Lecture 12: GSM Channels and Call Procedure

GSM and CDMA Systems

DI05011011: Mobile Communication

Agenda for Today

- 1. Physical vs. Logical Channels
- 2. Traffic Channels (TCH)
- 3. Control Channels (CCH) Overview
- 4. Broadcast Channels (BCH)
- 5. Common Control Channels (CCCH)
- 6. Dedicated Control Channels (DCCH)
- 7. GSM Call Procedure: Overview
- 8. Mobile Originating Call (MOC)
- 9. Mobile Terminating Call (MTC)
- 10. Summary

Physical vs. Logical Channels

- **Physical Channel:**
- - Defined by a specific radio frequency (FDMA) and a specific time slot (TDMA).
- - Example: Carrier frequency 890.2 MHz, Time Slot 3.
- **Logical Channel:**
- - Represents the *type of information* carried over the physical channel.
- - Multiple logical channels can be multiplexed onto a single physical channel.
- - Divided into two main categories: **Traffic Channels** and **Control Channels**.

Traffic Channels (TCH)

- Traffic Channels carry the actual payload: user speech or data.
- **TCH/F (Full Rate):**
- - Uses one full time slot per TDMA frame.
- - Carries voice encoded at 13 kbps.
- **TCH/H (Half Rate):**
- - Users share a time slot on alternate frames.
- - Carries voice encoded at 5.6 kbps.
- - Doubles network capacity at the cost of slightly lower voice quality.

Control Channels (CCH) Overview

- Control Channels carry signaling and synchronization data. They are crucial for network management.
- There are three main groups of Control Channels:
- **1. Broadcast Channels (BCH):** Downlink only. Network broadcasting to all MSs.
- **2. Common Control Channels (CCCH):** Uplink and Downlink. Used for call setup and paging.
- **3. Dedicated Control Channels (DCCH):** Bi-directional. Dedicated to a specific MS during a call.

1. Broadcast Channels (BCH)

- Transmitted by the BTS (Downlink) to all mobiles in the cell.
- **FCCH (Frequency Correction Channel):**
- - Helps the MS tune exactly to the BTS frequency.
- **SCH (Synchronization Channel):**
- - Provides TDMA frame synchronization and the BSIC (Base Station Identity Code).
- **BCCH (Broadcast Control Channel):**
- - Broadcasts general network info (Location Area Identity, network rules, adjacent cell frequencies for handoff monitoring).

2. Common Control Channels (CCCH)

- Used for access and paging before a dedicated connection is established.
- **PCH (Paging Channel) - Downlink:**
- - BTS uses PCH to alert an MS of an incoming call (paging).
- **RACH (Random Access Channel) - Uplink:**
- - MS uses RACH to request connection to the network (e.g., to make a call).
- - Uses Slotted ALOHA protocol.
- **AGCH (Access Grant Channel) - Downlink:**
- - BTS responds to a RACH request, assigning a specific dedicated channel to the MS.

3. Dedicated Control Channels (DCCH)

- Assigned to a specific MS for signaling during call setup or while a call is ongoing.
- **SDCCH (Stand-alone Dedicated Control Channel):**
- - Used for call setup, authentication, and SMS transfer before a Traffic Channel is assigned.
- **SACCH (Slow Associated Control Channel):**
- - Always paired with a TCH or SDCCH.
- - Carries continuous background signaling (power control, radio link measurements).
- **FACCH (Fast Associated Control Channel):**
- - Steals a TCH time slot for urgent signaling, like Handoff commands.

GSM Call Procedure: Overview

- A Mobile-to-Mobile call involves two main phases:
- **1. Mobile Originating Call (MOC):**
- - The process from the caller dialing the number to the network routing the call.
- **2. Mobile Terminating Call (MTC):**
- - The process of the network locating the receiver and ringing their phone.
- Both processes rely heavily on the logical channels we just discussed.

Mobile Originating Call (MOC) - Step 1

- **User A dials User B's number.**
- 1. **Channel Request:** MS-A sends a request on **RACH**.
- 2. **Channel Assignment:** BSC responds on **AGCH**, assigning an **SDCCH**.
- 3. **Service Request:** MS-A sends a connection request over **SDCCH** to the MSC.
- 4. **Authentication:** MSC/VLR authenticates MS-A (via AUC keys).
- 5. **Ciphering:** Network instructs MS-A to start encrypting data.

Mobile Originating Call (MOC) - Step 2

- 6. **Call Setup Message:** MS-A sends dialed number (User B) to MSC.
- 7. **Routing Analysis:** MSC analyzes the number and queries HLR to route the call.
- 8. **Traffic Channel Assignment:** BSC assigns a **TCH** to MS-A.
- 9. **Ringing:** MSC sends an 'Alerting' message back to MS-A (user hears ringback tone).
- - MS-A waits on the TCH for User B to answer.

Mobile Terminating Call (MTC)

- **Network needs to find User B.**
- 1. **Routing:** GMSC queries HLR to find User B's current VLR/MSC.
- 2. **Paging:** Destination MSC broadcasts a page on **PCH** in User B's Location Area.
- 3. **Response:** MS-B hears the page, requests access on **RACH**.
- 4. **Assignment:** BSC assigns an **SDCCH** via **AGCH**.
- 5. **Security:** Authentication and ciphering performed on MS-B.
- 6. **Setup:** MSC sends Call Setup message; MS-B rings.
- 7. **Answer:** User B answers, assigned a **TCH**. Call is connected!

Lecture Summary

- Logical channels define the type of data sent over physical RF timeslots.
- Traffic Channels (TCH) carry voice at full or half rates.
- Control Channels handle signaling: BCH (broadcast info), CCCH (access/paging), DCCH (dedicated signaling).
- A call consists of Mobile Originating (MOC) and Mobile Terminating (MTC) phases.
- Call setup requires sequential use of RACH, AGCH, SDCCH, and finally TCH.

Next Lecture Preview

- In the next lecture, we will focus on the security and performance enhancements in GSM:
- **1. Authentication and Security:** How A3, A5, and A8 algorithms protect your data.
- **2. Frequency Hopping:** Fast and Slow hopping.
- **3. Why do we need Frequency Hopping?** (Combating fading and interference).