

Forouzan

Chapter 16

Wireless WANs: Cellular Telephone and Satellite Networks

16-1 CELLULAR TELEPHONY

Cellular telephony is designed to provide communications between two moving units, called mobile stations (MSs), or between one mobile unit and one stationary unit, often called a land unit.

Topics discussed in this section:

Frequency-Reuse Principle

Transmitting

Receiving

Roaming

First Generation

Second Generation

Third Generation

Figure 16.1 Cellular system

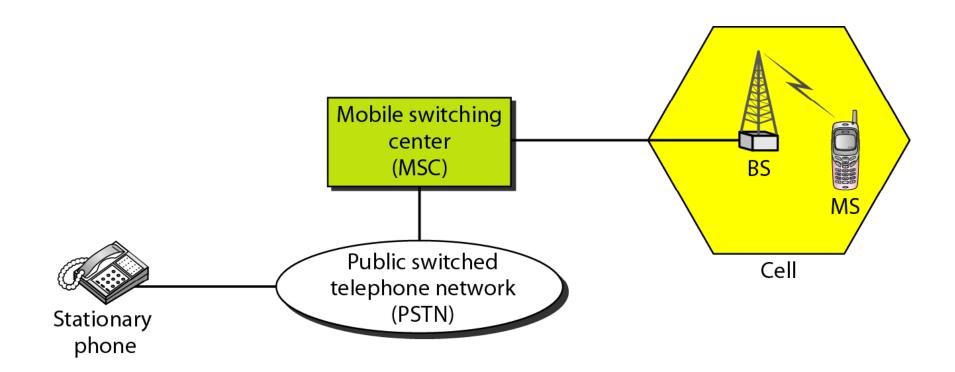
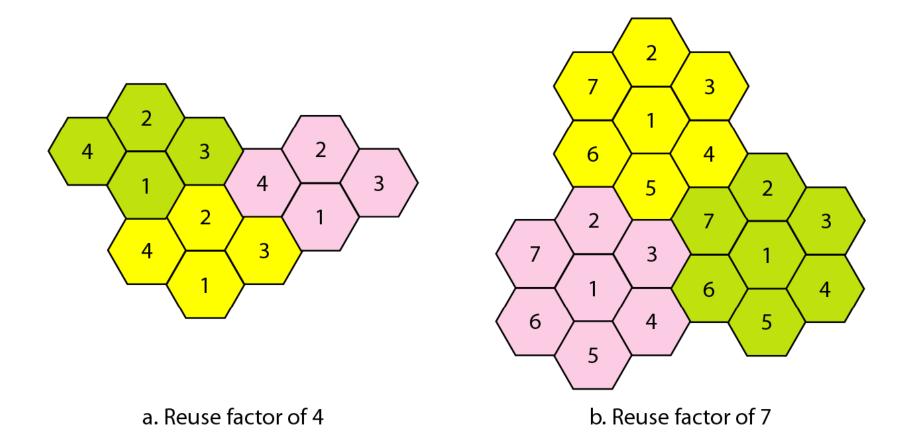


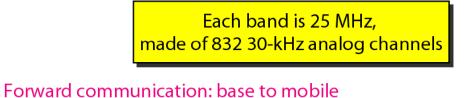
Figure 16.2 Frequency reuse patterns

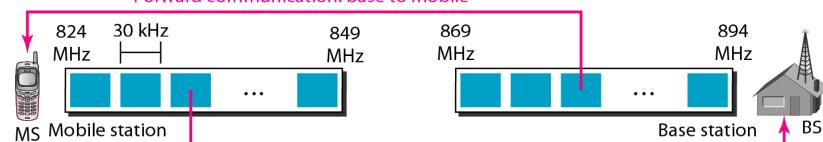




AMPS is an analog cellular phone system using FDMA.

