

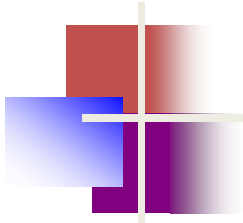
Wireless Mobile Communication

Lecture 21, 22, 23, 24

- Multiple Access Techniques

Topics to be Covered

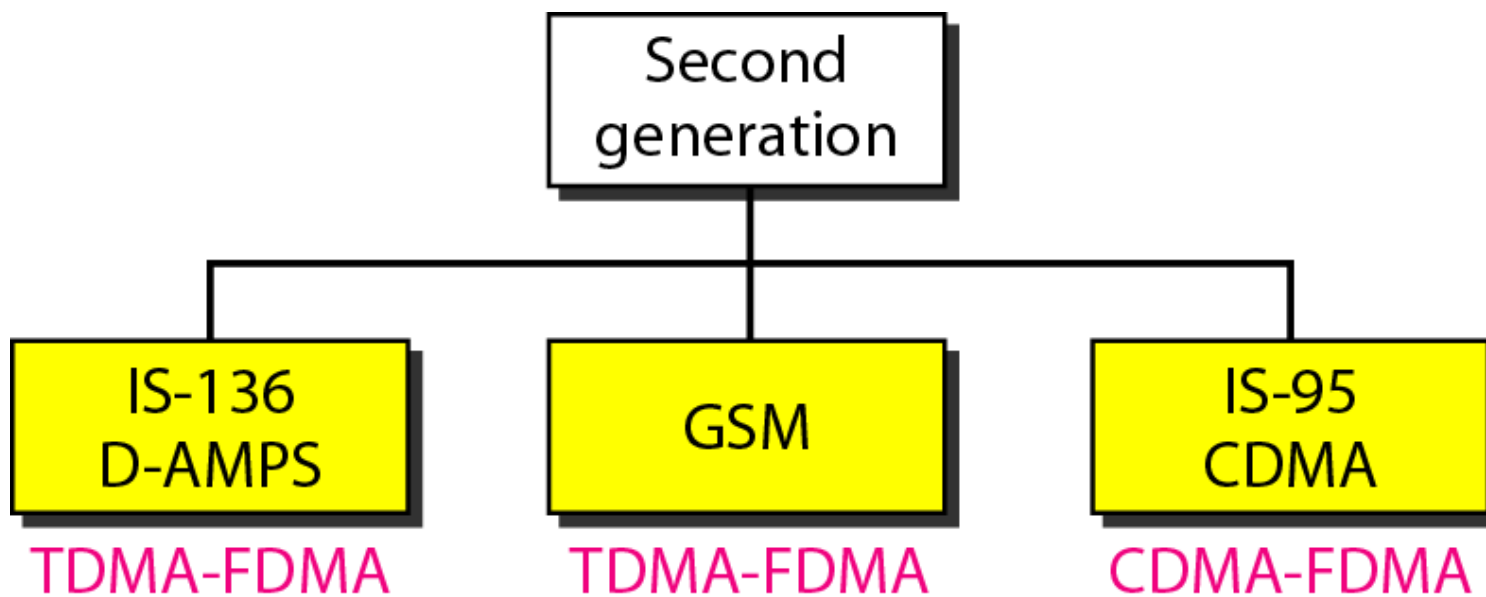
- AMPS
- IS-95
- FDMA
- TDMA



Note

AMPS is an analog cellular phone system using FDMA.

Figure 16.5 *Second-generation cellular phone systems*



Advanced Mobile Phone Service

- 1st Generation
- most common mobile phone service since early 80's
- developed by AT&T

