

PERSONAL COMMUNICATIONS SERVICES (PCS)

ECE 525E – WIRELESS & MOBILE
COMMUNICATION

Monday, February 17, 2025

MAJOR DEVELOPMENTS IN RADIO & MOBILE COMMUNICATION

- **1934** - Police Radio uses conventional AM mobile communication system.
- **1935** - Edwin Armstrong demonstrated FM.
- **1946** - First public mobile telephone service - Push-to-talk (Simplex).
- **1960** - Improved Mobile Telephone Service, IMTS - Full duplex.
- **1960** - Bell Lab introduce the concept of Cellular mobile system.
- **1968** - AT&T propose the concept of Cellular mobile system to FCC.
- **1976** - Bell Mobile Phone service Introduced. Has poor service due to call blocking.
- **1983** – Advanced Mobile Phone Service (AMPS)
- **1991** - Global System for Mobile (GSM)
- **1991** - U.S. Digital Cellular or Digital AMPS (DAMPS) IS-54, TDMA, DQPSK.
- **1993** - IS-95 CDMA QPSK, CDMA

DEFINITION OF PERSONAL COMMUNICATIONS SERVICES (PCS)

- Personal Communication Services (PCS) refers to a wide variety of wireless access and personal mobility services provided through a small terminal.
- There are two main categories of Personal Communication Systems:
 1. **Low-tier systems**, e.g. DECT, WiFi, Bluetooth usually acting as last-mile subscriber access
 2. **High-tier systems** e.g. GSM, CDMA, etc usually provided by licensed service provider

HIGH-TIER CELLULAR PERSONAL COMMUNICATION SYSTEMS

1. 1G, Advanced Mobile Phone Service (AMPS)
2. 2G, Global System for Mobile Communications (GSM)
3. 2G, Digital Advanced Mobile Phone Service (DAMPS)
4. 2G, Code Division Multiple Access - CDMA(IS-95)
5. 3G, WCDMA/UMTS, CDMA2000
6. 4G - Long Term Evolution (LTE)

ADVANCED MOBILE PHONE SERVICE (AMPS)

1. Advanced Mobile Phone System (AMPS) was the first cellular system.
2. Developed during the 1970s in the Bell Laboratories
3. From 1974 to 1978, the first large-scale AMPS trial was conducted in Chicago.
4. Commercial AMPS service became available since 1983.
5. It was used in Britain where it was called TACS and also in Japan where it was called MCS-L1
6. AMPS is based on **frequency division multiple access** (FDMA) technology for radio communications implemented with a frequency reuse scheme.
7. Voice channels are assigned to radio frequencies using FDMA.
8. AMPS operated in the **824-849 MHz (uplink)** and **869-894 MHz bands (downlink)**.
9. Later systems (GSM and DAMPS) inherited many principles from AMPS, e.g. Frequency bands and FDD techniques.

AMPS-TELEPHONE



AMPS-FREQUENCY PLAN

1. In AMPS, the cells were typically 10 to 20 km across; in later digital systems, the cells became smaller.
2. Each cell uses a set of frequencies which are not used in the neighbouring cells.
3. The design objective was to give cellular systems far more capacity than previous systems through the use of relatively small cells which shared frequency with far-away cells.

