CS 536 (Park) **Assignment XII** **Due: Nov. 22 (Fri.), 1996**

PROBLEM 1

(a) Read Sections 8.1, 8.2, 8.3, 8.4 from P & D.

(b) Read "A taxonomy for congestion control algorithms in packet switching networks," C. Yang and A. Reddy. *IEEE Network*, pages 34–45, July/August 1995. Give a one-page critique (pros/cons) of their classification scheme.

PROBLEM 2

Implement an adaptive congestion algorithm in a sender-router-receiver set-up (similar to previous assignments in the xinulab) which utilizes the help of the router as follows. The router maintains a user space buffer of size B wherein incoming UDP packets are enqueued. It dequeues packets with exponential service rate μ. The router sends a control packet to the sender each time it awakes to service its queue indicating whether the current queue length is larger than $B/2$ or not. Thus the control packet needs to carry a binary flag, being set to 1 if the current queue length is $> B/2$ and 0 if it is less than or equal to $B/2$.

The sender implements a rate-based congestion control algorithm whereby an interpacket spacing parameter Λ (msec) is used to separate successive packets in time. This is an infinite source model and the larger Λ the smaller the mean packet generation rate. The sender is to execute the following control law:

$$\Lambda(t+1) \leftarrow \Lambda(t) + \epsilon s(t) \tag{1}$$

where $s(t) = 1$ if the last control packet received had the binary flag set to 1, and $s(t) = -1$ if the last control packet received had the binary flag set to 0. Here $\epsilon > 0$ is an adjustment factor.

Test the algorithm using $\mu = 20$ such that the mean time between successive servicing of packets is $1/\mu = 50$ msec; set $B = 40$ (packets of fixed MTU size of 1kB) and set the initial value of Λ as $1/(2\mu)$. Run the algorithm five times using five different values for ϵ, from "very small" to "very large." For each run, record the size the of queue at each dequeueing instance into an array (do not use `printf` since this will slow the router down unnecessarily) and plot the trace at the end of the run. Each run should consist of the generation of 500 UDP packets. Note that the receiver here is a purely dummy entity. Give an interpretation of your data as a function of varying the parameter ϵ. Is there an "optimal" value for ϵ?

PROBLEM 3

(a) As a continuation of Problem 2, change the set-up slightly such that the control packet is not sent from the router directly to the sender but it is sent to the receiver which then forwards it to the sender. Thus the packet must be distinquishable from regular data packets by the receiver. Let the receiver implement a delaying action for each control packet where each control packet is delayed by a fixed amount of τ msec before being sent to the sender. For the "optimal" ϵ value found during the performance runs for Problem 2, repeat the runs and tracings of queue length at the router using four different values of τ from "small" to "large." What is the qualitative behavior observed for the queue length behavior as a function of τ?

(b) As a continuation of Problem 2, change the router such that its service rate μ varies as a function of the current queue length Q where $\mu = Q$ for $0 \leq Q \leq 20$ and $\mu = 40 - Q$ for $20 < Q \leq 40$. Repeat the experiments corresponding to Problem 2. What, if any, differences do you observe? Give an interpretation of your results.