Homework 1

Due: 25 September 2014, 11:59pm

Question 1 - Error correction/Detection and Modulation

a. Suppose there is a code that adds three bits to every bit pair: a copy of the original two bits and a parity bit. For example, 01 becomes 01011, and 11 becomes 11110. How many bit errors can this code detect? How many bit errors can this code correct (*i.e.*, what is the largest k such that the code can correct all possible k-bit flips)? Justify your answer.

b. We saw an example in class of the limits of data transmission rates in a telephone line with 3KHz bandwidth. If the SNR is 30.2dB, how many bits per sample (M) can we encode with a modulation scheme? If we wanted to use a scheme that encodes 64 bits per sample, what's the minimum value of the SNR in dB? How many times more powerful would the transmitter have to be to achieve this, if the line noise is kept constant?

Question 2 - Reliability in lower versus higher layers

a. Suppose you have a network with 4 wireless links between A and B, and that every packet sent in these links has a uniform and independent chance of being dropped of 10% (*i.e.*, a 90% chance of making it through). (*Hint*: in these problems, sometimes the probability of the complement of an event is much easier to calculate).

   (a) What is the chance that a packet will not make it through the 4 links?

   (b) Now let us add acknowledgments at each of these links, such that a packet will be dropped after 3 failed retransmissions. What is the probability that a packet will be dropped at a single link (*i.e.*, that it will fail after three attempted retransmissions?) Assume the acknowledgments can also be dropped with the same probability of 10%.

   (c) Using the result from the calculation above, what is the chance that a packet will arrive at B, if all four links are using up to 3 retransmissions?

b. In class we mentioned that some link layers will do acknowledgment and retransmissions up to a limited amount of times. Why is this done, if TCP already provides reliability?

Question 3 - Ethernet

a. Ethernet uses a randomized protocol for multiple stations to share the medium. What are some advantages of this protocol over a reservation-based protocol such as TDMA?

b. When would TDMA be a better choice and why?

c. Assuming that attenuation were not a problem, why would it be problematic to increase the maximum length of an Ethernet segment much beyond 2,500m?