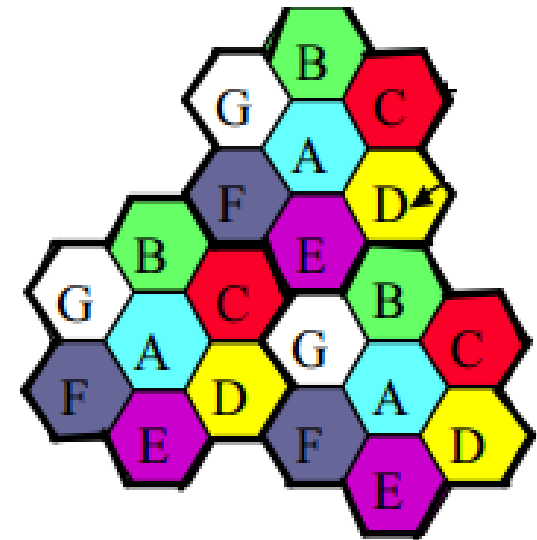


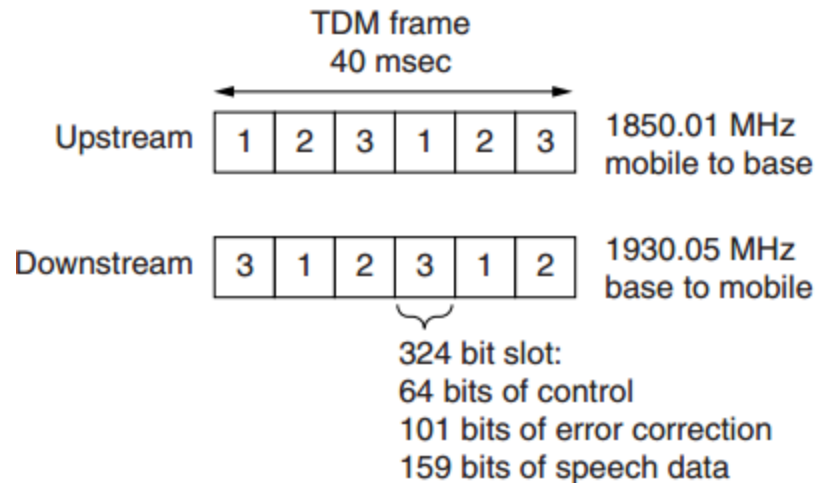
Fig. Frequency reuse.
Cells marked A used the same frequency. So do B, C, D, E and F

DIGITAL ADVANCED MOBILE PHONE SERVICE (DAMPS)

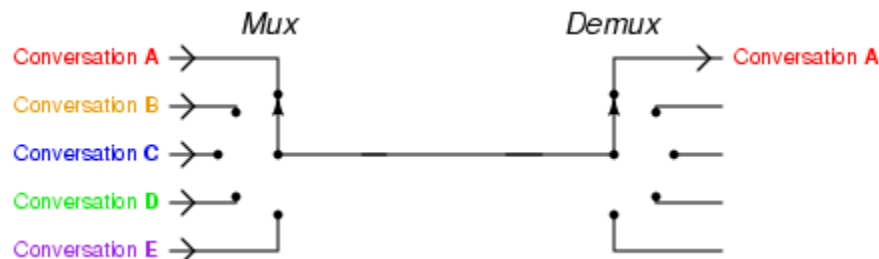
- DAMPS is a second generation AMPS that is fully digital, i.e uses both FDM and TDM but can co-exist with analogue AMPS.
- DAMPS is uses both 850 MHZ and 1900 MHZ bands as follows:
 - **Up-link:** 824 – 849 MHz and 1850 – 1910 MHz
 - **Down-Link:** 869 – 894 MHz and 1930 – 1990 MHz

TIME DIVISION MULTIPLEXING IN DAMPS

- Three users can share a frequency channel in AMPS using TDM

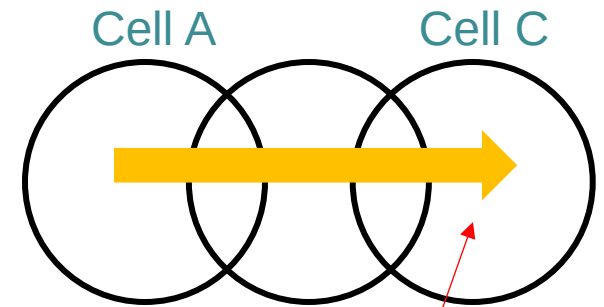


$$\text{Duration of timeslot} = \frac{40}{3} = 13.3 \text{ msec}$$



SUBRATING IN CELLULAR COMMUNICATION

- **Subrating** refers to the reduction of the sampling rate in cellular communication systems to increase channel capacity.
- **Subrating** can enable hand-off when the target cell has all its channels occupied.

