KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
COLLEGE OF COMPUTER SCIENCES & ENGINEERING

COMPUTER ENGINEERING DEPARTMENT

COE 540 – Computer Networks / ICS 570 Advanced Computer Networking
Assignment 3 – Due Date December 11th, 2007

Problem 1 (40 points): On the subject of Random Variables and Probability Theory

Let N be a geometric random variable with range 0, 1, 2, 3, … (i.e. N is defined as the number of failures before success in a series of IID Bernoulli trails with parameter p).

a) Use Matlab to plot the PMF and CDF of the r.v. N for $p = 0.2$. Use a range for N from 0 to 20.

b) Compute the quantity Prob[$N > k$].

c) Compute Prob[N is an even number].

d) Evaluate the corresponding probability generating function $G_N(z)$.

e) Use $G_N(z)$.to compute $E[N]$ and $E[N^2]$.

Problem 2 (50 points): On the subject of Markov Chains

Data in the form of fixed-length packets arrive in slots on the FOUR input lines of a multiplexer. A slot contains a packet with probability p, independent of the arrivals during other slots or on the other line. The multiplexer transmits one packet per time slot and has the capacity to store THREE packets only. If no room for a packet is found, the packet is dropped.

a) COMPUTE the probability of j (for all possible j values) packets arriving on the three input lines during any given time slot.
b) DRAW the state transition diagram and SPECIFY the transition matrix **P** – The state is taken to be the number of packets in the multiplexer.
c) If p is equal to 0.4, what is the probability that the MUX will contain 3 packets after 10 time slot (i.e. at the start of the 11th time slot)? Assume that we start with an empty MUX.
d) Let the load be defined as the mean number of arriving packets per time slot while throughput be defined as the mean number of transmitted packets per time slot. Use Matlab and show the code for:
    1) Plot the throughput versus the input load.
    2) Evaluate and plot the mean number of dropped packets per time slot.

Hint: Use the major exam question 2 for building the state transition diagram/matrix and then use the Matlab code provided on slide 86 package 4 (Example 9) - with the required modifications.

Problem 3 (30 points): On the subject of Delay and Queueing Models (1)

Assume a small enterprise is installing a PBX telephony system with c outgoing phone lines connecting the enterprise with the PSTN. If the population and calling behavior of the enterprise employees are such that calls are generated according to a Poisson arrival process with rate of 4 calls every 5 minutes. The mean call duration is 4 minutes. Assume that calls arriving to the PBX while the C outgoing lines are busy are blocked. Let $c = 5$.

(1) The offered load from the enterprise.

(2) The probability that a call originating from the enterprise is blocked.

(3) If it is desired to provide a quality of service (QoS) equal to 1% blocking for originating calls, what would be the minimum size (i.e. value of c) for the PBX achieving this QoS?

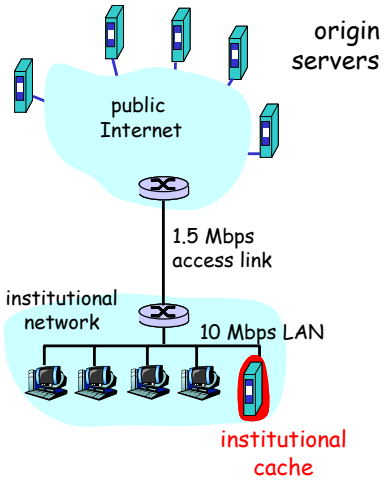
Hint: Use the M/M/c/c model.

Problem 4 (30 points):Internet Applications (1)

Consider the network layout shown in figure where an institutional network is connected to the Internet. Suppose that the average object size is 900,000 bits and that the average request rate is from the institution's browsers to the origin servers is 1.5 requests per second. Also suppose that the amount of time it take from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is two seconds on average. Model the total average response time as the sum of the average access delay (that is the delay from the Internet router to institution router), and the average Internet delay. For the average access delay, use $\Delta/(1-\Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link.

a. Find the total average response time.

b. Now suppose a cache is installed in the institutional LAN. Suppose the hit rate is 0.4. Find the total response time.



Problem 5: (20 points): On the subject of Internet Applications (2)

Consider the following alternative design for CDN network. A content provider `foo.com` wants the CDN `cdn.com` to distribution all its objects, including its HTML base objects. To this end, `foo.com` asks `cdn.com` to create and manage the authoritative DNS name server for `foo.com`. (a) In this alternative design, do any HTTP requests reach the origin server for `foo.com`? Why or Why not? (b) What are some advantages and disadvantages of this alternative design?

Problem 6 (30 points): On the subject of Internet Applications (3)

Suppose within your Web browser you click on a link to obtain a Web page. Suppose that the IP adderss for the associated URL is not cached in your local host, so that a DNS look-up is necessary to obtain the IP address. Suppose that *n* DNS servers are visited before your local host receives the IP address from DNS; the successive visits incur an RTT of RTT1, …, RTT*n*. Furthermore, suppose that the Web page associated with the link contains exactly one object, a small amount of HTML text. Let RTT0 denote the RTT between the local host and the server containing the object. Assume zero transmission time of the object.

(a) How much time elapses from when the client clicks on the link until the client receives the object.

(b) Suppose the HTML file indexes three very small objects on the same server. Neglecting transmission times, how much time elapses with (1) nonpersistent HTTP with no parallel TCP connections, (2) nonpersistent HTTP with parallel connections, (3) persistant HTTP with piplelining.

Problem 7 (30 points): On the subject of Transport Layer (1)

Consider transfering an enormous file of L bytes from host A to host B. Assume an MSS of 1460 bytes.

a) What is the maximum value of L such that TCP sequence numbers are not exhausted. Recall that the TCP sequence number field has four bytes.

b) For the L you obtain in (a) find how long it takes to transmit the file. Assume that a total of 66 bytes of transport, network, and data-link header are added to each segment.before the resulting packet is sent out over a 10 Mb/s link. Ignore flow control and congestion control so A can pump out the segments back to back and contineously.

Problem 8 (50 points): On the subject of Transport Layer (2)

Kurose's textbook (2nd eddition) Chapter 3 - Problem 26 (page 287).