Figure 16.3 Cellular bands for AMPS





Reverse communication: mobile to base

band

band

Figure 16.4 AMPS reverse communication band

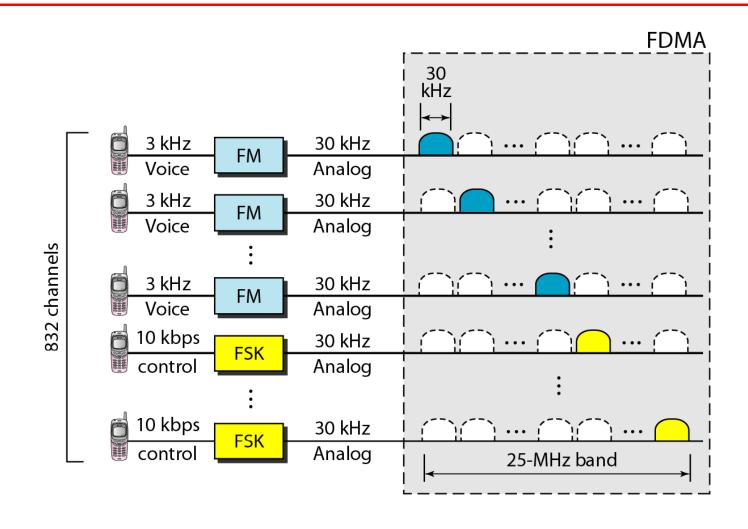


Figure 16.5 Second-generation cellular phone systems

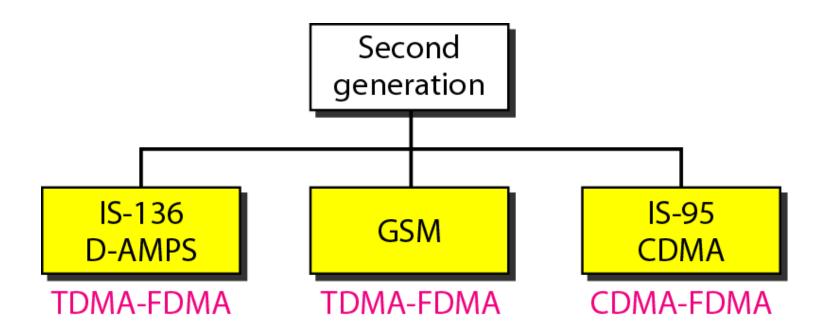
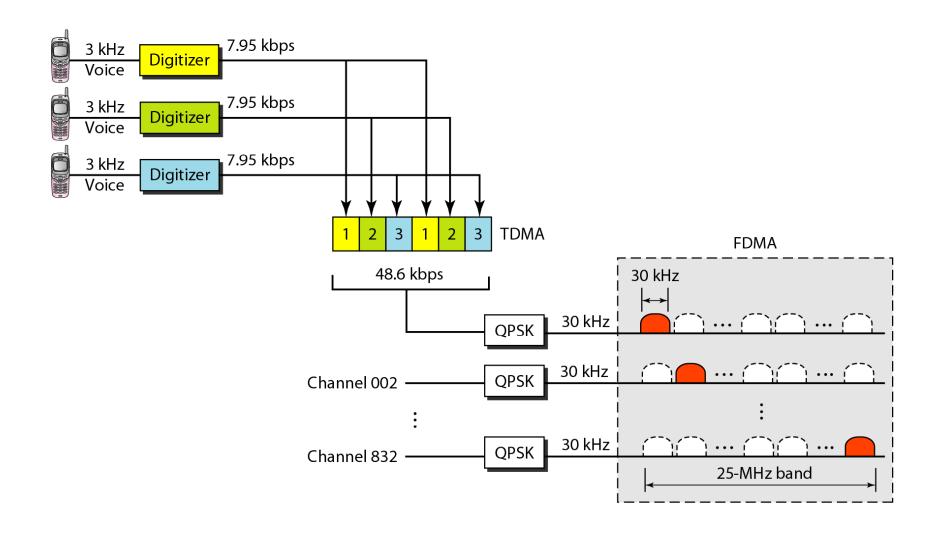