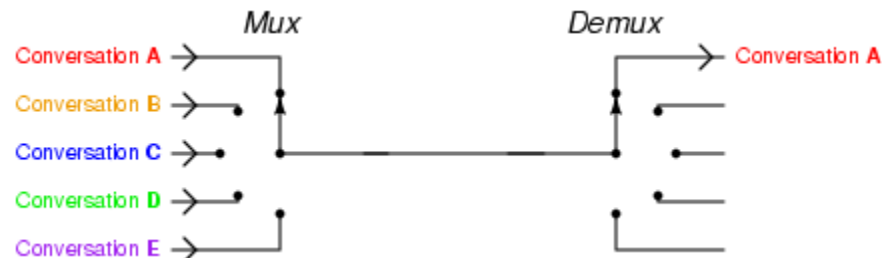
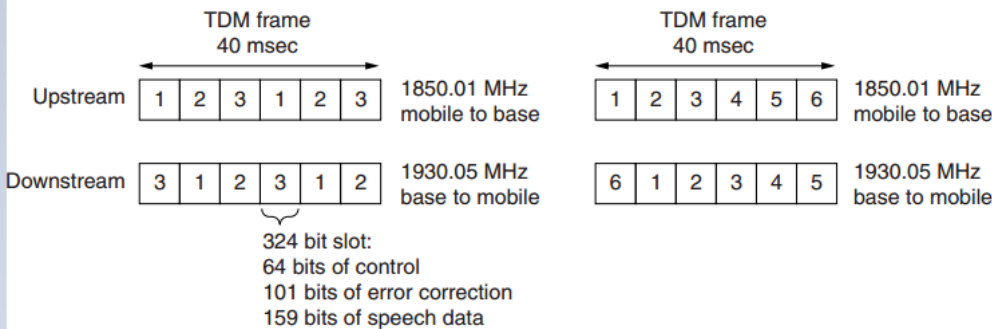


Why subrating?

When MS arrives in cell C when it is full, one channel is split into two by reducing the sampling rate to half. The quality of the voice falls but a call-drop is avoided.

SUBRATING IN DAMPS

- DAMPS was designed to provide for **subrating** when the target cell is full during hand-off.

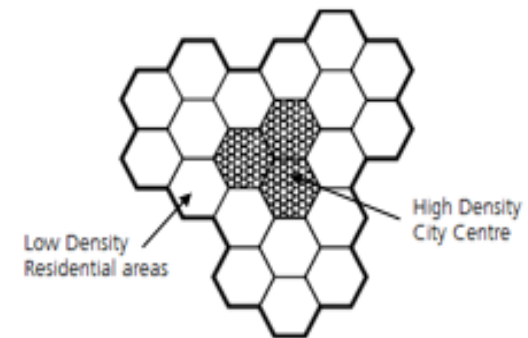
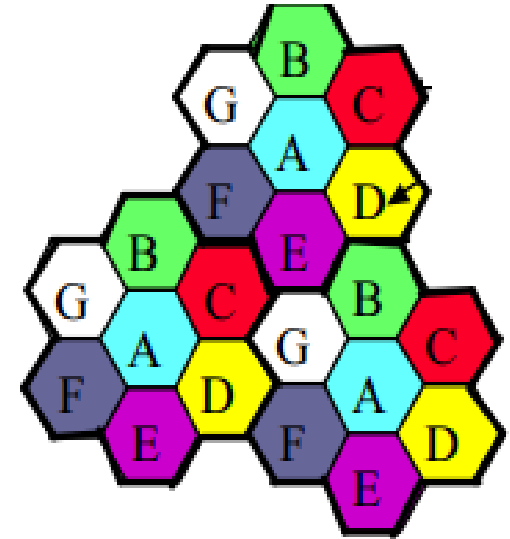


FIRST CELLULAR SYSTEM IN KENYA

1. The first cellular system in Kenya was the **Electronic Total Access Communication System (ETACS)** which was introduced in 1992 by the predecessor of Telkom Kenya.
2. ETACS was a British variant of AMPS.
3. ETACS was replaced by GSM in 1996.

