HELSINKI UNIVERSITY OF TECHNOLOGY
Networking Laboratory
S-38.1145 Introduction to Teletraffic Theory, Spring 2007

Exercise 4
13.2.2007

Problems 4, 5 and 6 are homework exercises. Return your answers into the course box of the laboratory (G-wing, 2. floor) latest at 10.00 on Tuesday 13.2.

1. *Demo*
   Consider a link in a circuit switched trunk network. Denote by n the number of parallel channels of the link. Users generate new calls according to a Poisson process. The mean interarrival time between new calls is denoted by t, and the mean call holding time by h. What is the queueing model in question? Determine the time blocking, the call blocking, and the traffic carried for $n = 2$, $t = 4$ min, and $h = 3$ min.

2. *Demo*
   Consider a link in a circuit switched access network. Denote by n the number of parallel channels of the link. There are k on-off type users generating new calls when idle. The mean idle time is denoted by t, and the mean call holding time by h. What is the queueing model in question? Determine the time blocking, the call blocking, and the traffic carried for $n = 2$, $k = 4$, $t = 9$ min, and $h = 3$ min.

3. *Demo*
   Consider the following simple teletraffic model:

   - Customers arrive according to a Poisson process with intensity λ.
   - Service times are IID and exponentially distributed with mean $1/\mu$.
   - There is one server ($n = 1$).
   - The number of waiting places is finite ($0 < m < \infty$).
   - Queueing discipline is FIFO.

   Let $X(t)$ denote the number of customers in the system at time t. What is the queueing model in question?

   (a) Draw the state transition diagram of Markov process $X(t)$.
   (b) Derive the equilibrium distribution of $X(t)$.
   (c) What is the probability that an arriving customer is lost?
   (d) What is the probability that an arriving customer that is not lost has to wait?

4. *Homework exercise*
   Consider the M/M/1/3 model with mean customer interarrival time of $1/\lambda$ time units and mean service time of $1/\mu$ time units. Let $X(t)$ denote the number of customers in the system at time t.

   (a) Draw the state transition diagram of Markov process $X(t)$.
   (b) Derive the equilibrium distribution of $X(t)$.
   (c) Assumed that $\lambda = \mu$, what is the mean number of customers in the system?

5. *Homework exercise*
   Consider the M/M/1/3/3 model where the mean idle time of a customer is $1/\nu$ time units and the mean service time is $1/\mu$ time units. Let $X(t)$ denote the number of customers in the system at time t.

(a) Draw the state transition diagram of Markov process $X(t)$.

(b) Derive the equilibrium distribution of $X(t)$.

(c) Assumed that $\nu = \mu$, what is the mean number of customers in the system?

6. *Homework exercise*

   Consider the M/M/1/2/3 model where the mean idle time of a customer is $1/\nu$ time units and the mean service time is $1/\mu$ time units. Let $X(t)$ denote the number of customers in the system at time t.

   (a) Draw the state transition diagram of Markov process $X(t)$.

   (b) Derive the equilibrium distribution of $X(t)$.

   (c) Assumed that $\nu = \mu$, what is the mean number of customers in the system?