NTNU
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TTM4100
Communication – Services and Networks

Assignment for Chapter 1: “Overview of Computer Networks and the Internet”

Deadline of submission: **22.01.2017**

The assignment questions are chosen from the Problems of Chapter 1 in the textbook: J. F. Kurose and K. W. Ross. *Computer Networking: A Top-Down Approach (International Edition, 6/e)*. Please note that there are some modifications to the questions in the textbook, the questions in this document are to be used if there are differences.

For each question or sub-question, several choices are provided and only one of them is correct. Submit your answers to the Its Learning system.

1. Consider the circuit-switched network in Figure 1.13 (page 28). Recall that there are *n* circuits on each link. (Problem P4, Chapter 1, page 71.)

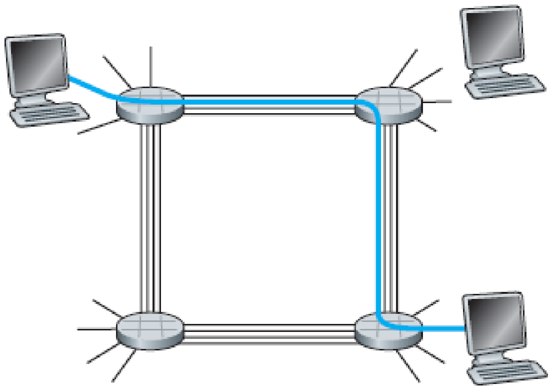

Figure 1.13 ♦ A simple circuit-switched network consisting of four switches and four links

1.a) What is the maximum number of simultaneous connections that can be in progress at any one time in this network?

1.a.1 4n
1.a.2 n/2
1.a.3 n
1.a.4 2n

1.b) Suppose that all connections are between the switch in the upper-left-hand corner and the switch in the lower-right-hand corner. What is the maximum number of simultanesous connections that can be in progress?

1.b.1 4n
1.b.2 n/2
1.b.3 n
1.b.4 2n

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. (Problem P6, Chapter 1, page 72.)

2.a) Express the propagation delay, d $_{prop}$, in terms of *m* and *s*.

2.a.1 $d_{prop} = 0$ ***seconds.***
2.a.2 $d_{prop} = 1/s$ ***seconds.***
2.a.3 $d_{prop} = m/s$ ***seconds.***
2.a.4 $d_{prop} = s/m$ ***seconds.***

2.b) Determine the transmission time of the packet, d $_{trans}$, in terms of *L* and *R*.

2.b.1 $d_{trans} = 0$ ***seconds.***
2.b.2 $d_{trans} = 1/R$ ***seconds.***
2.b.3 $d_{trans} = L/R$ ***seconds.***
2.b.4 $d_{trans} = R/L$ ***seconds.***

2.c) Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.

2.c.1 $d_{end\text{-}to\text{-}end} = (m/s + L/R)$ ***seconds.***
2.c.2 $d_{end\text{-}to\text{-}end} = m/s$ ***seconds.***
2.c.3 $d_{end\text{-}to\text{-}end} = L/R$ ***seconds.***
2.c.4 $d_{end\text{-}to\text{-}end} = (s/m + R/L)$ ***seconds.***

2.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?

2.d.1 The bit has left Host B.
2.d.2 The bit has reached Host B.
2.d.3 The bit is just leaving Host A.
2.d.4 The bit is in half-way of the link and has not reached Host B.

2.e) Suppose d $_{prop}$ is greater than d $_{trans}$. At time t = d $_{trans}$, where is the first bit of the packet?

2.e.1 The bit has left Host B.
2.e.2 The bit has reached Host B.
2.e.3 The bit is just leaving Host A.
2.e.4 The bit is in the link and has not reached Host B.

2.f) Suppose d $_{prop}$ is less than d $_{trans}$. At time t = d $_{trans}$, where is the first bit of the packet?

2.f.1 The bit has left Host B.
2.f.2 The bit has reached Host B.
2.f.3 The bit is just leaving Host A.
2.f.4 The bit is in the link and has not reached Host B.

