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

COMPUTER ENGINEERING DEPARTMENT

COE 540 – Computer Networks / ICS 570 Advanced Computer Networking
Assignment 1 – Due Date March 25th, 2008

Problem 1 (10 points): On the subject of signals and channels

Suppose a channel has the ideal low-pass frequency response $H(f) = 1$ for $-f_0 \leq f \leq f_0$ and $H(f) = 0$ elsewhere. Find the time domain impulse response of the channel, $h(t)$. Plot the $h(t)$ and identify the zero crossing points.

Problem 2 (1 points): On Framing, and Segmentation and Reassembly

Consider a data link control using fixed-length packets of K bits each. Each message is broken into packets using fill in the last packet of the message as required. For example, a message of 150 bits is broken into two packets of 100 bit each; using 50 bits of fill.

a) In a manner similar to the development of equations 2.42 and 2.43 in the textbook, write an expression for the number of bit transmission times required for message delivery, TC.

b) Compute the expectation for the number of bit transmission times required for message delivery, $E\{TC\}$.

Hint: $E\{\lceil M/K \rceil\} = E\{M/K\}+1/2$.

c) Find the value of K that minimizes $E\{TC\}$.

Problem 3 (15 points): On the subject of Parity and Error Detection

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

a) What is the necessary and sufficient condition for an error pattern $e(D)$ to be undetectable?

b) Prove that if the generator polynomial $g(D)$ has at least two non-zero terms (i.e. D^L and 1), then ALL SIGNLE bit errors are detected by the corresponding CRC code.

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

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

Problem 4 (20 points): On the subject of Parity and Error Detection

The effectiveness of a code for error diction is usually measured by three parameters:

(1) the minimum distance of the code,

(2) the burst-detecting capability, and

(3) the probability that a completely random string will be accepted as error-free.

a) (5 points) Define the terms: code, code word, burst-detecting capability.

b) (5 points) What is the burst-detecting capability for single parity checks, and for horizontal and vertical parity checks?

c) (10 points) Consider a simple party checking coding depicted in Figure

s1	s2	s3	c1	c2	c3	c4

s1, s2, and s3 are the *arbitrary* data bit while c1, c2, c3, and c4 are the parity bits calculated as: c1 = s1+s2+s3; c2 = s2+s3, c3 = s1+s3, and c4 = s1 + s2. List all the possible code words and find the minimum distance for this code. How many errors can this code correct?

Problem 5: (20 points): On the subject 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 links AB and BC both operate sliding window control protocols with W = 7.

a) (5 point) Plot the utilization of the link AB as a function of the unknown bit rate R. What is the limit of utilization as the link rate R approach infinity? Why?

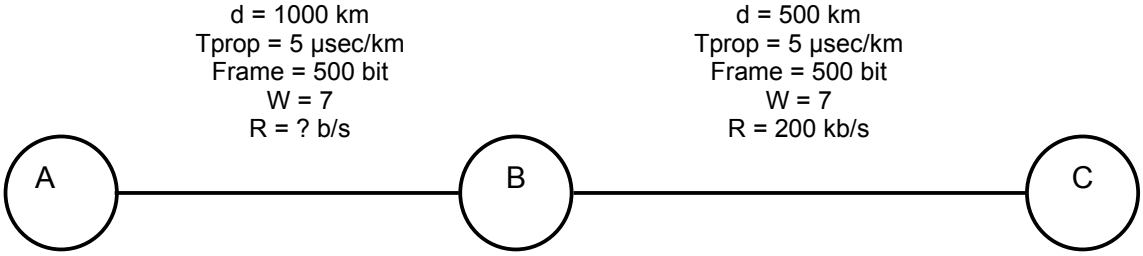
b) (5 points) Plot the throughput in bits per second of the link AB as a function of the unknown bit rate R. What is the limit of throughput as R tends to infinity?

Hint: for parts (a) and (b), ignore the link BC.

c) (5 points) What is the maximum data rate R for link AB such that the receive buffer at node B does NOT overflow.

Assume: all links operate full-duplex lines and error free channels. The data frame is 1000 bit long. Furthermore, ACK frames are separate frames of 100 bits in length and ignore the processing time for data and acknowledgment frames.

d) (5 point) Repeat (c) assuming the link bit rate from Riyadh (B) to Dammam (C) is 400 kb/s



Problem 6 (15 points): On the subject of ARQ

To prove the *correctness* of the Go-Bck-N ARQ algorithm, the textbook proves the *safety* and the *liveness* of the algorithm.

a) (5 points) What is meant by the safety and liveness of a retransmission algorithm?

b) (5 points) Sketch the main steps in the livness proof for the Go-Back-N algorithm? Do not reproduce the proof; Just illustrate the main point or steps needed for the proof. Refer to the textbook.

c) (5 points) For the generalized Go-Back-N explained in the textbook, show how retransmission of frames can still occur even on an error-free link.