HELSINKI UNIVERSITY OF TECHNOLOGY
Department of Communications and Networking
S-38.1145 Introduction to Teletraffic Theory, Spring 2009

Examination
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1. Consider telephone traffic carried by a 2-channel link in the telephone network. New calls arrive according to a Poisson process at rate 1 call/min, and the mean call holding time is 3 min. Determine

   (a) the traffic offered,

   (b) the call blocking, and

   (c) the traffic carried.

2. Buses arrive at a bus stop according to a Poisson process with an average interarrival time of 15 minutes. You arrive at the bus stop at a random time. Thus, you don't know when the previous bus left, nor when the next bus will arrive.

   (a) Let T denote the time until the arrival of the next bus. Specify the distribution and the mean value of the random variable T?

   (b) What is the probability that at least one bus arrives during the 15-minute interval following your arrival?

3. Consider a queueing system with 6 parallel servers and 4 waiting places. The average service time is 3 min. Customers are served in their arrival order. Assume an excessive arrival stream, that is, every time a customer leaves the system, a new customer arrives immediately. Therefore the system is always full. What is the average time a customer spends in the system?

4. Consider the M/M/1 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 $X(t)$. Are there any stability conditions?

   (c) Assume that $\mu = 3\lambda$. What is the probability that an arriving customer has to wait before service?

5. Consider a data network with 3 routers. A router breaks down after an exponentially distributed interval with mean $1/\nu$. A broken router is repaired for an exponentially distributed interval with mean $1/\mu$. If there are multiple routers broken down at the same time, they are repaired one-by-one. Let $X(t)$ denote the number of broken routers at time t.

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

   (b) Derive the equilibrium distribution of $X(t)$. Are there any stability conditions?

   (c) Assume that $\mu = \nu = 1$. What is the mean number of operating routers?