Chapter 2: Exercises for media and satellite communications (Solutions)

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1. If the SNR of a $20MHz$ Wi-Fi channel is $33dB$, what is the maximum data rate?

   Solution: $33dB$ means the power ratio is about 2000. Using the Shannon theorem, the maximum data rate is

   $$20 \times \log_2(1 + 2000)Mbps \approx 219Mbps$$

2. A single-layer blue-ray DVD can store 25GB. Estimate the equivalent data rate if you send 20 blue-ray DVD disk from Puerto Rico to New York, and the package is delivered in 48 hours.

   Solution:

   $$\frac{20 \times 25 \times 8\ Gbits}{48 \times 3600\ seconds} \approx 23.1Mbps$$

3. What is the propagation delay of light signal passing a 1000km long optical fiber?

   Solution: The speed of light in optical fiber is about $200km/ms$.

   $$\frac{1000\ km}{200\ km/ms} = 5ms$$

4. Find five transoceanic cables connecting Puerto Rico with other parts of the world. For each of them, you shall list the operator, location of adjacent node, length of cable, and capacity.

   Solution: N/A

5. In many antenna designs, the size of antenna is the same as the wavelength of signal. In such design, determine the size of an antenna for $2.4GHz$ signal and the size of an antenna for 60GHz signal.

   Solution:

   For $2.4GHz$ signal

   $$\lambda = \frac{v}{f} = \frac{3 \times 10^8\ m/s}{2.4 \times 10^9\ 1/s} = 0.125\ m = 12.5\ cm$$

   For $60GHz$ signal

$$\lambda = \frac{v}{f} = \frac{3 \times 10^8 \ m/s}{60 \times 10^9 \ 1/s} = 0.005 \ m = 5 \ mm$$

6. Suppose the distance between a Wi-Fi access point (AP) and a smartphone is 200 meters, what is the propagation delay for signal to travel from AP to smartphone?

   Solution:

   $$\frac{200 \ m}{3 \times 10^8 \ m/s} \approx 0.67 \mu s$$

7. A survey about the Iridium system.

   (a) What is the company that is operating the Iridium system now?

   (b) What is the website url?

   (c) Find the price for a typical phone and the cost for communication per minute.

   (d) What is the Iridium Next project?

8. A study for SpaceX's Internet-satellite plan. Try your best to find answers or justify possible answers.

   (a) How many satellites will be deployed?

   (b) What is the altitude of orbits for the satellites?

   (c) What is the frequency band used?

   (d) What is the expected data rate for a typical link?

   (e) How much power is necessary for the user terminal?

   (f) How much shall a user pay monthly?