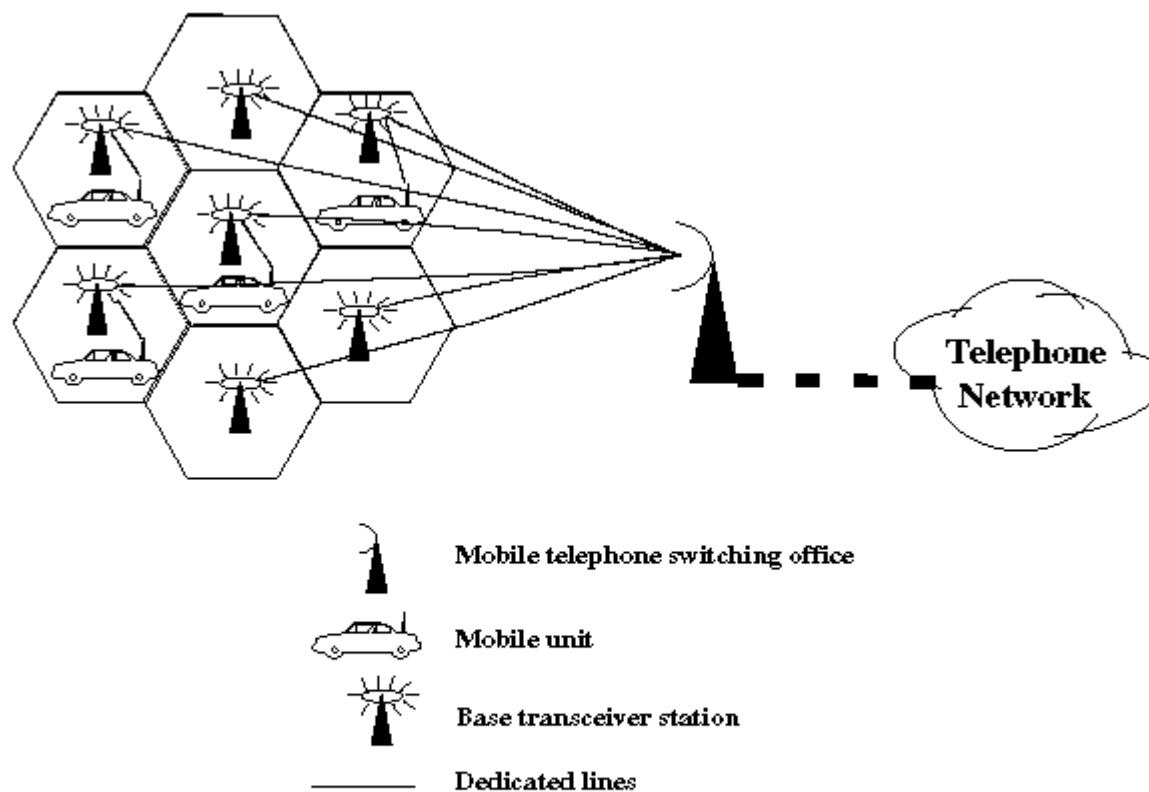


Figure 11.1 AMPS Layout

AMPS Spectral Allocation

- Two 25-MHz bands
 - base to mobile (869-894 MHz)
 - mobile to base (824-849 MHz)
- Each split in two to allow competition
 - each operator allocated 12.5 MHz bands
- 416 channels per operator
 - 395 for calls, 21 for control data

Figure 16.3 Cellular bands for AMPS

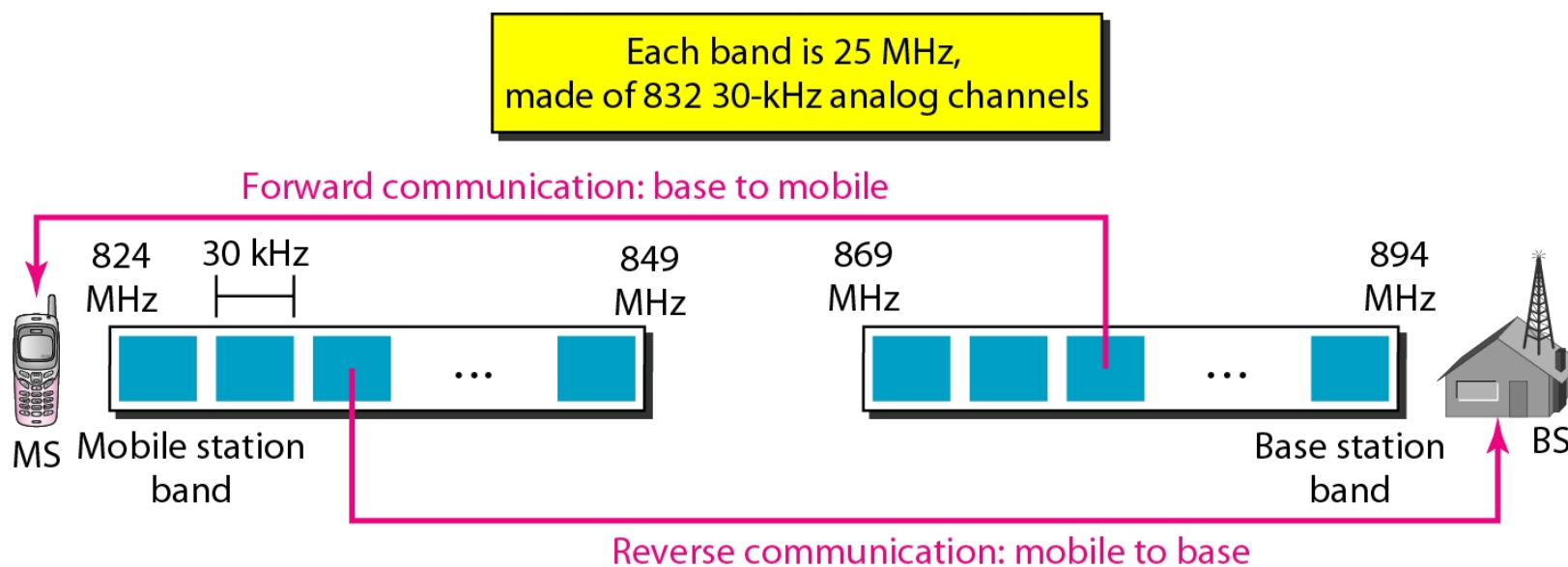
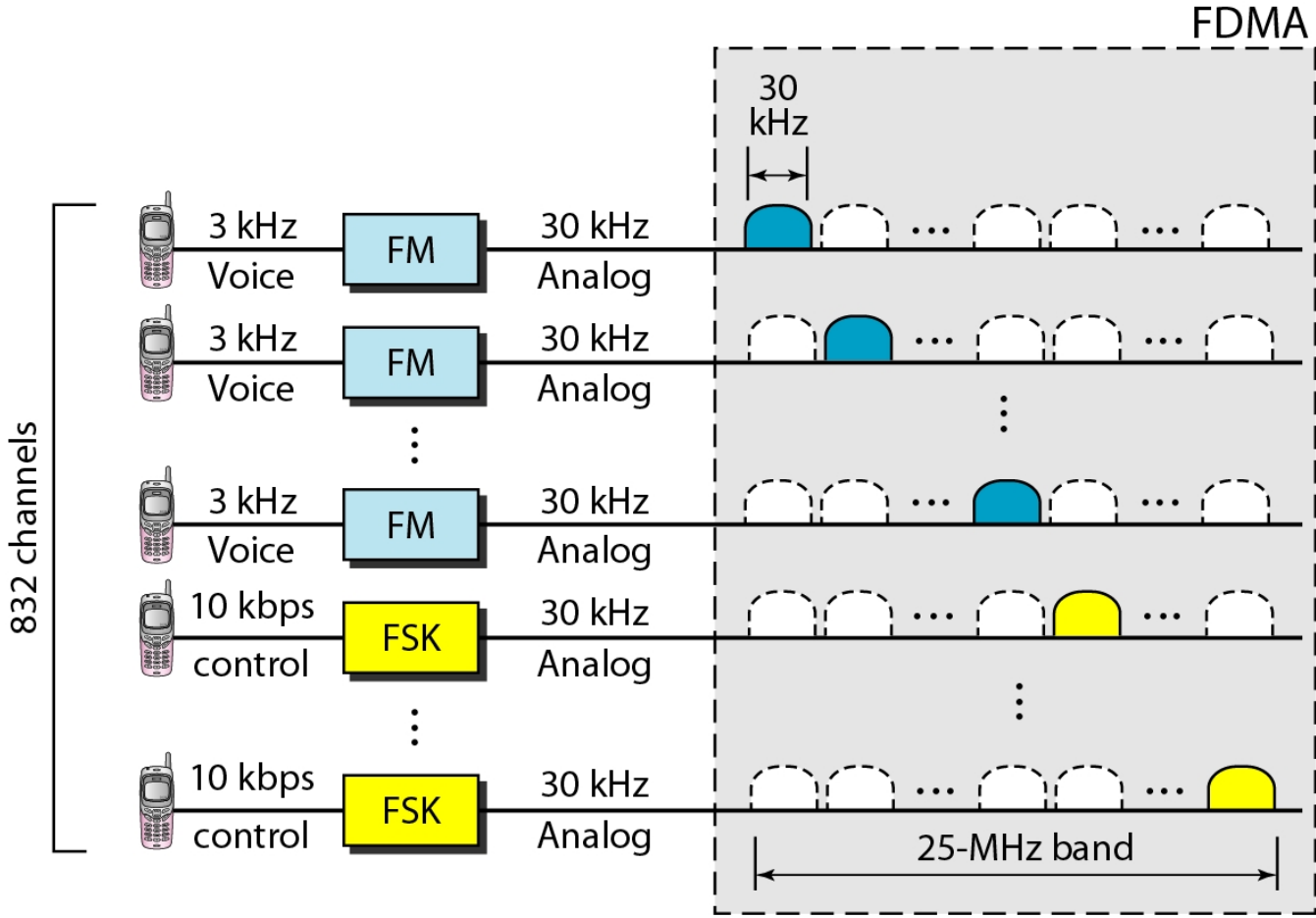
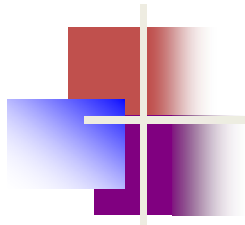


