Data Communications
Homework 1

1. 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-switching 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?

2. 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 $s=2.5*10^8$, $L=100$ bits and $R=28$ kbps. Find the distance m so that d_{prop} equals d_{trans}.

3. 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 48-byte packets. There is one link between host A and B; its transmission rate is 1 Mbps and its propagation delay is 2 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 coverts the packet's bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)?

4. In modern packet-switched networks, 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 illustrates the end-to-end transport of a message with and without message segmentation. Consider a message that is $7.5 * 10^6$ bits long that is to be sent from source to destination in the

figure. Suppose each link in the figure is 1.5 Mbps. Ignore propagation, queuing and processing delays.

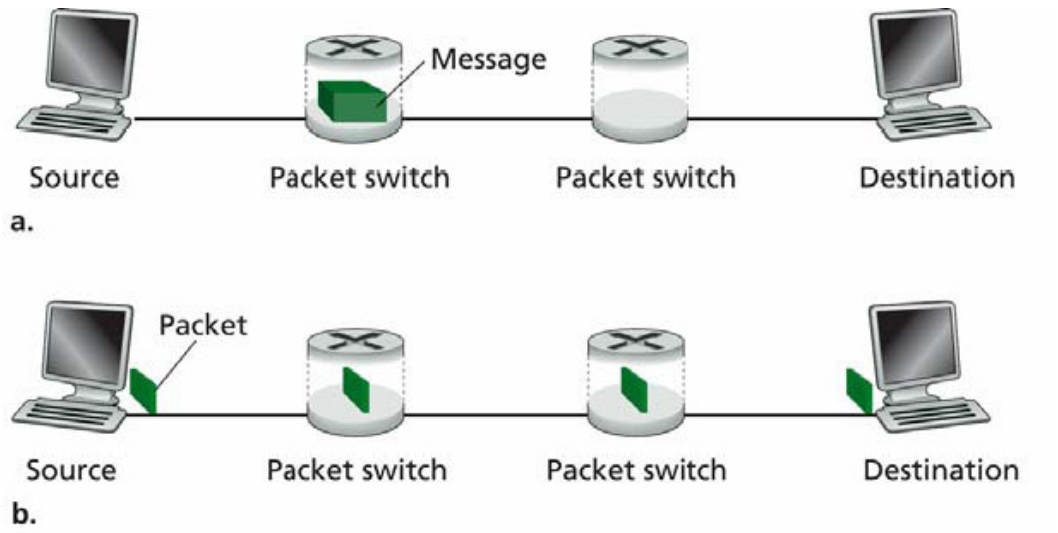

Figure: End-to-end message transport: (a) without message segmentation; (b) with message segmentation

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. 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.
c. Now suppose that the message is segmented into 5,000 packets, with each packet being 1,500 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?
d. Discuss the drawbacks of message segmentation.

Deadline: 15. November. 2011, 23.59

Submission: Please submit your homework to the Online Course System. Other submissions will ***NOT*** be graded. Please contact Ar. Gor. Necati Duran for further questions.

Homework Policies:

1. Cheating is strongly discouraged.
2. Late homeworks will be graded as 0.
3. Please comment your source codes.

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