Homework 1 assignment for ECE671

Posted: 02/09/21

Due: 02/16/21

Note: *In all written assignments, please show as much of your work as you can. Even if you get a wrong answer, you can get partial credit if you show your work. If you make a mistake, it will also help the grader show you where you made a mistake.*

Problem 1 (10 Points):

Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following questions, briefly justifying your answer:

a. Would a packet–switched network or a circuit-switched network be more appropriate for this application? Why?
b. Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?

Problem 2 (20 Points):

This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B.

a. Express the propagation delay, d_{prop}, in terms of m and s.
b. Determine the transmission time of the packet, d_{trans}, in terms of L and R.
c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.
d. Suppose Host A begins to transmit the packet at time $t=0$. At time $t=d_{trans}$, where is the last bit of the packet?
e. Suppose d_{prop} is greater than d_{trans}. At time $t=d_{trans}$, where is the first bit of the packet?
f. Suppose d_{prop} is less than d_{trans}. At time $t=d_{trans}$, where is the first bit of the packet?
g. Suppose $s=2.5*10^8$ m/s, $L=500$ bits, and $R=128$ kbps. Find the distance m so that d_{prop} equals d_{trans}.

Problem 3 (15 Points):
A packet switch receives a packet and determines the outbound link to which the packet should be forwarded. When the packet arrives, one other packet is halfway done being transmitted on this outbound link and four other packets are waiting to be transmitted. Packets are transmitted in order of arrival. Suppose all packets are 2,400 bytes and the link rate is 2 Mbps. What is the queuing delay for the packet? More generally, what is the queuing delay when all packets have length L, the transmission rate is R, x bits of the currently-being-transmitted packet have been transmitted, and n packets are already in the queue?

Problem 4 (25 Points):
Perform a Traceroute (command "traceroute" on Unix systems and "tracert" on Windows systems) between your computer and *www.ucsd.edu* at three different hours of the day. (Add screenshots of the three Traceroutes to your answer!). Note, the traceroute might not go all the way through to the web server. In that case you can abort at a router that partly matches the following name *uwcr-atg-1.infra.washington.edu*.

a. Find the average and standard deviation of the round-trip delays at each of the three hours.
b. Find the number of routers in the path at each of the three hours. Did the paths change during any of the hours?
c. Try to identify the number of ISP networks the Traceroute packets pass through from source to destination. Routers with similar names and/or similar IP addresses should be considered as part of the same ISP. In your experiments, do the largest delays occur at peering interfaces between adjacent ISPs?
d. Repeat the above for a destination on a continent different then the source. Compare the intra- and inter-continent results.

Problem 5 (15 Points):
Suppose you would like to urgently deliver 30 terabytes of data from Boston to Los Angeles. You have a 500 Mbps dedicated link for data transfer available. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain.

Problem 6 (15 Points):
Answer the following question about the paper "A Protocol for Packet Network Intercomunication" by Cerf and Kahn.

a. Explain why fragments of an original datagram are reassembled at the receiving host and not an intermediary gateway?
b. What is the purpose of the "process header" in TCP?
c. What are the ES and EM bit for?
d. Explain how the flow control mechanism in this early version of TCP is specified!
e. What mechanisms does the TCP protocol apply to recover from packet losses?