Cellular Mobile Networks - GSM

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GSM Introduction

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2G Mobile Systems - Overview

- Goal: compensating the disadvantages of previous analog (1G) systems
  - compatibility (at least within Europe)
  - protection against eavesdropping
  - improved handover
  - optimized signalling
- Dominant 2G systems:
  - IS-54, IS-136 (D-AMPS): USA
  - IS-95 (cdmaOne): USA, South America, Central Africa, Asia
  - Personal Digital Cellular (PDC), Japan
  - Global System for Mobile Communications (GSM): used worldwide
- 2G systems are incompatible to each other (workarounds are multi-band or multi-mode mobile stations)
- 2G services: focus (in the first phase) on voice telephony and low data rate data services

2G Systems Examples - IS-54, IS-136

- Interim Standard of the Electronic Industries Association (EIA), USA
- Also known as Digital - Advance Mobile Phone Service (D-AMPS), United States Digital Cellular (USDC) or North American Digital Cellular (NADC)
- Introduction in 1991 as a migration for the analog 1G AMPS system
- Uses the same frequencies as AMPS (reason: base stations could be partly reused, multi-mode mobile stations)
  - uplink: 824-849MHz
  - downlink: 869-894MHz
- Multiplexing scheme: TDMA/FDMA
- Duplexing scheme: FDD, with duplex distance 45MHz
- Channel bandwidth: 30kHz
- Channel data rate: 48,6kbit/s

2G Systems Examples - IS-95

- Interim Standard of the US Telecommunications Industry Association (TIA)
- Also known as "cdmaOne"
- First commercial CDMA network
- Uses the same frequencies as AMPS (reason: base stations could be partly reused, multi-mode mobile stations)
  - uplink: 824-849MHz
  - downlink: 869-894MHz
- Multiplexing scheme: CDMA/FDMA
- Duplexing scheme: FDD, with duplex distance 45MHz
- Channel bandwidth: 1,25MHz
- Channel data rate: 1,2288Mchip/s

2G Systems Examples - PDC

- Pacific Digital Cellular
- Also known as „Personal Digital Cellular“ or JDC (Japanese Digital Cellular)
- NTT DoCoMo „company standard“
- Introduction in 1993
- Extension in 1999 with PDC-P (wireless packet) for i-mode service
- Frequencies:
  - uplink: 810-830MHz and 1429-1453Mhz
  - downlink: 940-960MHz and 1477-1501Mhz
- Multiplexing scheme: TDMA/FDMA
- Duplexing scheme: FDD, with duplex distance 130MHz and 48MHz
- Channel bandwidth: 25kHz
- Channel data rate: 42kbit/s

2G Systems Examples - GSM

- Global System for Mobile Communication - ETSI Standard
- Introduction in 1991
- Frequencies:
  - uplink: 890-915MHz (GSM900) and 1710-1785MHz (GSM/DCS1800)
  - downlink: 935-960MHz (GSM900) and 1805-1880MHz (GSM/DCS1800)
  - further country specific carrier frequencies are available (aligned with available unused spectrum), e.g. GSM400, GSM700, GSM850, GSM/PCS1900
- Multiplexing scheme: TDMA/FDMA
- Duplexing scheme: FDD, with duplex distance 45MHz
- Channel bandwith: 200kHz
- Channel data rate: 270,833kbit/s
- Most popular standard for cellular mobile networks worldwide

GSM Advantages

- Advantages of GSM compared to 1G systems:
  - improved voice quality
  - (compared to 1G systems) relatively low costs for:
    - handsets
    - network operation
    - services
  - improved protection wrt. eavesdropping
    - encrypted connections (at the radio interface)
    - the encryption code changes over time and per subscriber
  - international roaming (using a single telephone number) possible

GSM History

- 1979: WARC (World Administrative Radio Conference) assigns the 900MHz frequency band for a future cellular mobile network
- 1982: CEPT (Conférence Européenne des Administrations des Postes et des Télécommunications) initiates the Groupe Spéciale Mobile
- 1986: 9 system concepts (analog and digital) were elaborated and are subject to discussion in Paris
- 1987: Decision for a fully digital narrow-band TDMA/FDMA system; Signing the Memorandum of Understanding (MoU) through major European operators to launch GSM networks from 1991/92 onwards
- 1989: The European Telecommunications Standards Institute (ETSI) is now responsible for the standardization (due to marketing reasons); Renaming to GSM = Global System for Mobile Communication
- 1992: Two GSM networks are launched in Germany (D1 and D2)

GSM Variants

System	GSM 900	Extension Band GSM 900	GSM 1800 (DCS-1800)	GSM 1900 (PCS-1900)
Frequenzen Uplink (MHz)	890 - 915	880-915	1710-1785	1850-1910
Downlink (MHz)	935-960	925-960	1805-1880	1930-1990
Bandbreite	25 MHz	35 MHz	75 MHz	60 MHz
Trägerabstand	200 kHz			
Verfügbare Kanäle	124	174	374	299
Übertragungsrate	270 kbit/s			
Netze (Deutschland)	D1/D2		E1/E2	(USA)

Evolution of 2G towards 3G Systems