Figure 16.6 D-AMPS





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

Figure 16.7 GSM bands

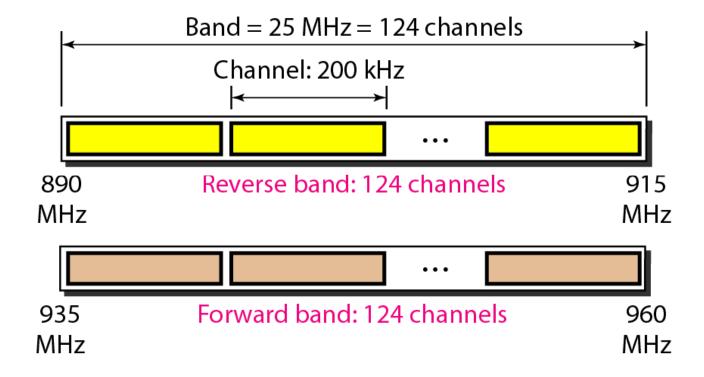


Figure 16.8 GSM

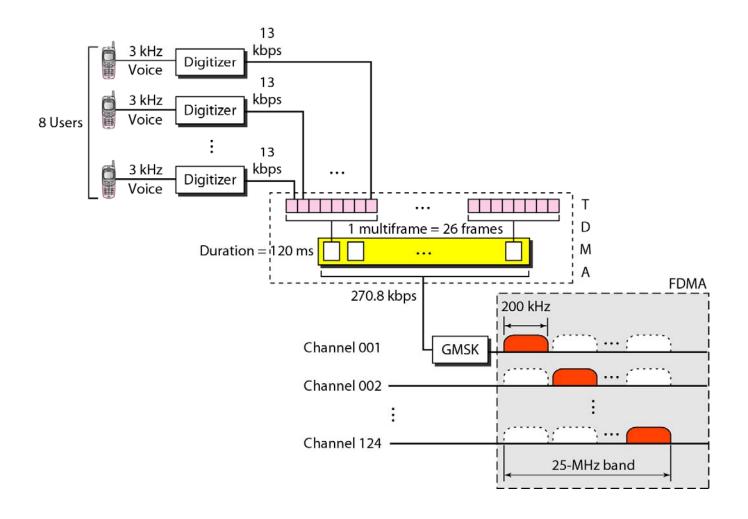
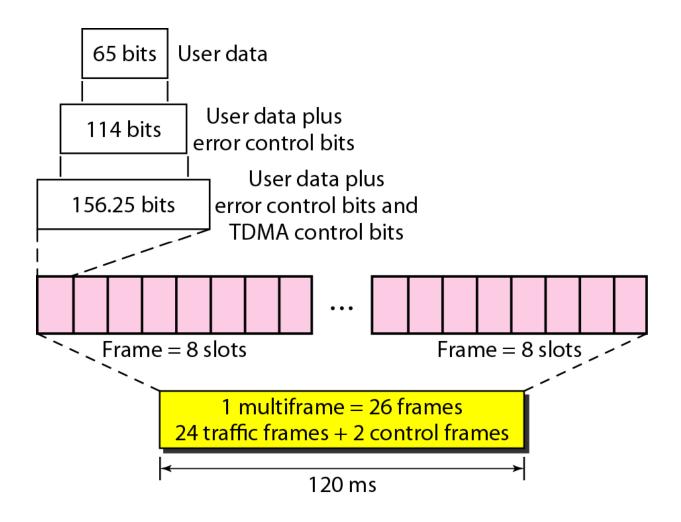


