
CHAPTER 16

Cellular Telephone and Satellite Networks

Solutions to Odd-Numbered Review Questions and Exercises

Review Questions

1. A *mobile switching center* coordinates communications between a *base station* and a *telephone central office*.
3. A *high reuse factor* is better because the cells that use the same set of frequencies are farther apart (separated by more cells).
5. *AMPS* is an analog cellular phone system using FDMA.
7. *GSM* is a European standard that provides a common second-generation technology for all of Europe.
9. The three orbit types are *equatorial*, *inclined*, and *polar*.
11. A *footprint* is the area on earth at which the satellite aims its signal.
13. Transmission from the earth to the satellite is called the *uplink*. Transmission from the satellite to the earth is called the *downlink*.
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

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

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

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

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

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

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

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

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

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 $B_{\text{FM}} = 2(1 + \beta)B$. **AMPS** uses $\beta = 5$. This means $B_{\text{FM}} = 10 \times B$.

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 $(18,000 \text{ km} + 6378 \text{ km}) = 24,378 \text{ km}$. Using the Kepler formula, we have

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

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 $(1400 \text{ km} + 6378 \text{ km}) = 7778 \text{ km}$. Using the Kepler formula, we have

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