

## Computer Network – Homework III

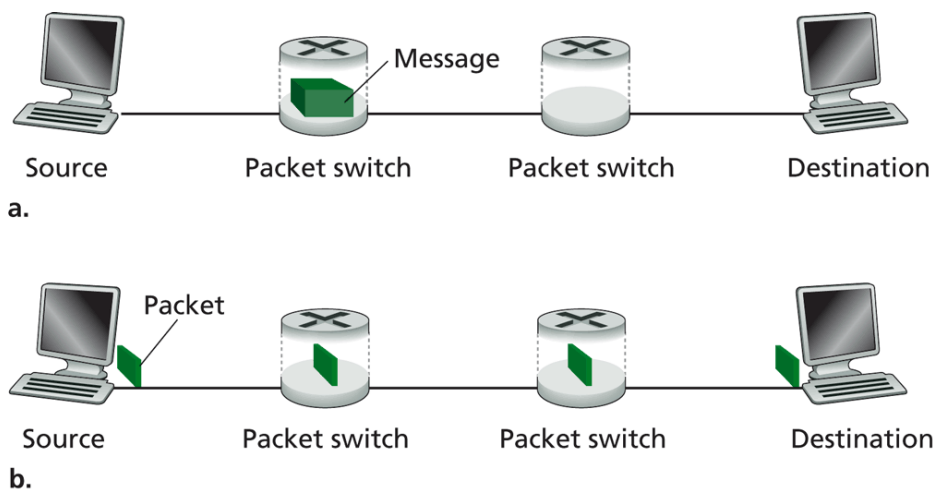
(revised in 4/12)

Due: 2010/4/14 in class

1. We want to send a packet of  $L$  bits over a path of  $Q$  links. A link  $i$  transmits at  $R_i$  bps,  $1 \leq i \leq Q$ . There are no queuing delays.
  - (a) **(out of the scope of this chapter)** Suppose the network is a packet-switched virtual-circuit network. Propagation delay is negligible. Denote the VC setup time by  $t_s$  seconds. Suppose the sending layers add a total of  $h$  bits of header to the packet. How long does it take to send a packet from source to destination?
  - (b) Suppose the network is a packet-switched datagram network and a connectionless service is used. Now suppose each packet has  $3h$  bits of header, and **propagation delay over a link  $i$  is  $D_i$  seconds,  $1 \leq i \leq Q$** . How long does it take to send a packet from source to destination?
  - (c) Suppose that the network is a circuit-switched network. Propagation delay is negligible. Further suppose that the transmission rate of the circuit between source and destination is  $R$  bps. Assuming  $t_s$  setup time and  $2h$  bits of header appended to the packet, how long does it take to send a packet?
2. Consider sending voice from Host A to Host B over a packet-switched network. Host A converts analog voice to a digital 32 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 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 at Host A) until the bit is decoded (as part of the analog signal at Host B)?
3. In 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. Figure 1 illustrates the end-to-end transport of a message with and without message segmentation. Consider a message that is  $7.5 \times 10^6$  bits long that is to be sent from source to destination in Figure 1. Suppose each link in the figure is 1.5Mbps. 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 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 second 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 the result with your answer in part (a) and comment.
- (d) Discuss the drawbacks of message segmentation.



**Figure 1** ♦ End-to-end message transport: (a) without message segmentation; (b) with message segmentation.

4. Within the web browser, a link is clicked to obtain a web page. Suppose that a DNS look-up is necessary to obtain the IP address, because IP address for the associated URL is not cached. Suppose that  $n$  DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of  $RTT_1, \dots, RTT_n$ . Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let  $RTT_0$  denote the RTT between the local host and the server containing the object. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object?

5. Referring to Problem 4, suppose the HTML file references three very small objects on the same server. Neglecting transmission times, how much time elapses with
- (a) Nonpersistent HTTP with no parallel TCP connections?
  - (b) Nonpersistent HTTP with parallel connections?
  - (c) Persistent HTTP with pipelining?