Figure 16.4 *AMPS reverse communication band*



AMPS Spatial Allocation

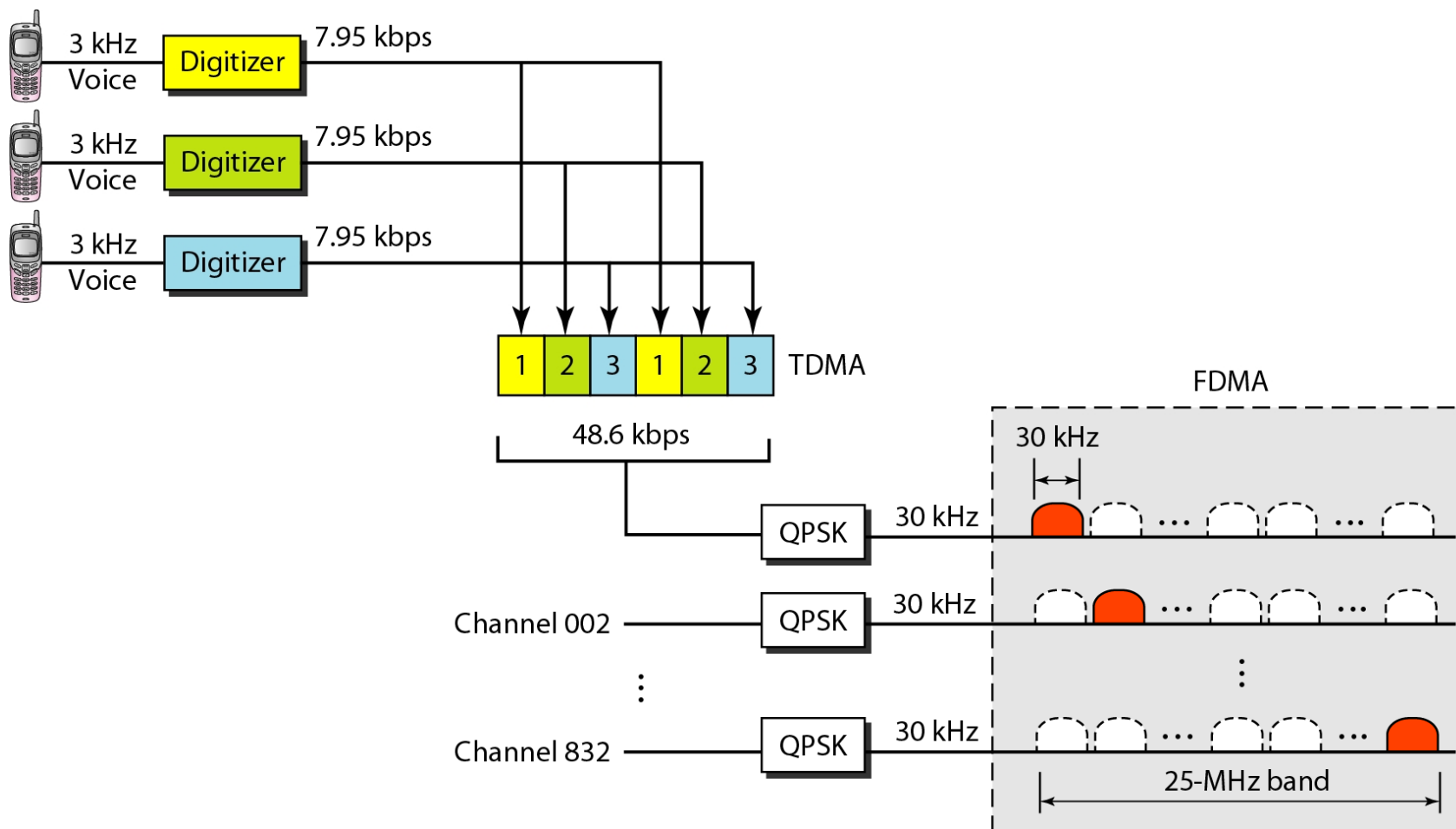
- Limited channels dictate frequency reuse in nearby cells
- Generally 10 to 50 frequencies assigned to cell
- Pattern of 7 cells smallest allowing sufficient isolation
- 57 frequencies per cell
- 6.5 to 13 km per cell
- May be split with lower power

