

Cellular telephone systems: GSM

- GSM = Global System for Mobile Communication
- Most widely used cellular telephone service in the world
- Let's first consider the radio interface – uses a combination of FDMA and TDMA
- Frequencies
 - GSM 900: 890-915 MHz and 935-960 MHz
 - GSM 1800: 1710-1785 MHz and 1805-1880 MHz (different frequencies in the USA)
- Duplexing
 - A “full-duplex” link maintains a completely bi-directional channel at all times
 - All telephone connections are full-duplex (distinct from half-duplex, where the uplink and downlink can only exist one at a time, like a walkie-talkie)
 - GSM uses frequency division duplexing – this is why there are two frequency ranges given above
 - uplink is the lower set of frequencies, and downlink is the upper set – when a call is set up you are assigned both an uplink and a downlink channel
- Division of the channel
 - Take GSM 900 uplinks as an example (downlink and GSM 1800 are similar)
 - FDMA: Frequencies divided into 124 channels of 200 kHz each
 - TDMA: Within each channel, time is divided into frames of 4.615 ms each; each frame contains 8 slots of duration 577 μ s (a slot is what is assigned to a user)

(Fig. 1)

- Slots consist of 546.5 μ s “burst” and 30.5 μ s of guard time (why is guard time needed?)
- Burst contains 148 bits (raw bit rate = 271 kbps) – contains 6 “tail bits” (3 on each end), 2 “S bits” (control), 26 training bits, and 114 data bits
- Bit rate per user = $114/0.004615 = 24.7$ kbps

(Fig. 2)

GSM Architecture

- Three major subsystems:
 - Radio subsystem – handles radio tasks, consists of mobiles and base stations
 - Network and switching subsystem – routes calls, performs handovers, localizes users worldwide
 - Operation subsystem – Security, authentication, billing.
- Radio subsystem:
 - Base stations are organized hierarchically into base station subsystems (BSS), containing several cells – tasks are divided into base transceiver station (BTS) and base station controller (BSC)
 - BTS: radios, antennas, signal processing, and amplifiers – one per cell
 - BSC: organizes radio frequencies, handles handovers within a given BSS – one per BSS
 - Recall Cellular IP

(Fig. 3)

- Mobile station (MS) is also part of the radio subsystem – most important task, aside from the obvious, is to hold the subscriber identity module (SIM)
- Network and switching subsystem:
 - Mobile services switching center (MSC): connect to several BSCs, each other, and possibly the outside world (gateway MSC) – handovers, connection to the PSTN, etc.
 - Home location register (HLR): Master database of all user data, e.g., identity, location
 - Visitor location register (VLR): One per MSC, contains copied information of all HLR information in that MSC's area
 - Compare HLR and VLR with home agent and foreign agent

(Fig. 4)