Introduction to Computer Networks

Chap. 1-2, Fall 2016

1. (5%) (a) What are the advantages of packet switching over circuit switching?
   (b) What the advantages of circuit switching over packet switching?

2. Suppose users share a 1 Mbps link. Also suppose each user requires 100 kbps when transmitting, but each user transmits only 10 percent of the time.
   (a) (5%) When circuit switching is used, how many users can be supported?
   (b) (5%) Suppose that packet switching is used. Also suppose that there are 40 users. Find the probability that more than 10 users are transmitting.

3. (5%) What are defined in a network protocol?
4. (5%) What are the layers in the Internet protocol stack?
5. (5%) What services are provided by the TCP protocol?
6. (5%) What services are not provided by the TCP or the UDP protocols?
7. (5%) What are the different types of name servers in the domain name system?
8. (5%) Describe the functions of a local name server.

9. Suppose there is exactly one packet switch between a sending host and a receiving host. The transmission rates between the sending host and the switch and between the switch and the receiving host are both R. The propagation delays between the sending host and the switch and between the switch and the receiving host are both D. The processing delays and queueing delays are zero.
   (a) (5%) Assuming that the switch uses stored-and-forward packet switching, what is the total end-to-end delay to send a packet of length L?
   (b) (5%) Suppose that the switch does not store-and-forward packets but instead immediately transmit each bit it receives before waiting for the entire packet to arrive. What is the total end-to-end delay to send a packet of length L?

10. (5%) The bandwidth-delay product for a communication link is defined as the product of the bandwidth and the propagation delay of the communication link. Provide an interpretation of the bandwidth-delay product.

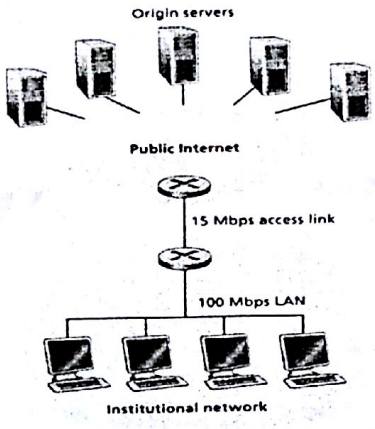
11. (5%) Consider the queueing delay in a router buffer. Suppose all packets are L bits, the transmission rate is R bps, and that N packets simultaneously arrive at the buffer every LN/R seconds. Find the average queueing delay of a packet.

Local host —RTT1— Local DNS —RTT2— auth DNS — server

RTT0

12. Suppose within your Web browser you click on a link to obtain a Web page. The IP address of the Web server is not cached in your local host. The authoritative DNS of the Web server is cached in the local DNS. Let the round trip time between the local host and the local DNS be RTT_1. Let RTT_2 denote the round trip time for the local DNS to query the authoritative DNS of the Web server to obtain the IP address of the Web server. The Web page references 10 objects of the same length on the same server. Let the round trip time between the local host and the Web server be RTT_0. Let the transmission time for the Web page be T_a and the transmission for each of the 10 objects is T_b. Neglecting the transmission time for the HTTP get requests, how much time elapses with
    (a) (5%) Non-persistent HTTP with no parallel TCP connections?
    (b) (5%) Non-persistent HTTP with parallel TCP connection?
    (c) (5%) Persistent HTTP with pipelining (i.e., multiple HTTP requests can be sent one after another without waiting for replies to previous requests)?

13.



Consider the above figure, for which there is an institutional network connected to the Internet. Suppose that the average object size is 900,000 bits and that the average request rate from the institution's browsers to the origin servers is 16 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is 1.5 seconds on the average. Model the total average response time as the sum of the average access delay 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) (10%) Find the total average response time.
    (b) (10%) Now suppose a cache is installed in the institutional LAN. Suppose the hit rate is 0.4. Find the total response time.