Fall 2012 SYSC 5201 Midterm Solution

90 Minutes
Close book

1. (40%) Provide simple and straight answers to the following questions.
   a. What are the key components of a protocol?
      Syntax, Semantics, Sequence
   b. What are the main challenges of core network?
      Transmission speed and scalability
   c. What are the main differences between optical and wireless links?
      Interference and transmission speed
   d. What are the main differences between client-server and peer-to-peer architectures?
      Peers are both client and server
   e. What are the main benefits of peer-to-peer architecture?
      Scalability by leveraging peer resources
   f. What are the main benefits of web caching?
      Save resources and reduce delays
   g. What is M/M/1 queue?
      Poisson arrival process, exponential service time, single server
   h. What happens when the following line of code is executed?
      modifiedSentence = inFromServer.readLine();
      Waiting for information from server
   i. What architecture does DNS system use?
      Hierarchical
   j. What are the main drivers for the new datacenter architecture?
      Cost and scalability

2. (20%) Suppose you would like to urgently deliver 40 terabytes data from Boston to Los Angeles. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain.
   Solution:
   40 terabytes = $40 * 10^{12} * 8$ bits. So, if using the dedicated link, it will take $40 * 10^{12} * 8 / (100 * 10^{6}) = 3200000$ seconds = 37 days. But with FedEx overnight delivery, you can guarantee the data arrives in one day, and it should cost less than $100.

3. (20%) Consider a network with two packet switches where packets from outside the network arrive at switch 1 at a Poisson rate 4 and at switch 2 at a Poisson rate 5. The service rates of 1 and 2 are respectively 8 and 10 with exponential distributed service times. A packet upon leaving switch 1 is equally likely either to go to switch 2 or to leave the system; whereas a departure from switch 2 will go 25% of the time to switch 1 and will depart the network otherwise.
   a. What is the average number of packets in the system (consisting of all

three switches)?

b. What is the average time a packet spends in the system?

c. What is the probability that there are *n* packets in switch 1 and *m* packets in switch 2?

Solution:

a) 7

b) 7/9

c) $\frac{1}{20}(\frac{3}{4})^n(\frac{4}{5})^m$

4. (20%) Consider distributing a file of F bits to N peers using a client-server architecture. Assume a fluid model where the server can simultaneously transmit to multiple peers, transmitting to each peer at different rates, as long as the combined rate does not exceed u_s.

   a. Suppose that $u_s/N \leq d_{min}$, where d_{min} is the download rate of the peer with the lowest download rate. Specify a distribution scheme that has a distribution time of NF/u_s.

   b. Suppose that $u_s/N \geq d_{min}$. Specify a distribution scheme that has a distribution time of F/d_{min}.

   Solution:

   a. Consider a distribution scheme in which the server sends the file to each client, in parallel, at a rate of a rate of u_s/N. Note that this rate is less than each of the client's download rate, since by assumption $u_s/N \leq d_{\min}$. Thus each client can also receive at rate u_s/N. Since each client receives at rate u_s/N, the time for each client to receive the entire file is $F/(u_s/N) = NF/u_s$. Since all the clients receive the file in NF/u_s, the overall distribution time is also NF/u_s.

   b. Consider a distribution scheme in which the server sends the file to each client, in parallel, at a rate of $d_{\min}$. Note that the aggregate rate, $N d_{\min}$, is less than the server's link rate u_s, since by assumption $u_s/N \geq d_{\min}$. Since each client receives at rate $d_{\min}$, the time for each client to receive the entire file is $F/d_{\min}$. Since all the clients receive the file in this time, the overall distribution time is also $F/d_{\min}$.