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

COMPUTER ENGINEERING DEPARTMENT

COE 540 – Computer Networks / ICS 570 Advanced Computer Networking
Assignment 2 – Due Date Nov 13th, 2007

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

If a channel impulse function, $h(t)$ is given by $h(t)=\begin{cases}\alpha e^{-\alpha t} & t\geq 0\\ 0 & \text{otherwise}\end{cases}$, compute the channel response for an input signal s(t) specified by $s(t)=\Pi\left(\left(t-T/2\right)/T\right)$, where $\Pi\left(t/\Delta\right)$ is a square pulse centered at t = 0 and has a width of Δ units. Plots the resulting response for T = 1 and α = 2 and compare to Fig. 2.3 (a).

Problem 2 (10 points): On channel capacity (Nyquist and Shannon Theorems)

Consider a GSM mobile channel whose bandwidth is equal to 200 kHz. The current implementation of GSM uses a modem technology that achieves a channel bit rate equal to 273. kb/s.

a) Ignoring noise and interference, what is the theoretical capacity limit on the GSM channel?

b) Accounting for noise and interference and considering a working GSM system whose SNR is equal to 14 dBs, what is the theoretical capacity limit on the GSM channel?

c) Given the limit specified in (b), what is the efficiency of the current implementation?

d) One important figure of merits for transmission on channels is the "spectral efficiency". This is simply the number of bits per second achieved per hertz. Compute this figure for current implementation and for the theoretical limit computed in (b).

e) For the working system whose SNR is equal to 14 dB, what is the $E_b/N0$ figure?

Problem 3 (15 points):

Consider a CRC error detection scheme with $g(D)=D^4+D+1$.

a) Encode the bits 10010011011.

b) Suppose the channel introduces the error pattern 100010000000000 (i.e. a flip from 1 to 0 or from 0 to 1 in the positions 1 and 5). What is the received frame? Can the error be detected?

c) Repeat part (b) with error pattern 100110000000000.

Problem 4 (10 points):

Consider simple parity checking depicted in figure.

S1	s2	…	s*n*-1	s*n*	c

The n data bits $s_1s_2...s_n$ are used to generate the parity bit c such that the number of ones in the string $s_1s_2\ldots s_nc$ is even. It is desired to evaluate the strength of this simple parity code and determine what fractions of errors are detected (or not detected) as a function of the data word length n. Assume that any bit of the string $s_1s_2\ldots s_nc$ can be in error with probability p and that errors in bits are independent.

a) Plot the fraction of undetected errors a function of bit error probability p for n = 3, 7, 15, 31 and 63. Consider the range of p from 10^{-2} to 1.

b) State your conclusions regarding the strength of this parity code and its relation to n and channel error probability, p.

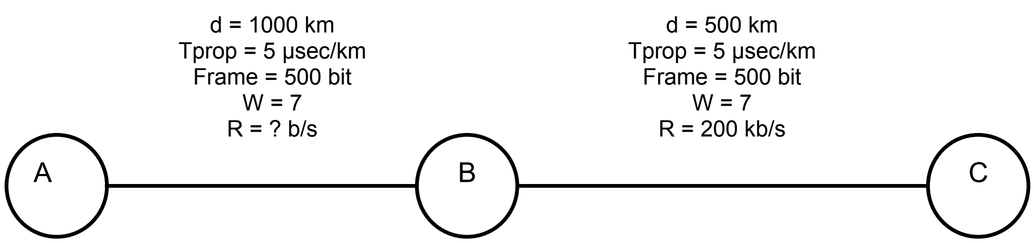
Problem 5: (15 points)

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) (10 point) What is the maximum data rate, R_AB, for link Qurayyat-Dammam such that the receive buffer at Riyadh node does NOT overflow.

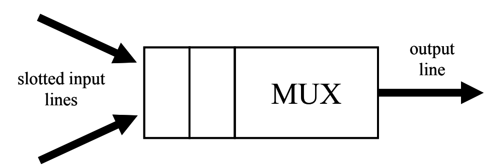
Assume: all links operate full-duplex lines and error free channels. Furthermore, ACK frames are separate frames of 100 bits in length and the processing time for data or acknowledgment frames require 0.5 milliseconds each.

b) (5 point) Repeat the problem assuming the link bit rate from Riyadh to Dammam is 400 kb/s



Problem 6 (10 points):

Data in the form of fixed-length packets arrive in slots on both of the input lines of a multiplexer. A slot contains a packet with probability p, independent of the arrivals during other slots or on the other line. The multiplexer transmits one packet per time slot and has the capacity to store two messages only. If no room for a packet is found, the packet is dropped.



a) Compute the probability of j packets arriving on both input lines during any given time slot.
b) Draw the state transition diagram and define the transition matrix **P** – The state is taken to be the number of packets in the multiplexer.
c) Show that as p approaches unity, the system exists mainly in state 2.
d) Plot $\pi 0$, $\pi 1$, and $\pi 2$ to verify the statement in (c).

Hint: This question is solved completely in the notes – the only requirement is to obtain the expressions in terms of p only.