Michael J. Sepcot
CS455 – Data Communications
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Assignment 2

1. Explain the terms "signal propagation delay" and "transmission delay". Assuming the velocity of propagation of an electrical signal is equal to the speed of light, determine the ratio of the signal propagation delay to the transmission delay, a, for the following types of data link and 1000 bits of data.

Signal Propagation Delay: the lag time between a signal being sent at a source and arriving at the destination.

$$T_P = \frac{Separation}{Velocity}$$

Transmission Delay: the time it takes to transmit a frame over a given link bit rate.

$$T_X = \frac{numBits}{BitRate}$$

(i) 100 m of UTP wire and a transmission rate of 1 Mbps,

$$a = \frac{T_P}{T_X} = \frac{100m / 3.0*10^8 m/s}{1000bits / 1*10^6 bits/s} = \frac{3.33*10^{-7}}{0.001} = 3.33*10^{-4}$$

(ii) 3 km of coaxial cable and a transmission rate of 10 Mbps,

$$a = \frac{T_P}{T_X} = \frac{3000m / 3.0*10^8 m/s}{1000bits / 10*10^6 bits/s} = \frac{1.0*10^{-5}}{1.0*10^{-4}} = 0.1$$

(iii) 50,000km satellite link and a transmission rate of 512 kbps.

$$a = \frac{T_P}{T_X} = \frac{5*10^7 m / 3.0*10^8 m/s}{1000bits / 512*10^3 bits/s} = \frac{0.1667}{0.00195} = 85.33$$

2. Assuming 8 signal levels are used to transmit a data bitstream of 20 kbps, derive

(i) the number of bits per original element, and

$$m = \log_2 M = \log_2 8 = 3 bits/element$$

(ii) the signaling rate in baud.

$$R = R_S \log_2 M \rightarrow R_S = \frac{R}{\log_2 M} = \frac{20000 bits/s}{\log_2 8} = 6666.667 baud$$

3. Explain why the binary sequence 101010 … is referred to as the worst-case sequence when deriving the minimum bandwidth requirements of a transmission line/channel.
The "10" sequence is the sequence that yields the shortest period and the highest fundamental frequency component.

4. Derive the minimum channel bandwidth required to transmit at the following bit rates assuming (a) the fundamental frequency only and (b) the fundamental and third harmonic of the worst-case signal are to be received:

$$f_0 = \frac{R}{2}$$

(i) 500bps,

a. 500 / 2 = 250; 0-250Hz **b. 0-750Hz**

(ii) 2000bps,

a. 2000 / 2 = 1000; 0-1000Hz **b. 0-3000Hz**

(iii) 1Mbps.

a. 1000000 / 2 = 500000; 0-500000Hz **b. 0-1.5MHz**

5. A modem to be used with a PSTN uses 4 levels per signaling element. Assuming a noiseless channel and a bandwidth of 2000 Hz, derive the Nyquist maximum information transfer rate in bps.

$$C = 2W \log_2 M = 2 * 2000 * \log_2 4 = 8000 bps$$