CS341: Intro to Computer Networks

Fall 2018
Homework #2
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[Problem 1.] Suppose users share a 5 Mbps link. Also suppose each user transmits continuously at 2.5 Mbps when transmitting, but each user transmits only 15 percent of the time.

a. When circuit switching is used, how many users can be supported?
b. For the remainder of this problem, suppose packet switching is used. Why will there be essentially no queuing delay before the link if two or fewer users transmit at the same time? Why will there be a queuing delay if three users transmit at the same time?
c. Suppose now there are three users. Find the probability that at any given time, all three users are transmitting simultaneously. Find the fraction of time during which the queue grows.

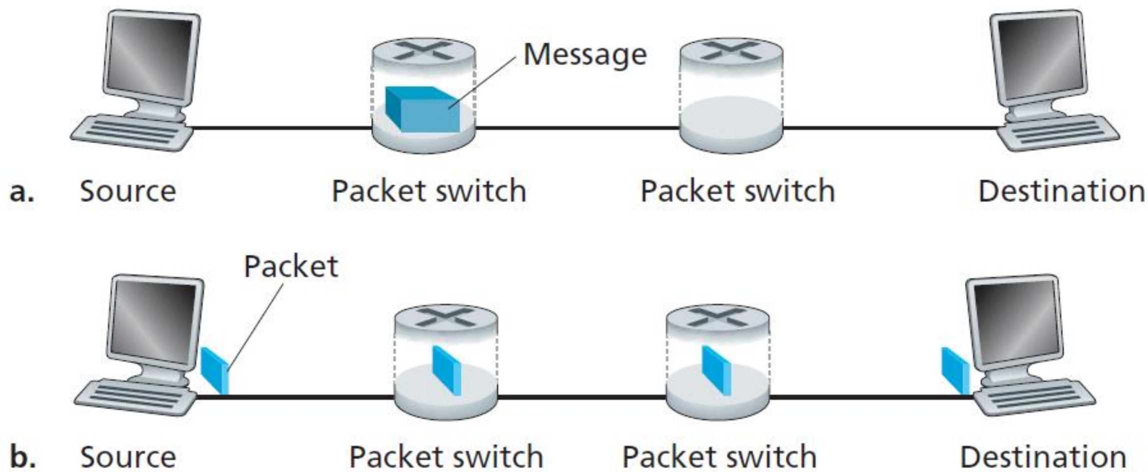
[Problem 2.] Consider two hosts, A and B, connected by a single link of rate *R* bps. Suppose that the two hosts are separated by *m* meters, and suppose the propagation speed along the link is *s* meters/sec. Host A is to send a packet of size *L* bits to Host B.

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 $s = 2.5 \cdot 10^8$, $L = 120$ bits, and $R = 56$ kbps. Find the distance *m* so that d_{prop} equals d_{trans}.

[Problem 3.] Perform a *traceroute* from a machine you have access to *www.eecs.umich.edu* at three different times of day. (Cut and Paste the output from your *traceroute* into your assignment).

a. For each of the three times of day, what is the average of the RTT delay from your machine to *www.eecs.umich.edu*?
b. How many routers are in the path at each time of day? Did the set of routers or the number of routers ever change?
c. For one of your times of day, can you identify an ISP in the path from source to destination? There's no right or wrong answer here - just see what you can find about one or more of the ISPs that you find in one of your *traceroutes*. You will also find the *whois* command useful. Whois runs natively on Macs and Unix machines. It's not natively available on a Windows machine, but you can use the site http://www.whois.net/

[Problem 4.] In modern packet-switched networks, including the Internet, the source host segments long, application-layer messages (for example, an image or a music file) into smaller packets and sends the packets into the network. The receiver then reassembles the packets back into the original message. We refer to this process as *message segmentation*. The figure below illustrates the end-to-end transport of a message (a) without and (b) with message segmentation. Consider a message that is $8 \cdot 10^6$ bits long that is to be sent from source to destination in the figure below. Suppose each link in the figure is 2 Mbps. Ignore propagation, queuing, and processing delays.



