HELSINKI UNIVERSITY OF TECHNOLOGY
Networking Laboratory
S-38.145 Introduction to Teletraffic Theory, Spring 2005

Exercise 9
7.4.2005

Problems 2–3 are homework exercises. Mark the problems you have solved in the beginning of the exercise class.

1. *Demo*
   Consider data traffic on a link between two routers at flow level. The traffic consists of TCP flows, generated with rate λ. The link capacity is denoted by C and the random flow size by L. In addition to the shared link, the rate of TCP flows is limited by access links. Let r denote the capacity of each access link. Consider this as an M/M/n-PS queueing model. Suppose that $\lambda = 80$ flows per second, $E[L] = 0.125 \cdot 10^6$ bytes, $C = 100$ Mbps, and $r = 10$ Mbps. Determine the throughput θ. What if $C = 10$ Gbps?

2. *Homework exercise (2 points)*
   Consider still elastic data traffic on a link. Assume now that $\lambda = 20$ flows per second, $E[L] = 0.125 \cdot 10^6$ bytes, and $C = r = 10$ Mbps. In addition, there is an admission control mechanism (to avoid overload situations) that rejects new TCP connections whenever the shared link is loaded by more than ten flows.

   (a) Let $X(t)$ denote the number of ongoing flows at time t. According to Kendall's notation, what is this queueing model? Process $X(t)$ is a Markov process. Draw the state transition diagram of this Markov process. Under which conditions is the system stable (i.e. the equilibrium distribution exists)? Derive the equilibrium distribution.

   (b) What is the probability that a new TCP connection is accepted? What is the mean total delay for a flow? Determine also the throughput.

3. *Homework exercise (1 point)*
   Derive the equilibrium distribution for the M/M/1/2/3 model.