CHAPTER 16

Cellular Telephone and Satellite Networks

Solutions to Review Questions and Exercises

Review Questions

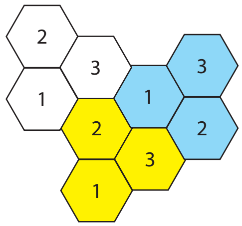
1. A ***mobile switching center*** coordinates communications between a ***base station*** and a ***telephone central office***.
2. A ***mobile switching*** center connects cells, records call information, and is responsible for billing.
3. A ***high reuse factor*** is better because the cells that use the same set of frequencies are farther apart (separated by more cells).
4. 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.
5. ***AMPS*** is an analog cellular phone system using FDMA.
6. ***D-AMPS*** is a digital cellular phone system that is backward compatible with AMPS.
7. ***GSM*** is a European standard that provides a common second-generation technology for all of Europe.
8. ***CDMA*** encodes each traffic channel using one of the rows in the Walsh-64 table.
9. The three orbit types are ***equatorial***, ***inclined***, and ***polar***.
10. A ***GEO*** satellite has an equatorial orbit since the satellite needs to remain fixed at a certain spot above the earth.
11. A ***footprint*** is the area on earth at which the satellite aims its signal.
12. 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.
13. Transmission from the earth to the satellite is called the ***uplink***. Transmission from the satellite to the earth is called the ***downlink***.
14. ***GPS*** is a satellite system that provides land and sea navigation data for vehicles and ships. The system is also used for clock synchronization.

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

16.1 EXERCISES

16. Figure 16.1 shows one possibility.

Figure 16.1 *Exercise 16*



17. ***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

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

18. 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

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

19. 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

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

20. 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

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

21. In Exercise 17, 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

Efficiency = 56 / 50 = **1.12 calls/MHz**

22. In Exercise 18, 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

Efficiency = 356 / 50 = **7.12 calls/MHz**

23. In Exercise 19, 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

Efficiency = 7936 / 50 = **158.72 calls/MHz**

24. In Exercise 20, 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

Efficiency = 1100 / 50 = **22 calls/MHz**

25. 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 $\beta = 5$. This means $\mathbf{B_{FM} = 10 \times B}$.
26. ***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.**
27. ***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

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

28. ***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

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

29. ***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

Period = (1/100) (distance) $^{1.5}$ = (1/100) (7778)$^{1.5}$ = 6860 s = **1.9 hours**