# CHAPTER 16

## PRACTICE SET

## Questions

**Q16-1.** In a *hard handoff*, a mobile station communicates with only one base station. In a *soft handoff*, a mobile station communicates with two base stations at the same time.

**Q16-2.** A *mobile switching center* coordinates communications between a base station and a *telephone central office.*

**Q16-3.** WiMax defines a wireless WAN.

**a.** The *fixed WiMax* uses a star-topology to create a wireless WAN between a *base station* (BS) and some *fixed subscribed stations* (FSubs).

**b.** The *mobile WiMax* also uses a star-topology to create a wireless WAN between a *base station* (BS) and some *mobile subscriber stations* (MSubs).

**Q16-4.** A *high reuse factor* is better because the cells that use the same set of frequencies are farther apart (separated by more cells).

**Q16-5.** *D-AMPS* is a digital cellular phone system that is backward compatible with AMPS.

**Q16-6.** *AMPS* is an analog cellular phone system using FDMA.

**Q16-7.** *GPS* is a satellite system that provides land and sea navigation data for vehicles and ships. The system is also used for clock synchronization.

**Q16-8.** A footprint is the area on earth at which the satellite aims its signal.

**Q16-9.** A *mobile switching* center connects cells, records call information, and is responsible for billing.

**Q16-10.** The three orbit types are *equatorial, inclined,* and *polar.*

**Q16-11.** A *GEO* satellite has an equatorial orbit since the satellite needs to remain fixed at a certain spot above the earth.

**Q16-12.** The main difference between *Iridium* and *Globalstar* is the relaying mechanism. Iridium requires relaying between satellites. Globalstar requires relaying between satellites and earth stations.

**Q16-13.** This is the case of a *mobile WiMax*. The mobile phone communicates with a *mobile subscriber station* (MSub).

**Q16-14.** *GSM* is a European standard that provides a common second-generation technology for all of Europe.

**Q16-15.** *CDMA* encodes each traffic channel using one of the rows in the Walsh-64 table.

**Q16-16.** Transmission from the earth to the satellite is called the *uplink*. Transmission from the satellite to the earth is called the *downlink*.

**Q16-17.** A satellite orbiting in a *Van Allen belt* would be destroyed by the charged particles. Therefore, satellites need to orbit either above or below these belts.

**Q16-18.** This is the case of a *fixed WiMax*. The desktop is connected to a fixed subscriber station (FSub).

**Q16-19.**

**a.** AMPS belongs to the first generation.

**b.** D-AMPS belongs to the second generation.

**c.** IS-95 also belongs to the second generation.

# Problems

**P16-1.** *GPS* satellites are orbiting at 18,000 km above the earth surface. Considering the radius of the earth, the radius of the orbit is then (18,000 km + 6378 km) = 24,378 km. Using the Kepler formula, we have

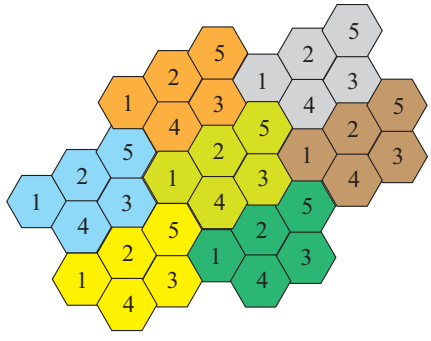
$$\text{Period} = (1/100)\ (\text{distance})^{1.5} = (1/100)\ (24{,}378)^{1.5} = 38062 \text{ s} = 10.58 \text{ hours}$$

**P16-2.** In *IS-95*, separate bands are assigned for each direction in communication. This means 20 analog channels are available in each cell (assuming no control

channels). Each analog channel carries 64 digital traffic channel (9 channels are for control). With a reuse factor of 1, we have

$$\text{Maximum number of simultaneous calls} = [(20) \times 55] / 1 = 1100$$

**P16-3.** The following figure shows one possibility.



**P16-4.** In problem P16-7, we showed that the maximum simultaneous calls per cell for *GSM* is 7936. Using the total bandwidth of 50 MHz (for both directions), we have

$$\text{Efficiency} = 7936 / 50 = 158.72 \text{ calls/MHz}$$

**P16-5.** Let us assume that WiMax uses only TDM. In each time slot, a frame is in the air. The base station fills the data to send to substation in the downstream subframe; the substations fills the data to send to the base station in the upstream subframe. Let us give a very simplified example to make the point clear. Assume that the time slot is one minute and the communication is instantaneous. This means in each minute there is a frame in the air.