Figure 16.9 Multiframe components





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

Figure 16.10 IS-95 forward transmission

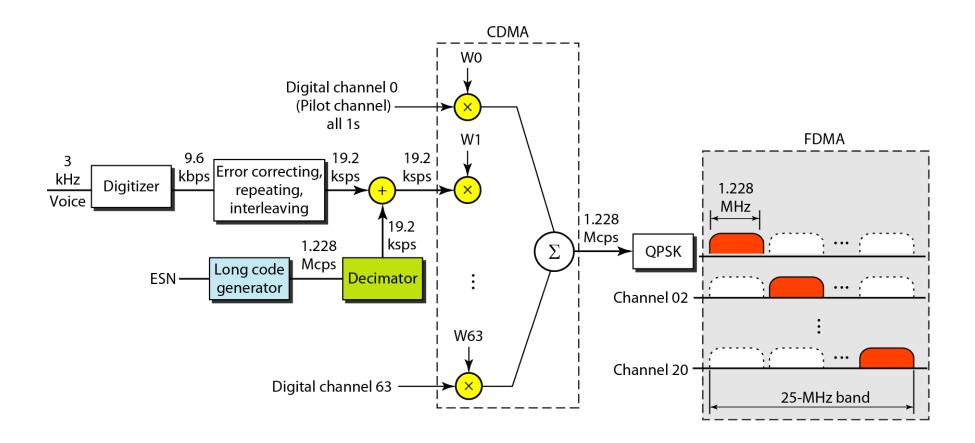
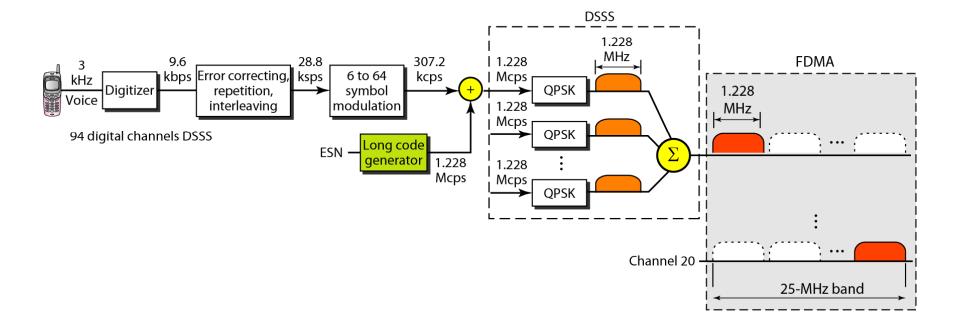


Figure 16.11 IS-95 reverse transmission



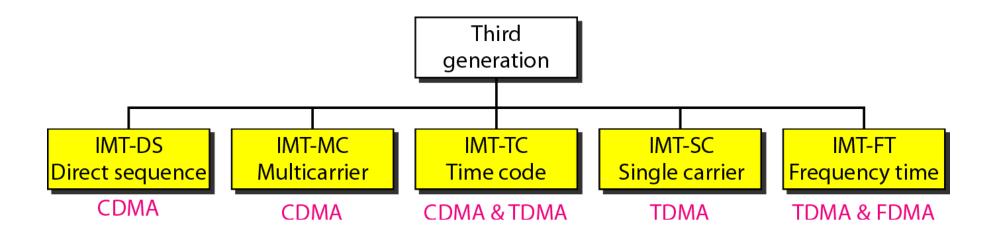


IS-95 is a digital cellular phone system using CDMA/DSSS and FDMA.



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

Figure 16.12 IMT-2000 radio interfaces



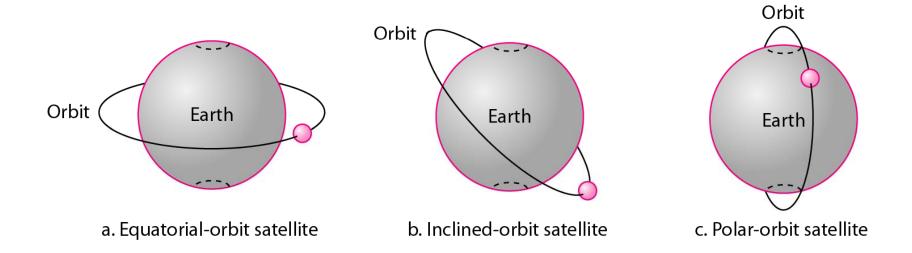
16-2 SATELLITE NETWORKS

A satellite network is a combination of nodes, some of which are satellites, that provides communication from one point on the Earth to another. A node in the network can be a satellite, an Earth station, or an enduser terminal or telephone.

Topics discussed in this section:

Orbits
Footprint
Three Categories of Satellites
GEO Satellites
MEO Satellites
LEO Satellites

Figure 16.13 Satellite orbits



Example 16.1

What is the period of the Moon, according to Kepler's law?

Period =
$$C \times \text{distance}^{1.5}$$

Here C is a constant approximately equal to 1/100. The period is in seconds and the distance in kilometers.



Example 16.1 (continued)

Solution

The Moon is located approximately 384,000 km above the Earth. The radius of the Earth is 6378 km. Applying the formula, we get.

