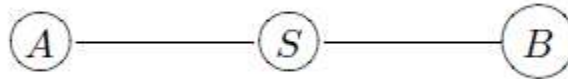
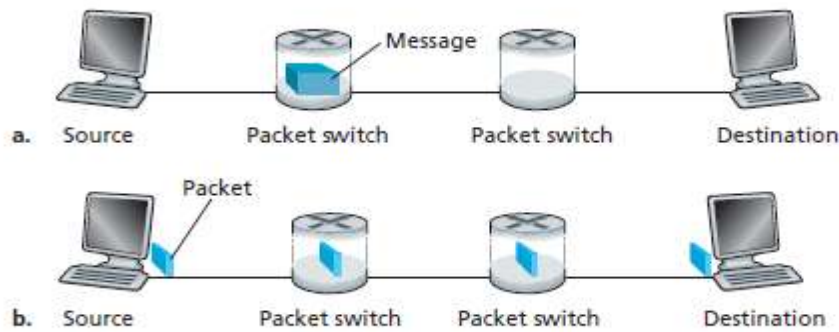


**JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY**  
**COMPUTER NETWORKS (10B11CI511)**  
**BTECH 7<sup>TH</sup> SEM 2019**  
**TUTORIAL-2 (23<sup>rd</sup> July to 6<sup>th</sup> Aug 2019)**

- Q1. Hosts A and B are each connected to a switch S via 10-Mbps links as shown above. The propagation delay on each link is  $20\mu\text{s}$ . S is a store-and-forward device that can send and receive bits simultaneously; it begins retransmitting a received packet  $35\mu\text{s}$  after it has finished receiving it (if it can). Calculate the total time in milliseconds required to transmit 12,000 bits from host A to host B (1) as single packet (2) as three packets of 4000bits packet size



- Q2. 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:
- Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?
  - 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?
- Q3. Suppose users share a 2 Mbps link. Also suppose each user transmits continuously at 1 Mbps when transmitting, but each user transmits only 20 percent of the time. (See the discussion of statistical multiplexing in Section 1.3.)
- When circuit switching is used, how many users can be supported?
  - 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?
  - Find the probability that a given user is transmitting.
  - 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.
- Q4. 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*. Figure 1.27 illustrates the end-to-end transport of a message with and without message segmentation. Consider a message that is  $8 \cdot 10^6$  bits long that is to be sent from source to destination in Figure 1.27. Suppose each link in the figure is 2 Mbps. Ignore propagation, queuing, and processing delays.



**Figure 1.27** ♦ 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. 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.
  - d. In addition to reducing delay, what are reasons to use message segmentation?
- Q5. Consider the discussion in Section 1.3 of packet switching versus circuit switching in which an example is provided with a 1 Mbps link. Users are generating data at a rate of 100 kbps when busy, but are busy generating data only with probability  $p = 0.1$ . Suppose that the 1 Mbps link is replaced by a 1 Gbps link.
- a. What is  $N$ , the maximum number of users that can be supported simultaneously under circuit switching?
  - b. Now consider packet switching and a user population of  $M$  users. Give a formula (in terms of  $p$ ,  $M$ ,  $N$ ) for the probability that more than  $N$  users are sending data.
- Q6. Consider a packet of length  $L$  which 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  $d_i$ ,  $s_i$ , and  $R_i$  denote the length, propagation speed, and the transmission rate of link  $i$ , for  $i = 1, 2, 3$ . The packet switch delays each packet by  $d_{proc}$ . Assuming no queuing delays, in terms of  $d_i$ ,  $s_i$ ,  $R_i$ , ( $i = 1, 2, 3$ ), 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  $2.5 \cdot 10^8$  m/s, the transmission rates of all three links are 2 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?
- Q7. 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 1,500 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?

- Q8. Consider sending a large file of  $F$  bits from Host A to Host B. There are three links (and two switches) between A and B, and the links are uncongested (that is, no queuing delays). Host A segments the file into segments of  $S$  bits each and adds 80 bits of header to each segment, forming packets of  $L = 80 + S$  bits. Each link has a transmission rate of  $R$  bps. Find the value of  $S$  that minimizes the delay of moving the file from Host A to Host B. Disregard propagation delay.

Reference: The questions have been prepared from homework exercises of “Computer Networking a Top down Approach”, Sixth Edition