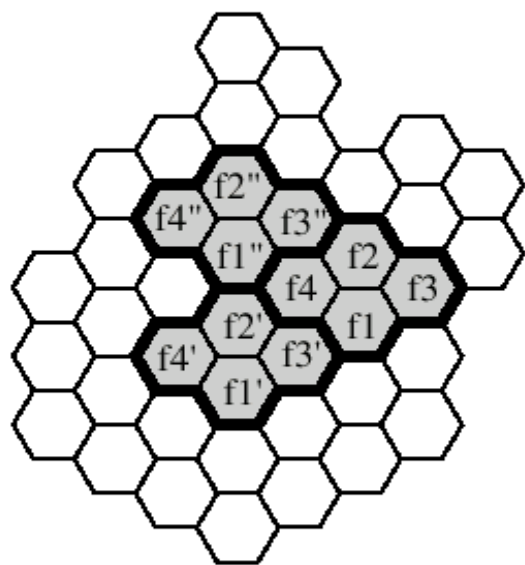


Note

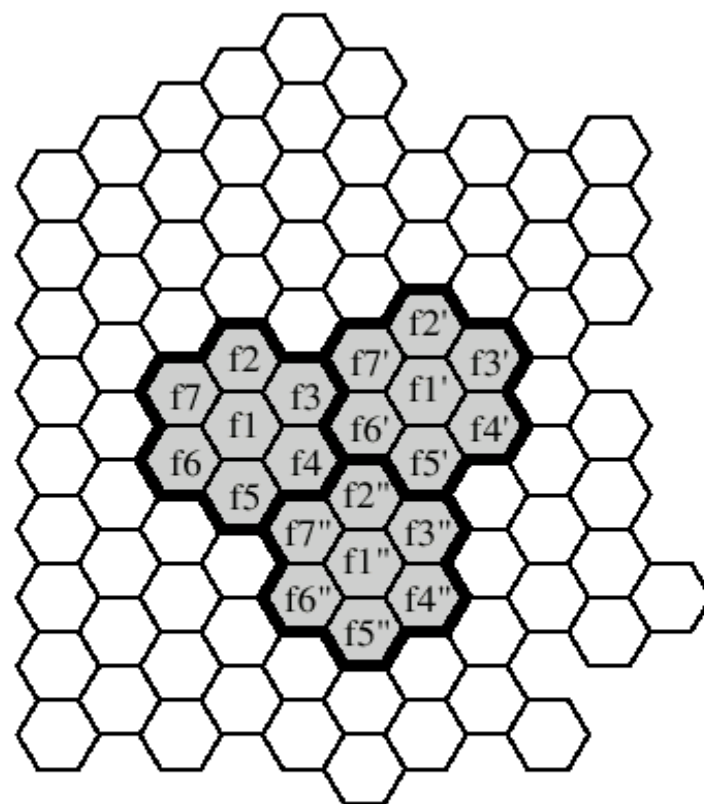
D-AMPS, or IS-136, is a digital cellular phone system using TDMA and FDMA.

Figure 16.6 *D-AMPS*





(a) Frequency reuse pattern for $n = 4$



(b) Frequency reuse pattern for $n = 7$

AMPS Components

- Mobile Units
 - contains a modem that can switch between many frequencies
 - 3 identification numbers: electronic serial number, system ID number, mobile ID number
- Base Transceiver
 - full-duplex communication with the mobile
- Mobile Switching Center

AMPS Mobile Units

- Modem that can switch between frequencies
- Power output of unit controlled to match size of cell
- Three identification numbers
 - electronic serial number - 32 bits
 - system operator identification number - 15 bits
 - mobile identification number - 34 bits - phone #

AMPS Logon

- When mobile becomes operational, it senses control channels to determine channel and base station received best
- Exchanges information via base station
- Announces its system id # to identify its home carrier
- Home carrier contacted for authorization and to locate mobile for incoming calls

AMPS Handoffs

- Roaming operator must move between cells
 - Different cells have different frequencies and power levels
- Choice of handoff depends on received power from base stations and controlled by mobile switching center

Global System for Mobile Comm.