FREQUENCY REUSE CONCEPT

- Cells are usually circular but are **more easily modelled as hexagons** as shown in the diagram
- Cells usually arranged in **clusters of 4, 7 or 12**.
- Each letter indicates a cell using a group of frequencies
- In this plan (shown), there is **a buffer of two cells between any two frequencies**.
- In practice, **finding elevated sites at appropriate location is usually a big problem in network planning**.
- In areas where the number of users has increased, **cells are usually split into smaller ones** (micro and pico cells) and the power transmission levels are reduced to minimize interference to cells in neighbouring clusters.



AMPS CHANNELS

1. AMPS uses 832 full-duplex channels as follows:
 - **Up-link:** 824 – 849 MHz
 - **Down-Link:** 869 – 894 MHz
2. Each simplex channel has a bandwidth of 30 KHz.
3. The 832 channels are divided into four categories:
 - a) **Control channels** which manage the system (downlink)
 - b) **Paging channels** which alert mobile users on incoming call (downlink)
 - c) **Access channels** for call set-up and channel assignment (bi-directional)
 - d) **Traffic channels** to carry voice, fax or data

AMPS HANDOFF

- At any time each mobile is connected to one **Base Station Transceiver (BTS)**.
- If the **Mobile Telephone Switching Office (MTSO)** notices that the signal is fading, then it requests the neighbouring base stations to measure the power from the mobile.
- Hand-over is made to the neighbouring base station reporting the highest power signal from the mobile.
- There are two types of hand-offs, i.e.
 - **Soft hand off** where the mobile acquires the next BTS before the previous signs off (not used in 1st generation)
 - **Hard Handoff** where the mobile disconnects from the BTS before acquiring the next BTS.
- AMPS used Hard handoff only.

FACTS AT SAFARICOM.CO.KE

- 1. Safaricom was founded in 1997** as a subsidiary of Telkom Kenya.
- 2. 40 percent acquisition by Vodafone Group PLC** in May 2000.
- 3. Public offering of 25 percent shares** through the NSE in 2008.
- 4. Total economic value was estimated at KES 542 Billion by 2024**

Facts about Safaricom

- Employs over 4,000 staff directly and over 500,000 indirectly;
- Has approximately 3,000 base stations across the country ;
- Has the largest call center in Sub-Saharan Africa.
- Has International roaming relations with almost 500 operators worldwide

GLOBAL SYSTEM FOR MOBILE COMMUNICATION

1. GSM is a digital cellular system developed by **Groupe Special Mobile** of Conference Europeenne des Postes et Telecommunications (CEPT) and its successor **European Telecommunications Standard Institute (ETSI)**.
2. The goal of the GSM development process was to offer **compatibility of cellular services among European countries**. At the time there were different standards in different countries, e.g. NMT (Scandinavian), ETACS (UK).
3. GSM combines both time division multiple access (TDMA) and FDMA.

