KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
COLLEGE OF COMPUTER SCIENCES & ENGINEERING

COMPUTER ENGINEERING DEPARTMENT

COE 540 – Computer Networks
Assignment 1 – Due Date Nov 30th, 2008

Problem 1 (30 points): On the channels and modems

a) If a channel impulse function, $h(t)$, compute the channel response, $r(t)$, for an input signal $s(t)$. $h(t)$ and $s(t)$ are specified by

$$h(t)=\begin{cases}\alpha e^{-\alpha t} & t\geq 0\\ 0 & \text{otherwise}\end{cases},\ \text{and}\ s(t)=\begin{cases}1 & 0\leq t\leq T\\ 0 & \text{otherwise}\end{cases}$$

Using the graphical method for computing the convolution as explained in class. Show your work.

b) If a data sequence, given by [1 1 1 -1 1 1 -1 -1 -1], is encoded using s(t), i.e. using Non-Return to Zero (NRZ) encoding scheme. Plot the channel output signal. Assume the one bit is sent every T seconds.

c) Discuss the effect of α on ISI.

Problem 2 (30 points): On the Subject of Framing

Suppose that the string 0101 is used as the bit string to indicate the end of a frame and the bit stuffing rule is to insert a 0 after each appearance of 010 in the original data. Thus 010101 would be modified by stuffing to 01001001. In addition, if the frame proper ends in 01, a 0 would be stuffed after the first 0 in the actual termination string 0101.

a) Show how the string 11011010010101011101 would be modified by this rule.

b) Describe the destuffing rule required at the receiver.

c) How would the string 11010001001001100101. be destuffed?

Problem 3 (40 points): On the subject of Parity and Error Detection

Consider the CRC procedure explained in class and illustrated in the textbook.

a) Show that if $g(D)$ is chosen as a primitive polynomial of degree L, and the frame length is restricted to be at most 2^L-1, then all double errors are detected?

b) Prove that if the generator polynomial $g(D)$ has a factor of $(1+D)$, then ALL sequences of ODD number of errors are detected.

c) Describe the practical guidelines for choosing a good generator polynomial g(D). What are the properties of such code in terms of minimum distance, burst detecting capability, and probability of undetectable errors.

d) Let $g(D) = D^4+D^2+D+1$, and the data string $s_3s_2s_1s_0$ = 1011. Compute the transmitted frame x.

Hint: *Refer to the textbook pages 63 and 64.*

Problem 4 (30 points): On the subject of Automatic Repeat Request

(1) Prove the correctness of the generalized stop-and-wait algorithm described in textbook.

(2) Explain how does ARPANET ARQ extends the stop-and-wait algorithm to achieve higher efficiency.

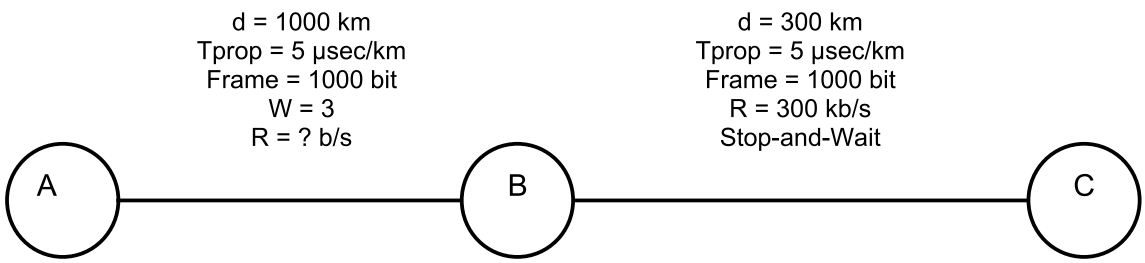
(3) For what circumstances, selective reject is deemed more efficient and an improvement over go-back N.

Problem 5: (30 points): On the Subject of Performance of ARQ

It is desired to DESIGN a communication link from Qaurayyat (A) to Riyadh (B) and from Riyadh (B) to Dammam (C). The figure below shows three nodes: A, B, and C connected using two links. If link AB operates sliding window protocol with $W = 3$, while the link BC operates a stop-and-wait protocol. Ignore acknowledgments and processing time.

a) Calculate the maximum rate at which link AB will be operating at 100% utilization.

b) If the link BC is operating at extremely high bit rate, calculate the maximum rate that can be assigned for link AB such that the buffers at node B do not over flow.



Problem 6 (30 points): On the subject of Maximum Frame Size

Consider a stream-type traffic produced by a source at rate R bits per second. It traverses a path in the network where the capacities of the traversed links along the path are given by C_1, C_2, …, C_n where $C_i > R$ for $i = 1, 2, \ldots, n$. If these links handle payloads of at most K data bits with an added V bits for overhead. Define the network delay to be the time from when the given bit enters the network until it leaves.

a) Develop an expression for the total delay defined to be the time from generation of first bit till the time first bit arrives at destination. Assume no queueing at the nodes along the path.

Hint: assume $(K+V)/C_i \leq R/K$, i.e. each link can transmit frames as fast as they are generated.

b) Is it better to choose K large or small? Discuss in relation to the capacity of the links C_i, and the delay expression developed in (a).

c) What is the argument for limiting the maximum packet length on the network?

Problem 7 (20 points): On the subject of Framing and Entropy

Assume frame length K, in bytes, is geometrically distributed with parameter p. That is the probability of frame length K equal to i is given by

$$\mathrm{Prob}\left[K = i\right] = p\left(1-p\right)^{i-1}$$

for $i = 1, 2, \ldots, \infty$.

a) Compute the minimum number of bits required to encode the frame length information. Provide a plot for this minimum as a function of the parameter p.

b) Explain the unary-binary encoding. What is the expected overhead for unary-binary encoding?