- 2nd Generation
- First appeared in 1991 in Europe
- Similar to working of AMPS
- Designed to support phone, data, and image
- Rates up to 9.6 kbps
- GSM transmission is encrypted using secret keys

Global System for Mobile Communication

- Developed to provide common 2nd-generation technology for Europe
- 200 million customers worldwide, almost 5 million in the North America
- GSM transmission is encrypted
- Spectral allocation: 25 MHz for base transmission (935–960 MHz), 25 MHz for mobile transmission (890–915 MHz)

GSM SIM

- Subscriber Identity Module
- Smart card or plug-in module to activate unit
- stores
 - subscriber's identification number
 - networks subscriber is authorized to use
 - encryption keys
- Can use any unit anywhere with your SIM

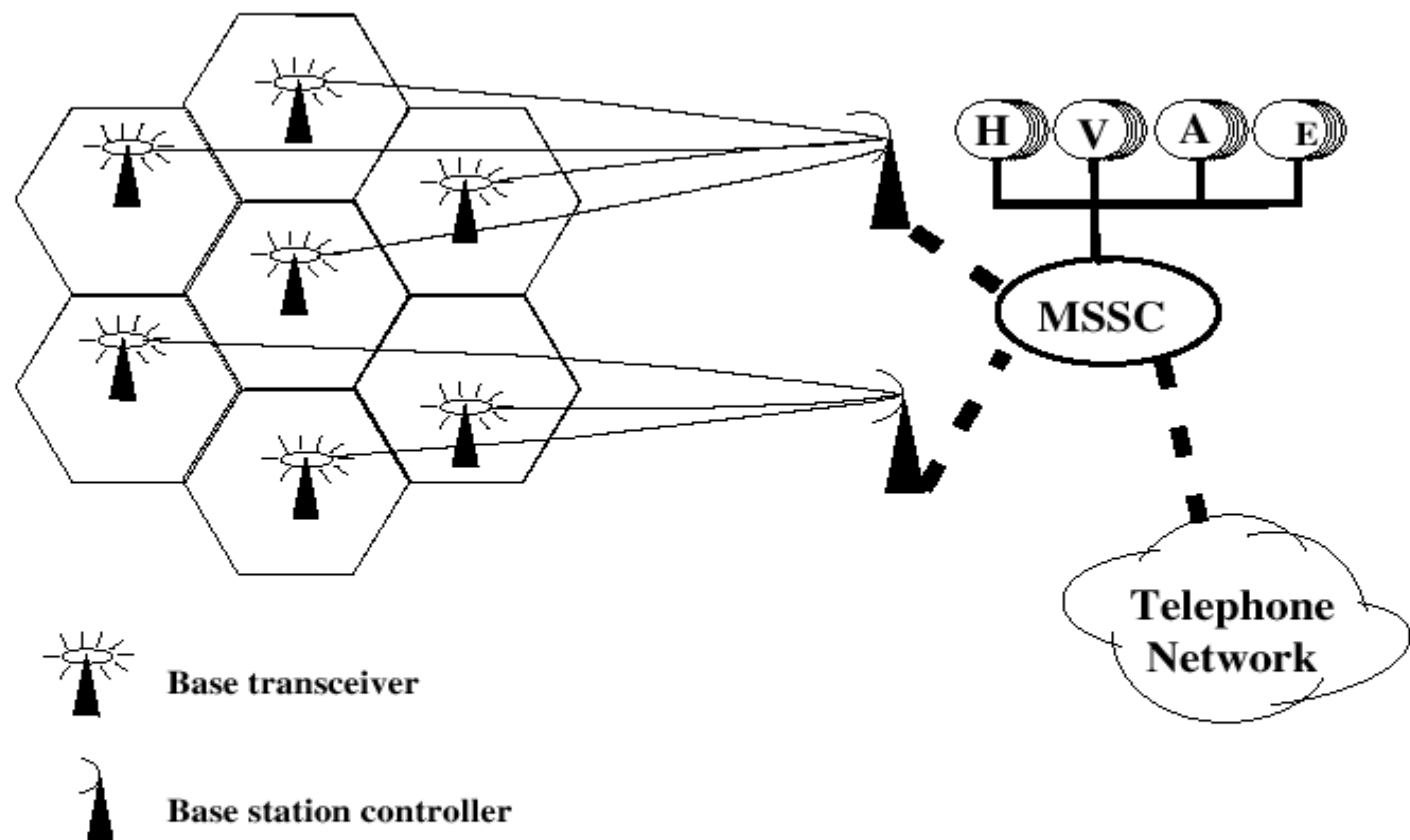


Figure 13.4 GSM Layout

Multiple Access

- Four ways to divide the spectrum among active users
 - frequency-division multiplexing (FDM)
 - time-division multiplexing (TDM)
 - code-division multiplexing (CDM)
 - space-division multiplexing (SDM)

GSM Access Methods

- FDM too wasteful
- TDMA - time-division multiple access
 - early lead - more successful experience
- CDMA - code-division multiple access
 - theoretical advantages
 - increased range
 - choice for 3rd generation

