FAST - National University of Computer & Emerging Sciences, Karachi

Computer Network (CS 3001)

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Assignment no. 1

Max. Marks: 2.5
Section: CS-7A & SE-5A
Date: 9/19/2021

Assignment Instructions:

1. **Assignment no: 1 is from chapter 1 of the textbook, the material is provided on google classroom.**
2. **Write the roll no: and name on the front page of your assignment.**
3. **The assignment must be submitted in handwritten form on Google Classroom. Use your name and roll number as your file name when saving pdf.**
4. **Explain your answer with the help of a figure and with a detailed explanation. Please show all the steps involved in obtaining your answer.**
5. **The marks of the assignment is depending on the class test, which will conduct after the submission of assignment no. 1.**
6. **No Plagiarism!**

Deadline to submit the assignment no: 1 is 26th September 2021

1. 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 R_1 and R_2, respectively. Assuming that the switch uses store-and-forward packet switching, what is the total end-to-end delay to send a packet of length L? (Ignore queuing, propagation delay, and processing delay.

2. Which layers in the Internet protocol stack does a router process and what kind of message use in this layer? Which layers does a link-layer switch process? Which layers does a host process? Explain with the help of figure.

3. Why layering is important in internet protocol stack? Explain your answer in detail with the help of figure or analogy. Name the protocols use in each inter protocol layer?

4. Consider the circuit-switched network in Figure 1.13. Recall that there are four circuits on each link. Label the four switches A, B, C, and D, going in the clockwise direction.

    a. What is the maximum number of simultaneous connections that can be in progress at any one time in this network?
    b. Suppose that all connections are between switches A and C. What is the maximum number of simultaneous connections that can be in progress?
    c. Suppose we want to make four connections between switches A and C, and another four connections between switches B and D. Can we route these calls through the four links to accommodate all eight connections?

5. 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?
Suppose $s = 2.5 * 10^8$, L = 1500 bytes, and R = 10 Mbps. Find the distance m so that d_{prop} equals d_{trans}.

6. Suppose there is a 10 Mbps microwave link between a geostationary satellite and its base station on Earth. Every minute the satellite takes a digital photo and sends it to the base station. Assume a propagation speed of $2.4 * 10_8$ meters/sec.
   a. What is the propagation delay of the link?
   b. What is the bandwidth-delay product, $R.d_{prop}$?
   c. Let x denote the size of the photo. What is the minimum value of x for the microwave link to be continuously transmitting?

7. Suppose two hosts, A and B, are separated by 20,000 kilometers and are connected by a direct link of R = 5 Mbps. Suppose the propagation speed over the link is $2.5 * 10^8$ meters/sec.
   a. Calculate the bandwidth-delay product, R * dprop.
   b. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?
   c. Provide an interpretation of the bandwidth-delay product.
   d. What is the width (in meters) of a bit in the link? Is it longer than a football field?
   e. e. Derive a general expression for the width of a bit in terms of the propagation speed s, the transmission rate R, and the length of the link m.

8. In this problem, we consider sending real-time voice from Host A to Host B over a packet-switched network (VoIP). Host A converts analog voice to a digital 64 kbps bit stream on the fly. Host A then groups the bits into 56-byte packets. There is one link between Hosts A and B; its transmission rate is 10 Mbps and its propagation delay is 10 msec. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packet's bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal

9. Review the car-caravan analogy in Section 1.4. Suppose the caravan has 10 cars, and that the tollbooth services (that is, transmits) a car at a rate of one car per 2 seconds. Assume a propagation speed of 100 km/hour.
   a. Suppose the caravan travels 175 km, beginning in front of one tollbooth, passing through a second tollbooth, and finishing just after a third tollbooth. What is the end-to-end delay?
   b. Repeat (a), now assuming that there are eight cars in the caravan instead of ten.

10. Consider a packet of length L that begins at end system A and travels over three links to a destination end system. These three links are connected by two packet switches. Let di, si, and Ri denote the length, propagation speed, and the transmission rate of link i, for i = 1, 2, 3. The packet switch delays each packet by dproc. Assuming no queuing delays, in terms of di, si, Ri, (i = 1, 2, 3), and L, what is the total end-to-end delay for the packet? Suppose now the packet is 1,500 bytes, the propagation speed on all three links is 2.5 # 108m/s, the transmission rates of all three links are 2.5 Mbps, the packet switch processing delay is 3 msec, the length of the first link is 5,000 km, the length of the second link is 4,000 km, and the length of the last link is 1,000 km. For these values, what is the end-to-end delay?

11. In the above problem, suppose R1 = R2 = R3 = R and dproc = 0. Further suppose that the packet switch does not store-and-forward packets but instead immediately transmits each bit it receives before waiting for the entire packet to arrive. What is the end-to-end delay?

Best of Luck!