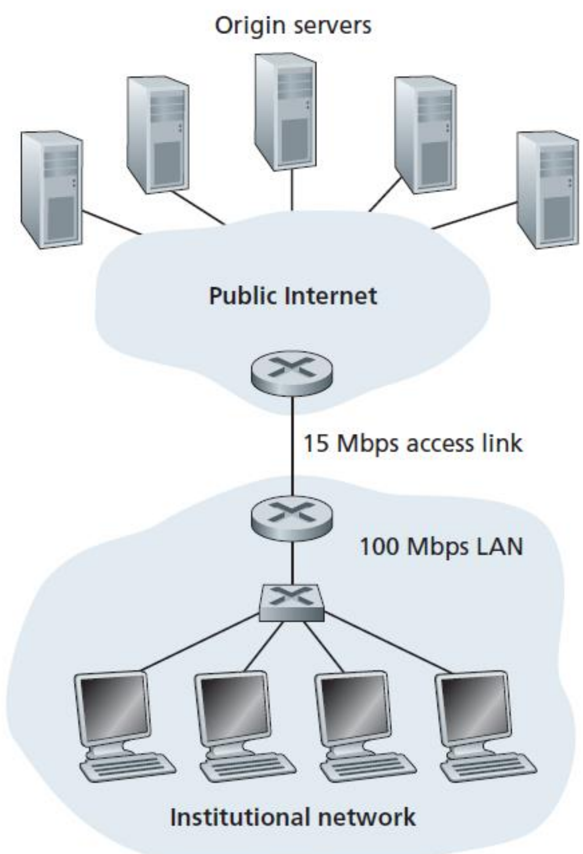
a. Consider sending the message from source to destination *without* message segmentation. How long does it take to move the message from the source host to the first packet switch? Keeping in mind that each switch uses store-and-forward packet switching, what is the total time to move the message from source host to destination host?
b. Now suppose that the message is segmented into 800 packets, with each packet being 10,000 bits long. How long does it take to move the first packet from source host to the first switch? When the first packet is being sent from the first switch to the second switch, the second packet is being sent from the source host to the first switch. At what time will the second packet be fully received at the first switch?
c. How long does it take to move the file from source host to destination host when message segmentation is used? Compare this result with your answer in part (a) and comment.

[Problem 5.] Consider the following string of ASCII characters that were captured by Wireshark when the browser sent an HTTP GET message (i.e., this is the actual content of an HTTP GET message). The characters *<cr><lf>* are carriage return and line-feed characters (that is, the italized character string *<cr>* in the text below represents the single carriage-return character that was contained at that point in the HTTP header). Answer the following questions, indicating where in the HTTP GET message below you find the answer.

GET /cs341/index.html HTTP/1.1*<cr><lf>*Host: gaia.cs.umass.edu*<cr><lf>*User-Agent: Mozilla/5.0 (Windows;U; Windows NT 5.1; en-US; rv:1.7.2) Gecko/20040804 Netscape/7.2 (ax) *<cr><lf>*Accept:ext/xml, application/xml, application/xhtml+ xml, text/html;q=0.9, text/plain;q=0.8,image/png,*/*;q=0.5*<cr><lf>*Accept-Language: en-us,en;q=0.5*<cr><lf>*Accept-Encoding: zip,deflate*<cr><lf>*Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7*<cr><lf>*Keep-Alive: 300*<cr><lf>*Connection:keep-alive*<cr><lf><cr><lf>*

a. What is the URL of the document requested by the browser?
b. What version of HTTP is the browser running?
c. Does the browser request a non-persistent or a persistent connection?
d. What is the IP address of the host on which the browser is running?
e. What type of browser initiates this message? Why is the browser type needed in an HTTP request message?

[Problem 6.] Consider the figure below, for which there is an institutional network connected to the Internet. Suppose that the average object size is 850,000 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 three seconds on average (see Section 2.2.5). Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) 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. Find the total average response time.
b. Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.4. Find the total response time.

[Problem 7.] What are your favorite human protocol(s)? Why are they your favorite, and how do they operate?

[Problem 8.] What are the differences between FingerIO and SkinTrack? Which one do you think is better? Why?

[Essay] You're invited to a dinner meeting with your department (e.g., Computer Science) chair, your school (e.g., Engineering) dean, and KAIST president. You're asked to (i) suggest a restaurant, and (ii) raise top 3 issues that they can help improve the student welfare. Which dinner venue would you suggest and why? What would be the 3 issues you bring up? Remember that you are representing the entire student body, not your personal interest.