CS 536 (Park) **Assignment II** **Due: Sep. 5 (Thu.), 1996**

PROBLEM 1

Read Chapt. 3 (pp. 88–121) from P & D and give a 1-page summary of the material, stressing the parts that you find interesting and important. Include your own viewpoints, if any, when writing your commentary. *Remark: Your write-up should be typed, not greater than 12pt font size, and not smaller than 10pt. Do not double space your writing.* (*These write-up instructions will not be repeated henceforth.*)

PROBLEM 2

(a) This is an extension of Problem 4, Assignment I. Assume the same situation as before except that now buffer capacity is 0. That is, whenever two packets arrive at the link at the same time, one of them must be dropped. Specify instances of $X_1(t)$ and $X_2(t)$ for which the link utilization is maximized; repeat the same problem when utilization is to be minimized. Show your calculations.

(b) Assume buffer capacity is still 0. Suppose $X_1(t)$, $X_2(t)$ are given as i.i.d. (independent identically distributed) stochastic processes—i.e., the family of random variables

$$\{ X_i(t) : 0 \text{ ms} \leq t \leq 10 \text{ sec}, \ i = 1, 2 \}$$

is mutually independent and possess identical probability distributions—where $\mathbf{P}(X_i(t) = 1) = 1/2$ and $\mathbf{P}(X_i(t) = 0) = 1/2$. What is the average utilization of the link? Note that here the *average* is w.r.t. to the probability distribution $\mathbf{P}$.

(c) Generalize (b) to the case when $\mathbf{P}(X_i(t) = 1) = p$ and $\mathbf{P}(X_i(t) = 0) = 1 - p$ where $0 \leq p \leq 1$. For what values of p is utilization maximized? For what values is it minimized? Give a verbal, intuitive interpretation of your result.

PROBLEM 3

(a) Explain why ATM came about as a confluence of TDM in telephony, packet switching in data communication, and the thrust to integrate all forms of data under a single internetworking umbrella. In particular, include in your discussion the *bully effect* and why ATM packets (i.e., *cells*) are of "small" fixed size. How did the cell size of 53 bytes come about? (Note that the 53 bytes consists of 5 bytes header information and 48 bytes payload.)

(b) Assume you are asked to improve upon the notion of TDM by designing a version called *statistical* TDM (STDM) which operates like TDM except that now user A is allowed to "steal" user B's slot in the same frame if B is not using it. If a frame contains 8 slots, each slot encodes 16 bits of information, frames are transferred at the rate of 1000 frames per second, and up to 8 users are allowed to share the STDM channel at the same time, what is the maximum data rate (in bps) achievable noting that the *identity* of the user must now be specified on *every* slot? Sketch the multiplexing and demultiplexing procedures needed for this scheme.

(c) As a continuation of (b), if the behavior of the users in the pure TDM case were such that all 8 sources had data to transmit at every frame, what is the drop in performance (in %) as a result moving to STDM?

If the sources in the TDM case were such that one source always had enough data to send to fill every slot in a frame, but only one of the remaining 7 frames is filled for each transmitted frame, what is the gain in efficiency (in %) obtained by moving from TDM to STDM?

(d) Can you improve upon the solution of (b) for STDM such that an even higher data rate is *potentially* attainable? Sketch a solution and indicate the circumstances under which it would indeed achieve a higher data rate. (*Hint: Try to combine the best aspects of TDM and the STDM solution of (b).*)

PROBLEM 4

Exercises from P & D: 1.11, 1.12; 3.2, 3.3.