UNIVERSITY OF DELAWARE
DEPARTMENT OF COMPUTER & INFORMATION SCIENCES

CISC 852-010: Computer Network Performance

Spring Semester, 2008 Adarsh Sethi

Homework 2

Due Date: Thursday March 6, 2008

1. Customers arrive at an airline check-in counter at a rate of ten per minute. The average time it takes to wait in line, check baggage, and leave the counter is 5 minutes. About 30% of the time, customers are asked to go through additional security which requires an average of a 5 minute extra wait. This additional check also occurs at the same check-in counter. About 10% of the time, customers must spend an extra 3 minutes on average because their baggage exceeds the allowable limit. Assuming the system to be in equilibrium, use Little's Theorem to find the average total number of customers in the system that includes the check-in counter and its queue. Also find the average total delay of a customer.

2. Packets arrive at a network switch at a rate of 5000 packets per second. With probability 0.1, a packet is classified as a high-priority packet, while all remaining packets are classified as low-priority packets. When the system is in equilibrium, the average delay experienced by high-priority packets in the switch is 20 msec. while the average delay experienced by low-priority packets is 60 msec. Find
   (a) the average number of high-priority packets in the switch at any time.
   (b) the average number of low-priority packets in the switch at any time.
   (c) the average number of total packets in the switch at any time.
   (d) the average delay experienced by any packet.

3. We have derived the expression $\rho = 1 - p_0$ for a single-server queuing system in equilibrium relating the utilization factor, ρ, to the probability that the server is idle, p_0. Derive a similar expression for a system with two servers in equilibrium, relating ρ to p_0 and p_1, where p_0 and p_1 are the probabilities of finding 0 and 1 customers in the system respectively.

4. A single-server queuing system in equilibrium has a server that services customers at an average service rate of μ. Explain, both intuitively and mathematically, why the average departure rate of customers from the server is not the same as the average service rate μ. Obtain an expression for the average departure rate as a function of μ and p_0, the probability of finding the server idle.