**a.** During the first half of each minute, the base station is sending data to the substations and the substations are receiving data from the base station (downstream communication).

**b.** During the second half of each minute, the substations are sending data to the base station and the base station is receiving data from the substations (upstream communication).

**P16-6.** *D-AMPS* sends 25 frames per seconds in each channel. Each frame carries 6 slots. This means that the total number of slots in each channel is 150 slots/s. Each frame is shared by three users, which means each user sends 50 slots/s.

**P16-7.** In problem P16-6 we showed that the maximum simultaneous calls per cell for D-*APMS* is 356. Using the total bandwidth of 50 MHz (for both directions), we have

$$\text{Efficiency} = 356 / 50 = 7.12 \text{ calls/MHz}$$

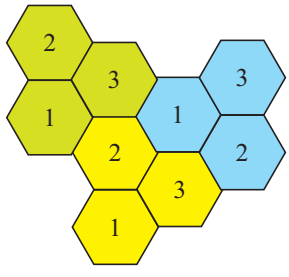
**P16-8.** *Iridium* satellites are orbiting at 750 km above the earth surface. Considering the radius of the earth, the radius of the orbit is then (750 km + 6378 km) = 7128 km. Using the Kepler formula, we have

$$\text{Period} = (1/100)\ (\text{distance})^{1.5} = (1/100)\ (7128)^{1.5} = 6017 \text{ s} = 1.67 \text{ hours}$$

**P16-9.** *In AMPS*, there are two separate bands for each direction in communication. In each band, we have 416 analog channels. Out of this number, 21 channels are reserved for control. With a reuse factor of 7, the maximum number of simultaneous calls in each cell is

$$\text{Maximum number of simultaneous calls} = (416 - 21) / 7 = 56.4 \approx 56$$

**P16-10.** The following figure shows one possibility.




**P16-11.** In *GSM*, separate bands are assigned for each direction in communication. This means 124 analog channels are available in each cell (assuming no control channels). Each analog channel carries 1 multiframe. Each multiframe carries 26 frames (2 frames are for control). Each frame allows 8 calls. With a reuse factor of 3, we have

$$\text{Maximum number of simultaneous calls} = [(124) \times 24 \times 8] / 3 = 7936$$

**P16-12.** If WiMax uses only TDM, upstream and downstream data are sent in one time slot, but the first half of the slot is occupied by the downstream data and the second half by the upstream data.

**P16-13.** *Globalstar* satellites are orbiting at 1400 km above the earth surface. Considering the radius of the earth, the radius of the orbit is then (1400 km + 6378 km) = 7778 km. Using the Kepler formula, we have

$$\text{Period} = (1/100)\ (\text{distance})\ 1.5 = (1/100)\ (7778)1.5 = 6860\ \text{s} = 1.9\ \text{hour}$$

**P16-14.** In problem P16-5, we showed that the maximum simultaneous calls per cell for *APMS* is 56. Using the total bandwidth of 50 MHz (for both directions), we have

$$\text{Efficiency} = 56 / 50 = 1.12\ \text{calls/MHz}$$

**P16-15.** A 3-KHz voice signal is modulated using FM to create a 30-KHz analog signal. As we learned in Chapter 5, the bandwidth required for FM can be determined from the bandwidth of the audio signal using the formula

$$B_{FM} = 2(1 + \beta)B.$$

*AMPS* uses $\beta + 1 = 5$. This means $BFM = 10 \times B = 30$ KHz.

**P16-16.** In *D-AMPS*, there is only one band with 832 channels. Since duplexing is provided at the digital level, this means that 832 analog channels are available in each cell (assuming no control channels). With a reuse factor of 7 and the fact that each analog channel combines three duplex digital channels, the maximum number of simultaneous calls in each cell is

$$\text{Maximum number of simultaneous calls} = [(832) \times 3] / 7 = 356.57 \approx 356$$

**P16-17.** In problem P16-8, we showed that the maximum simultaneous calls per cell for *IS-95* is 1100. Using the total bandwidth of 50 MHz (for both directions), we have

$$\text{Efficiency} = 1100 / 50 = 22\ \text{calls/MHz}$$