Figure 16.7 *GSM bands*

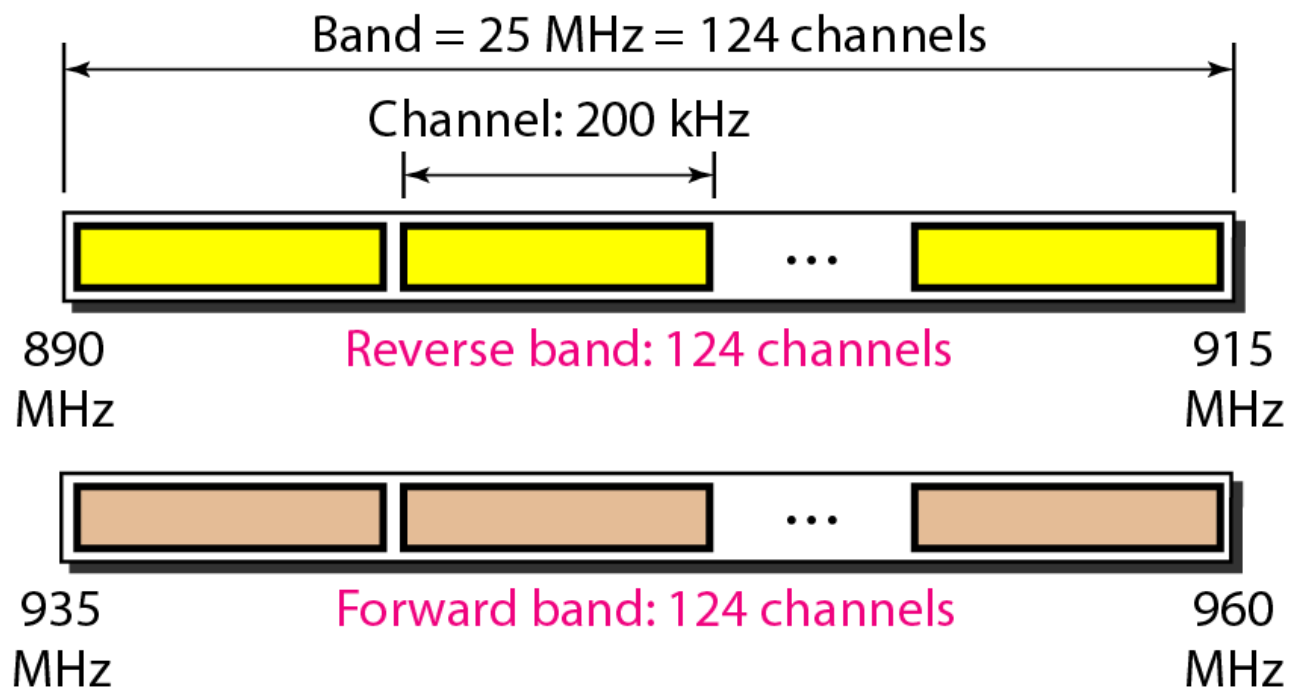


Figure 16.8 *GSM*

