Aalto University
School of Electrical Engineering
Department of Communications and Networking
S-38.1146 Introduction to Performance Analysis, Autumn 2011

Examination
26.10.2011
Tirronen

Please answer to all five (5) questions

1. Explain briefly the following terms/concepts:

a) Memoryless property of the exponential distribution

b) FIFO

c) PASTA

d) MTTF

e) M/M/1

f) discrete event simulation

2. Packets arrive to an input buffer of a server according to a Poisson process with average interarrival time of 150 milliseconds. Let T denote the time until the arrival of the next packet.

   a) You check the buffer at a random time instant. What is the distribution of the random variable T?

   b) You check the buffer just after the previous packet has been arrived. What is the distribution of T in this case? What is the expected waiting time before the next packet arrives?

   c) You check the buffer at random time instant. Let X denote the number of packets which arrive during the next 50 milliseconds. What is the distribution of the random variable X?

3. Consider a statistical multiplexer in a packet switched network. The multiplexer has four input links and one output link. The input links each have capacity 100 Mbps. These links feed packets into the multiplexer on average with the following rates: 10, 12, 5 and 3 packets per millisecond. The average size of the packets is 125 bytes. Let us model the system as M/M/1 queueing model. a) What is the capacity requirement (in Mbps) for the output link so that the system is stable? b) What is the average total delay of a packet in the system if we know that there are 10 packets on average in the system?

4. Consider the $M/M/2/2/2$ teletraffic model. Single user is idle $1/\nu$ time units on average and spends in the system $1/\mu$ time units on average. Let $X(t)$ denote the number of customers in the system at time t. a) Draw the state transition diagram of the Markov process $X(t)$. b) Derive the equilibrium distribution of the system c) What is the time blocking in this system? d) What is the call blocking in this system?

5. A network switch consists of six independent components: three ports, a switching matrix, a power supply unit (PSU) and a backup power supply unit. For the whole system to work, at least two of the ports have to be in working condition. You can consider each of the power supplys to be working independently of each other, and at least one of them has to be online to provide power for the switch. Finally, the switching matrix has to be in working condition for the whole switch to provide its intended service.

   a) Draw the reliability block diagram of the structure.

   b) Calculate the structure function $\phi(x)$ of the switch.

   c) If all the components are repairable, what is the average availability of the system if the average availability of one port is A_{P} (same for all ports), average availability of one power supply is A_{PSU} (same for both PSUs) and the average availability of the switching matrix is A_{SM}?