Winter 2010 SYSC 5201 Midterm

90 Minutes
Close book

1. (30%) Provide simple and straight answers to the following questions.
    a. What is the main challenge in network edge?
       Various access technologies and limited bandwidth
    b. What is the main disadvantage of radio media?
       Interference
    c. What is Little's Law?
       $L = \lambda T$
    d. What are the main differences between client and server?
       Server is always on while client is on intermittently. Client initiates service.
    e. Which factors affect the transmission delay of a packet?
       Packet size and bandwidth
    f. Which factors affect propagation delay?
       Distance and signal propagation speed.
    g. What is the main difference between persistent and non-persistent HTTP?
       Persistent HTTP uses one TCP connection while non-persistent HTTP uses multiple.
    h. How does a distributed peer-to-peer architecture keep and access index information?
       Using DHT
    i. What is the main difference between SMTP and POP3?
       SMTP is a push protocol while POP3 is a pull protocol.
    j. What is a socket?
       An interface and API between application layer and transport layer.

2. (30%) Consider a network with three packet switches. Packets arrive at switches 1, 2, 3 in accordance with Poisson processes having respective rates 5, 10, 15. The transmission times at the three switches are exponential with respective rates 10, 50, 100. A packet completing service at switch 1 is equally likely to either (a) go to switch 2, (b) go to switch 3, or (c) leave the system. A packet departing at switch 2 always go to switch 3. A departure packet from switch 3 is equally likely to either go to switch 2 or leave the system. Ignore propagation and processing delays.
    a. What is the average number of packets in the network (consisting of all three switches)?
    b. What is the average time a packet spends in the network?
    c. What is the probability that there are more than 4 packets in switch 1?

   Solution:

   a) 82/13
   b) 41/195

c) $\sum_{n=5}^{\infty}(\frac{1}{2})^n\left(\frac{1}{2}\right) = (\frac{1}{2})^6(\sum_{n=0}^{\infty}(\frac{1}{2})^n) = \frac{1}{32}$

3. (40%) Consider distributing a file of F bits to N peers using a P2P architecture. Assume a fluid model. For simplicity assume that d_{min} is very large, so that peer download bandwidth is never a bottleneck. Suppose that $u_s \leq (u_s + u_1 + \cdots + u_n)/N$. Specify a distribution scheme that has a distribution time of F/u_s.
Solution:
Define $u = u_1 + u_2 + \ldots.. + u_N$. By assumption

$u_s <= (u_s + u)/N$ Equation 1

Divide the file into N parts, with the i^{th} part having size $(u_i/u)F$. The server transmits the i^{th} part to peer i at rate $r_i = (u_i/u)u_s$. Note that $r_1 + r_2 + \ldots.. + r_N = u_s$, so that the aggregate server rate does not exceed the link rate of the server. Also have each peer i forward the bits it receives to each of the N-1 peers at rate r_i. The aggregate forwarding rate by peer i is $(N-1)r_i$. We have

$(N-1)r_i = (N-1)(u_s u_i)/u <= u_i$,

where the last inequality follows from Equation 1. Thus the aggregate forwarding rate of peer i is less than its link rate u_i.

In this distribution scheme, peer i receives bits at an aggregate rate of

$$r_i + \sum_{j<>i} r_j = u_s$$

Thus each peer receives the file in F/u_s.