Period =
$$\frac{1}{100}$$
(384,000 + 6378)^{1.5} = 2,439,090 s = 1 month



Example 16.2

According to Kepler's law, what is the period of a satellite that is located at an orbit approximately 35,786 km above the Earth?

Solution

Applying the formula, we get

Period =
$$\frac{1}{100}$$
(35,786 + 6378)^{1.5} = 86,579 s = 24 h



Example 16.2 (continued)

This means that a satellite located at 35,786 km has a period of 24 h, which is the same as the rotation period of the Earth. A satellite like this is said to be stationary to the Earth. The orbit, as we will see, is called a geosynchronous orbit.

Figure 16.14 Satellite categories

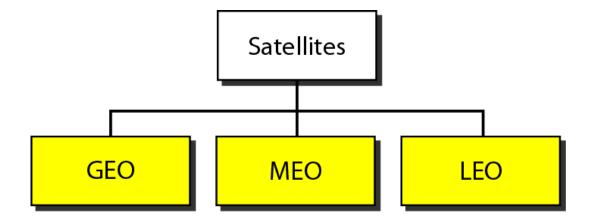


Figure 16.15 Satellite orbit altitudes

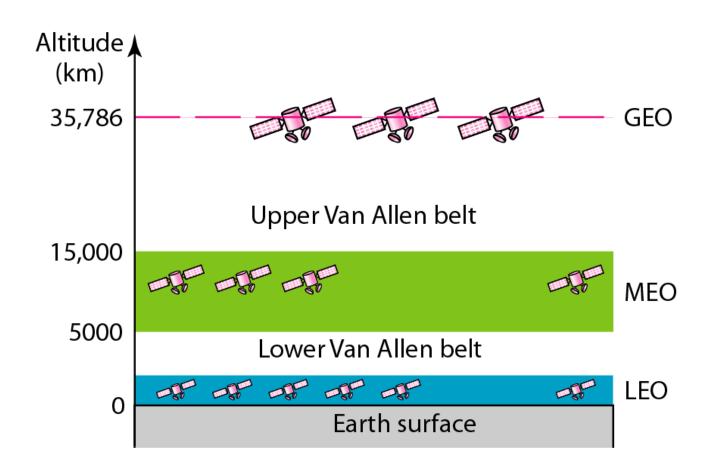


Table 16.1 Satellite frequency bands

Band	Downlink, GHz	Uplink, GHz	Bandwidth, MHz
L	1.5	1.6	15
S	1.9	2.2	70
С	4.0	6.0	500
Ku	11.0	14.0	500
Ka	20.0	30.0	3500

