* wide frequency band simultaneously without interfering, separated only by unique codes.

How is spreading achieved?

- Spreading is achieved by multiplying the original data signal with a high-speed pseudo-random sequence (Spreading Code).
- - **Data Rate (R)**: Original speed of voice/data (e.g., 10 kbps).
- - **Chip Rate (W)**: Speed of the spreading code (e.g., 1.25 Mbps).
- **Processing Gain (PG)**:
 - - The ratio of Spread Bandwidth to Data Bandwidth: ' $PG = W / R$ '
 - - Higher processing gain means better resistance to interference.

- **GSM Identifiers:**

- - **IMSI/TMSI:** Permanent and temporary subscriber IDs.

- - **IMEI:** Hardware ID.

- - **MSISDN:** Dialable phone number.

- - **LAI/BSIC:** Location and cell tower IDs.

- **Spread Spectrum:**

- - Intentionally spreading a signal over a wide bandwidth.

- - Provides interference immunity, security, and enables multiple access via unique codes (CDMA).

- In the next lecture, we will dive fully into CDMA systems:
- **1. CDMA Principle:** How users share the same frequency and time.
- **2. Orthogonal Codes:** The mathematical "languages" used to separate users.
- **3. Advantages of CDMA:** Soft handoff, power control, and capacity improvements.