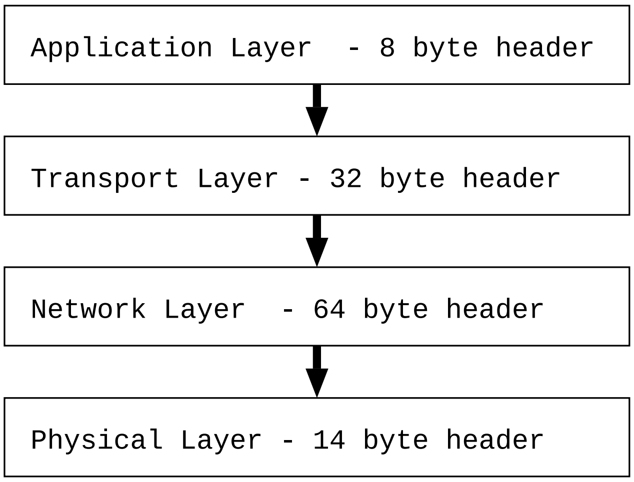
CPS 470/570: Homework 1 Due Thursday September 13, 1995

Please use additional paper as necessary. When answering questions, please state any and all assumptions you are making.

Part 1: Layering and Efficiency

One of the measures of the *goodness* of a set of protocols is the efficiency with which the protocols can utilize the underlying communications system. One characteristic of protocols that affects their efficiency is the amount of overhead introduced through additional protocol specific traffic. In this case, efficiency is measured as the ratio of the amount of data transferred to the total number of bytes transferred.
Consider the following four-layer protocol stack. Each protocol introduces some fixed amount of additional information by adding a protocol specific header to the data being transmitted.



Assuming that all protocol headers are added to all traffic that is sent, what is the efficiency of this protcol for sending 1 byte of user data. Compare this to 10 bytes of user data, 1000 bytes of user data and 1,000,000 bytes of user data?
Note: For this problem, assume that the underlying layers can transmit infinite message sizes. As we will see later, this is not a valid real-world assumption. It just makes life easier for this problem.

Part 2: Topologies

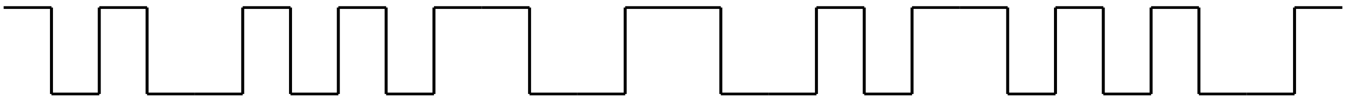
1. In a fully connected network, every node has a dedicated connection to every other node. What is the total number of lines L, for a network of $N = \{2, 10, 100, 1000\}$ nodes? For each value of N, how many connection endpoints are needed at each node?

2. As you can see from the answer to the previous question, a fully connected network is a only practical for a small number of nodes. Instead, we usually prefer a shared network.

   What must we do in order to share a physical connection between multiple hosts? What are the problems that this presents?

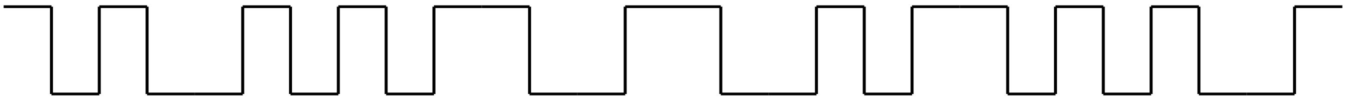
Part 3: Encodings

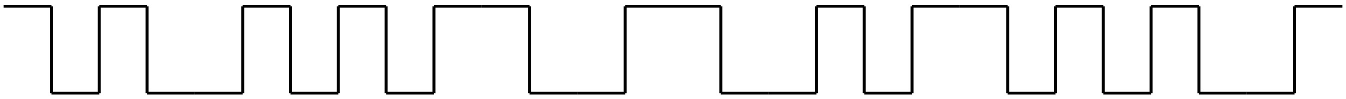
1. Give NRZ-L,NRZ-I,Manchester, and Differential Manchester encodings of the following bit sequence: 1 0 1 1 0 0 0 1
2. Imagine that you are a digital decoder and you receive the following sequence of pulses. List **all** of the things you must know in order to decode this sequence?



3. Now, go ahead and make assumptions for these things and decode the message. Using the 7-bit ASCII table on page 99 of Halsall, what are the character(s) encoded in this message?

   Here are some more copies of the stream to experiment with.





Part 4: Analog/Digital

1. Estimate the number of bits stored in a music compact disc (CD). Your estimate should be based on the following:
   (a) the original analog signal contains 2 channels (left and right), each with a maximum frequency of 20 kHz.
   (b) the sampled signal is quantized into one of 65536 quantization levels (16 bit samples).
   (c) The CD contains 60 minutes of music.
2. If rather than storing the digitized signal above, we would like to transmit it, answer the following:
   (a) What would the data rate required be?
   (b) Assuming a noiseless channel with a single bit per signalling unit, what is the minimum channel bandwidth required to carry the signal?
   (c) Compare the answer in b) above to the bandwidth required to carry the original analog signal. What happened?