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Computer comm networks

HW 2

1. If a binary signal is sent over a 3-kHz channel whose signal-to-noise ratio is 20 dB, what is the maximum achievable data rate? How about when the chanel is noise free. Problem 4, page 187 of the text.

    a. So , signal to noise ratio implies that, 10 $\log_{10}$ (S/N)=20 => $\log_{10}$ (S/N) = 2 => S/N = 10^2 = 100
    b. Then we use max data rate = B $\log_2$ (1 + S/N) bits/sec = (3000 Hz) $\log_2$ (1 + 100) bits/sec = (3000 Hz) $\log_2$ (101) bits/sec = (3000) (6.643) bits/sec = 19.92 kbps.
    c. **So , the final max data rate is 19.92 kbps , no real “best” noise to signal ration , it can really be increased almost indefinably. Around 41dB + is really good. , data rate increases as signal to noise does.**

2. Calculate the end-to-end transit time for a packet for both GEO (altitude: 35,800 km), MEO (altitude: 18,000 km) and LEO (altitude: 750 km) satellites. Speed of light = 300,000 km/s. Problem 13, page 188 of the text.

    a. Formula for end to end transit time:
        1. Transit time = 2xaltitude/speed of light (in a vacuum)

    b. **Substitute given values for altitude and we get roughly:**
        a. **2x 35k km / 300k km/sec = 239 milliseconds. = geo earth orbit**
        b. **2x 18k km / 300k km/sec = 120 milliseconds = medium earth orbit**
        c. **2x 750 km / 300k km/sec = 5 milliseconds = low earth orbit**

3. Ten signals, each requiring 4000 Hz, are multiplexed onto a single channel using FDM. What is the minimum bandwidth required for the multiplexed

channel? Assume that the guard bands are 400 Hz wide. What is maximum achievable data rate per channel with 8-level signals ? Problem 25, page 189 of the text.

a. Calculate minimum bandwidth:
    1. 1 less signal required to avoid interference.
    2. 9 total guard bands needed.
    3. Formula = min bandwidth = number of signals x bandwidth of signal + number of signals -1 x guard band
    4. 10*4000 Hz + (10-1)*400 Hz
    5. Or **43,600 Hz min**
    6. Formula for maximum data rate = 2 x bandwidth of signal x log2(number of levels)
    7. 2 x 4000 x Hz x log2(8)
    8. **24k Hz max**

4. What is the percent overhead on a T1 carrier? That is, what percent of the 1.544 Mbps are not delivered to the end user? Problem 27, page 189 of the text.

    a. T1 carrier = 24 channel , a single channel has 8 bits.
    b. 7 bits are data and one is for control , that is not delivered to end user.
    c. Bit 1 = framing code not delivered to user.
    d. So in total there are 25 bits not delivered to user
    e. **Therefore the percent not delivered to user is (25 x 8000 / 1544000) x 100% = 12.95 %**

5. In a typical mobile phone system with hexagonal cells, it is forbidden to reuse a frequency band an adjacent cells. However, non-adjacent cells can use the same frequency. If 840 frequencies are available, What is the maximimum number of requencies a given cell can use in a 7-cell cluster? Problem 40, page 190 of the text.

a. Formula = number of frequency used in each cell without reusing
   = number of available frequency / number of unique cells.
b. So 840/3
c. **280 frequencies per cell.**