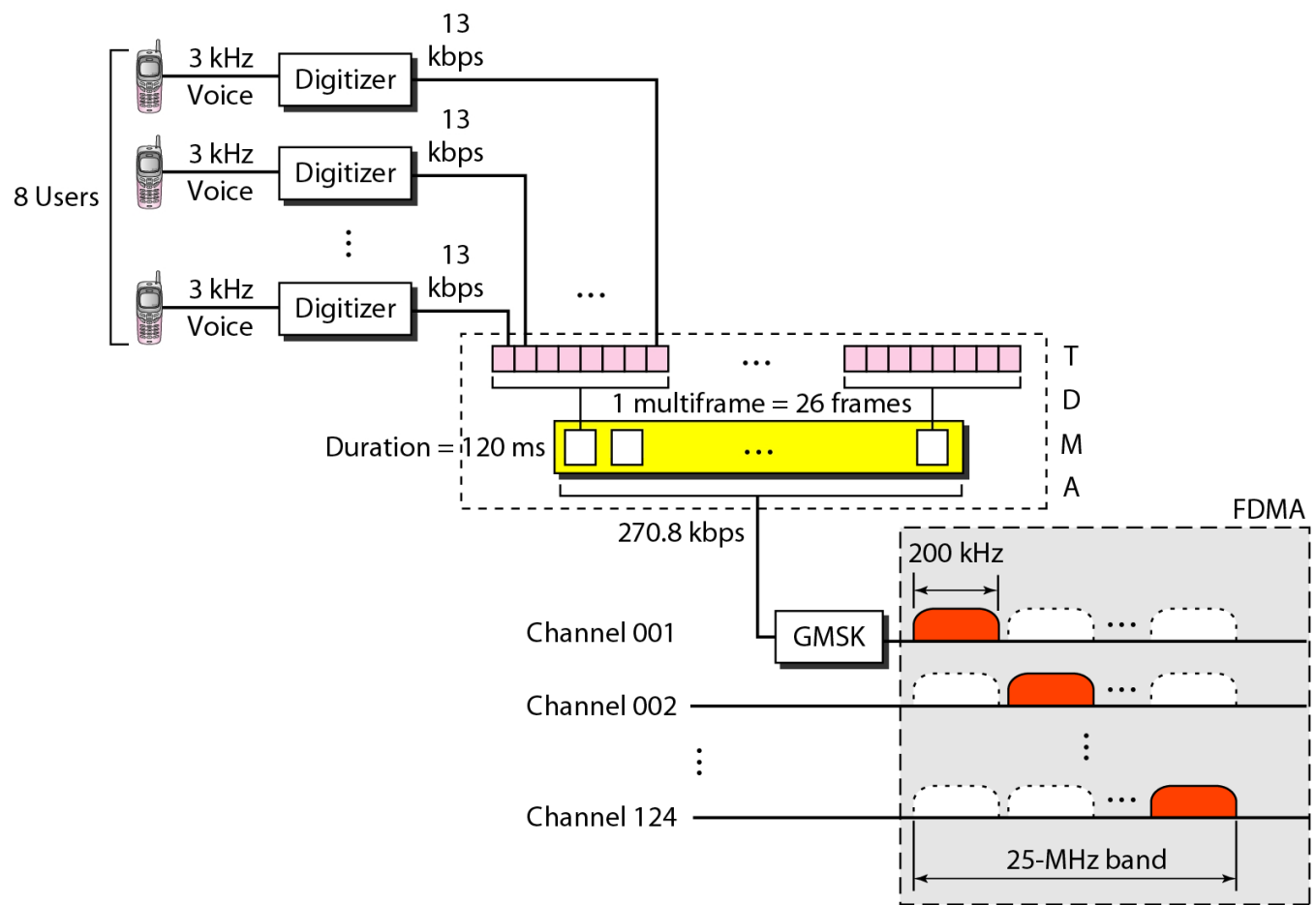
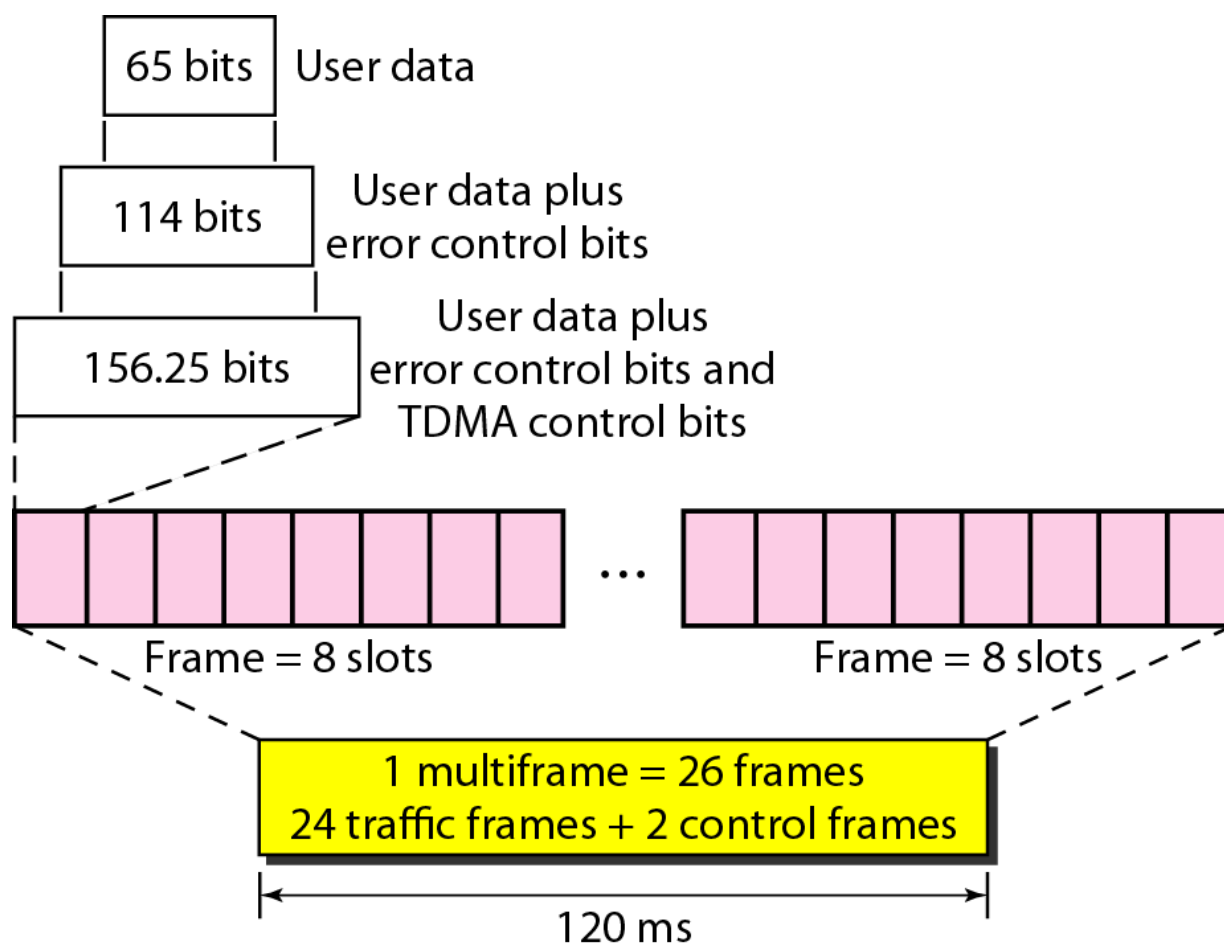
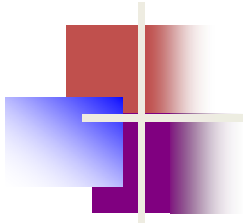