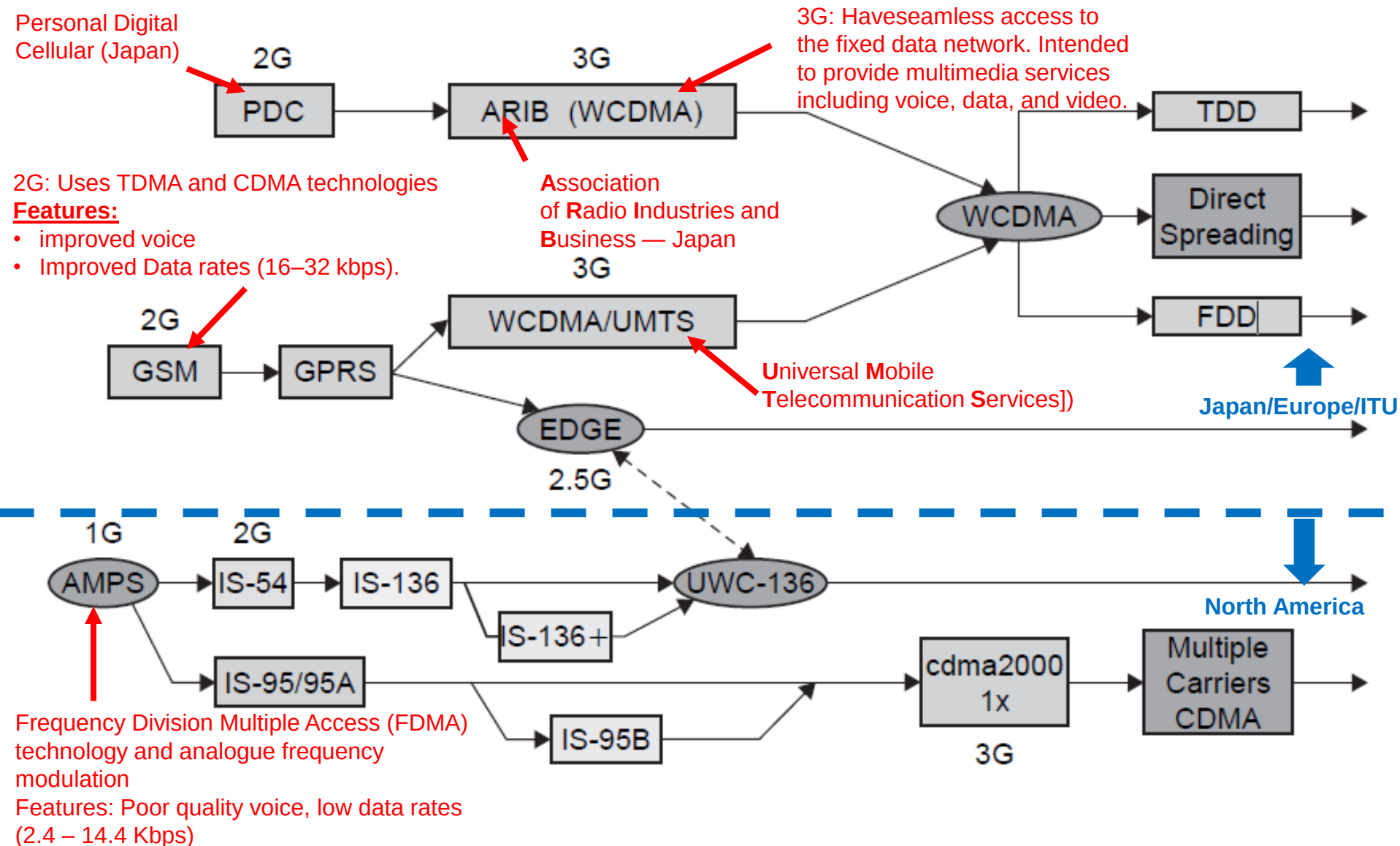
GLOBAL SYSTEM FOR MOBILE COMMUNICATION

1. The frequency carrier is divided into **eight time slots** where the nominal speech coding rate is 13 Kbps.
2. A GSM base station, every pair of radio transceiver-receiver supports **eight channels**, whereas an AMPS base station needed one such pair for every voice channel.
3. The **GSM Mobile equipment control their RF output** power to counter interference at low levels.
4. The GSM air interface has been evolved into **Enhanced Data Rate for GSM Evolution (EDGE)** with variable data rate and link adaptation.

GENERATIONS OF MOBILE COMMUNICATION SYSTEMS

- **1st Generation:** Analogue systems, e.g. AMPS
- **2nd Generation:** Global System for Mobile Communication (GSM) designed for voice and low rate data services.
- **3rd Generation:** Higher system capacity with high speed data/internet access (> 2Mbps)

EVOLUTION OF WIRELESS WIDE AREA NETWORKS



EVOLUTION OF CELLULAR SYSTEMS