Figure 16.16 Satellites in geostationary orbit

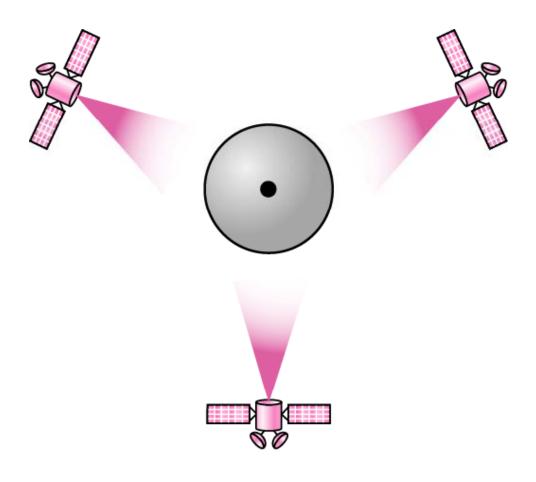


Figure 16.17 Orbits for global positioning system (GPS) satellites

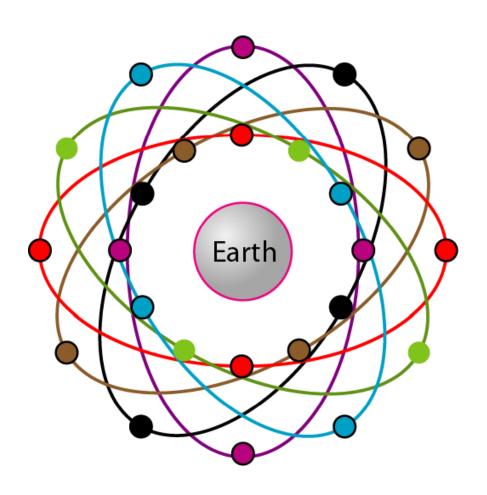
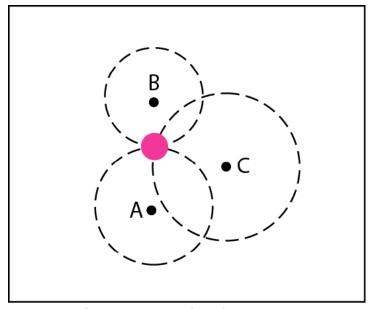
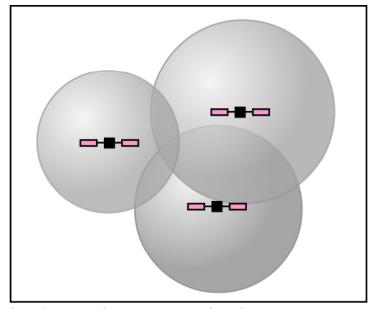


Figure 16.18 Trilateration



a. Two-dimensional trilateration



b. Three-dimensional trilateration

Figure 16.19 LEO satellite system

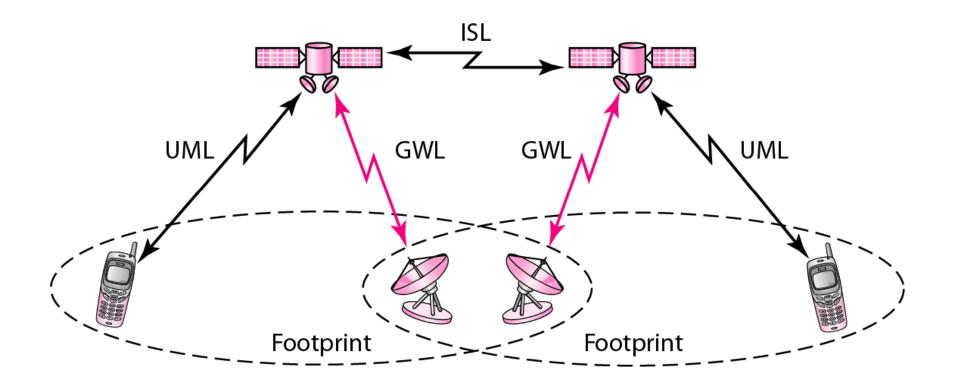
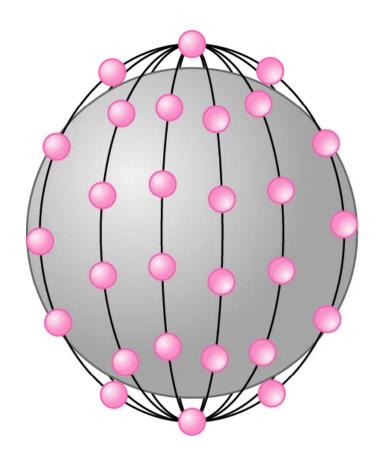


Figure 16.20 Iridium constellation



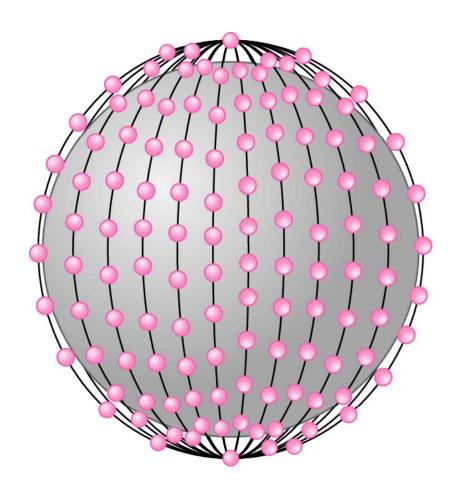


The Iridium system has 66 satellites in six LEO orbits, each at an altitude of 750 km.



Iridium is designed to provide direct worldwide voice and data communication using handheld terminals, a service similar to cellular telephony but on a global scale.

Figure 16.20 Teledesic





Teledesic has 288 satellites in 12 LEO orbits, each at an altitude of 1350 km.