Figure 16.9 *Multiframe components*





Note

GSM is a digital cellular phone system using TDMA and FDMA.

Figure 16.10 IS-95 forward transmission

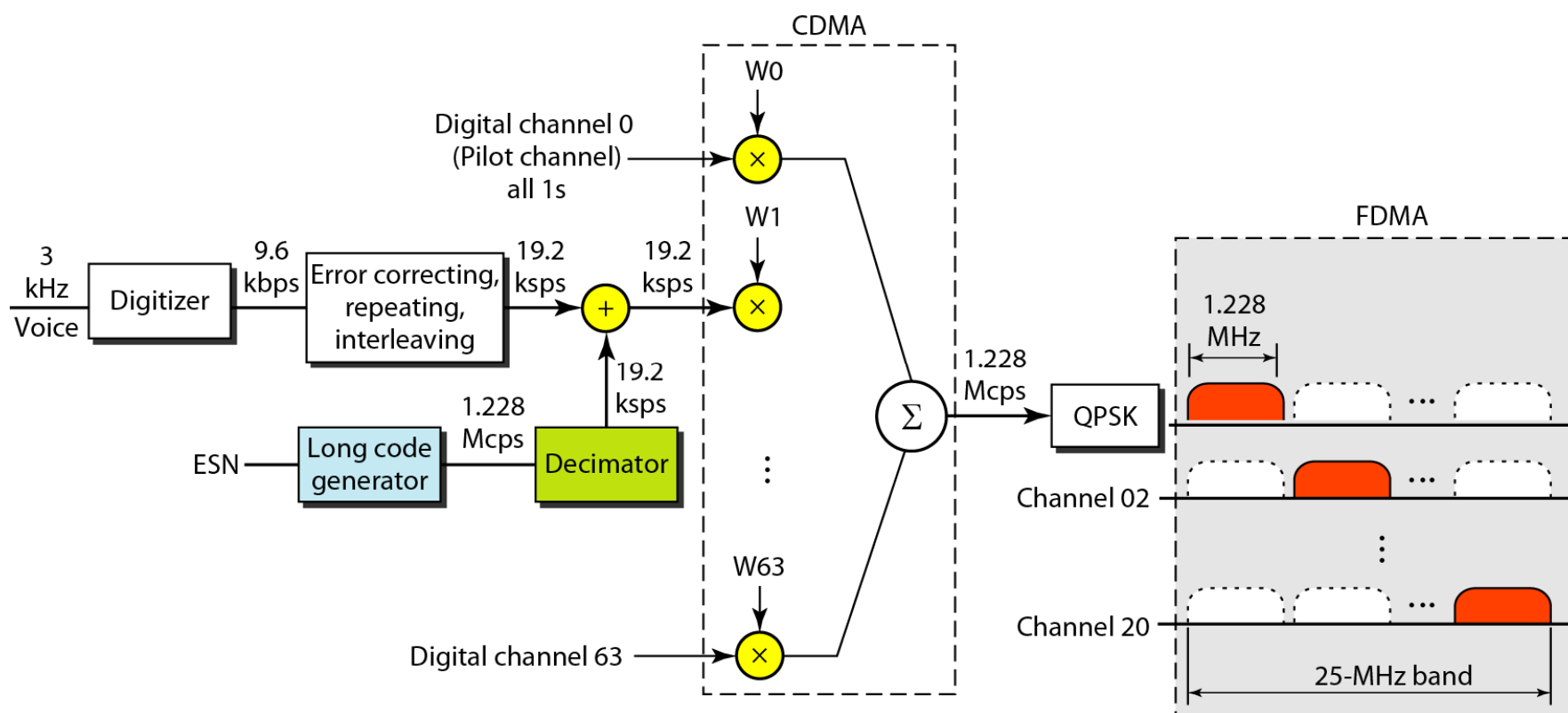
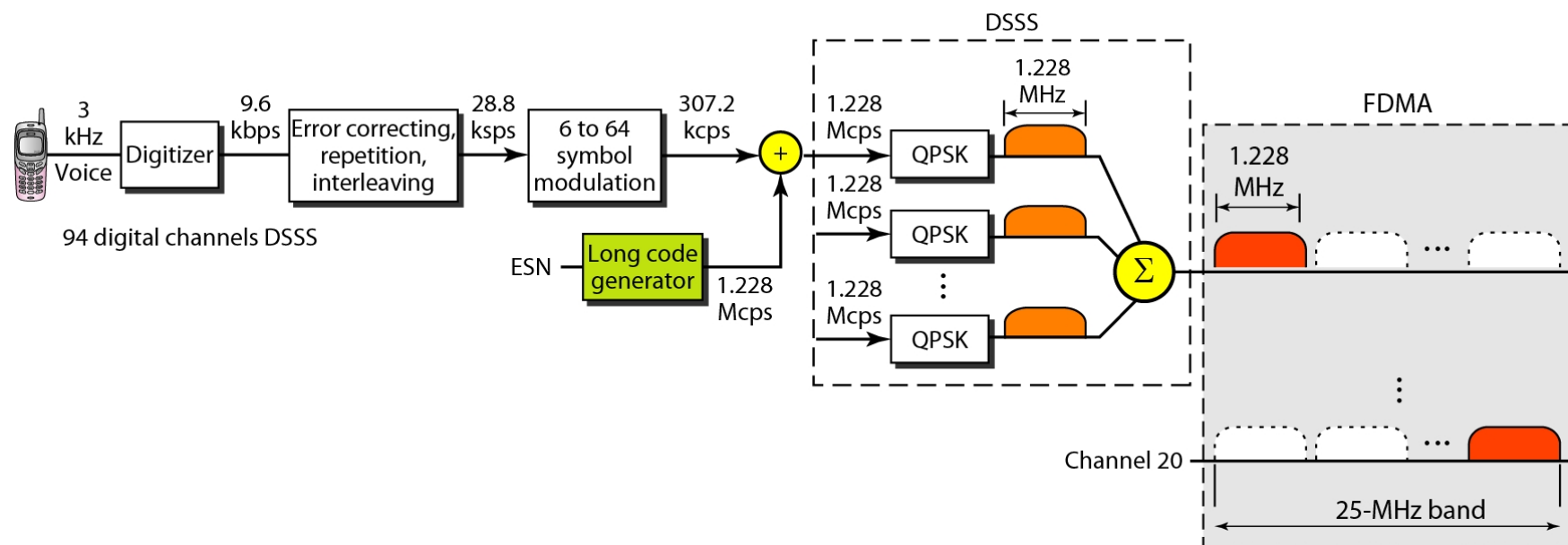
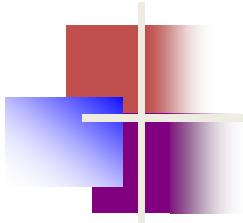


Figure 16.11 IS-95 reverse transmission





Note

IS-95 is a digital cellular phone system using CDMA/DSSS and FDMA.

Choice of Access Methods

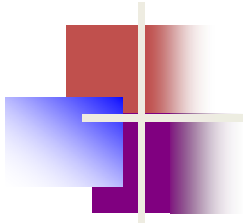
- FDM, used in 1st generation systems, wastes spectrum
- Debate over TDMA vs CDMA for 2nd generation
 - TDMA advocates argue there is more successful experience with TDMA.
 - CDMA proponents argue that CDMA offers additional features as well, such as increased range.
 - TDMA systems have achieved an early lead in actual implementations
 - CDMA seems to be the access method of choice for third-generation systems

3rd Generation Wireless

- Provide high speed wireless for voice, data, video and multimedia
- ITU's view
 - voice quality of wired
 - 144 kbps high-speed roaming / 384 kbps low-speed
 - adaptive interface to internet for asymmetric speed
 - more efficient use of spectrum
 - support wide variety of equipment, services, etc

PCS & PCN

- Personal Communications Services (PCS)
 - find person easily
 - use communication system anywhere with single account
- Personal Communications Network (PCN)
 - use terminal in wide variety of environments to connect to information services



Note

The main goal of third-generation cellular telephony is to provide universal personal communication.

Figure 16.12 *IMT-2000 radio interfaces*