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

2.g.1 193 km
2.g.2 493 km
2.g.3 893 km
2.g.4 1693 km

3. Consider a packet of length *L* which begins at end system A, travels over one link to a packet switch, and travels from the packet switch over a second link to a destination end system. Let d_i, s_i and R_i denote the length, propagation speed, and the transmission rate of link *i*, for $i = 1,2$. The packet switch delays each packet by d_{proc}. (Problem P10, Chapter 1, page 73.)

3.a) Assuming no queuing delays, in terms of d_i, s_i, R_i ($i=1,2$), and L, what is the total end-to-end delay for the packet?

3.a.1 $d_{end\text{-}end} = L/R_1 + d_1/s_1 + d_{proc}$
3.a.2 $d_{end\text{-}end} = d_1/s_1 + d_2/s_2 + d_{proc}$
3.a.3 $d_{end\text{-}end} = L/R_1 + L/R_2 + d_1/s_1 + d_2/s_2$
3.a.4 $d_{end\text{-}end} = L/R_1 + L/R_2 + d_1/s_1 + d_2/s_2 + d_{proc}$

3.b) Suppose now the packet length is *1,000* bytes, the propagation speed on both links is $2.5 \cdot 10^8$ m/s, the transmission rates of both links is *1* Mbps, the packet switch processing delay is *2* msec, the length of the first link is *6,000* km, and the length of the last link is *3,000* km. For these values, what is the end-to-end delay?

3.b.1 18 msec
3.b.2 30 msec
3.b.3 54 msec
3.b.4 56 msec

4. Suppose *N* packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length *L* and the link has transmission rate *R*. What is the average queuing delay for the *N* packets? (Problem P13, Chapter 1, page 73.)

4.1 $NL/(2R)$
4.2 $(N-1)L/(2R)$
4.3 L/R
4.4 NL/R

5. In modern packet-swiched 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 ino the original message. We refer to this process as message segmentation. Figure 1.27 (page 77) 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. (**Problem P31 (a-c), Chapter 1, page 77.**)**

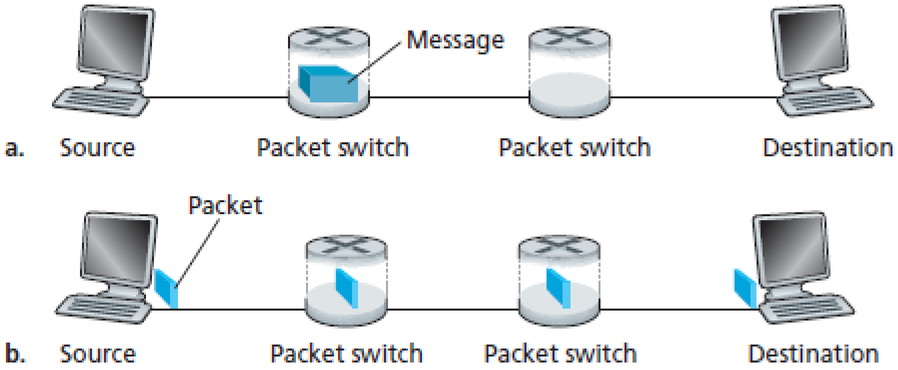

Figure 1.27 ♦ End-to-end message transport: (a) without message segmentation; (b) with message segmentation

5.a.1) 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? (First part of P31.a)

5.a.1.1 *4 sec*
5.a.1.2 *8 sec*
5.a.1.3 *12 sec*
5.a.1.4 *16 sec*

5.a.2) 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? (Second part of P31.a)

5.a.2.1 *4 sec*
5.a.2.2 *8 sec*
5.a.2.3 *12 sec*
5.a.2.4 *16 sec*

5.b.1) Now suppose that the message is segmented into 4000 packets, with each packet being 2000 bits long. How long does it take to move the first packet from the source host to the first switch? (First part of Problem P31.b**)**

5.b.1.1 *1 msec*
5.b.1.2 *2 msec*
5.b.1.3 *3 msec*
5.b.1.4 *4 msec*

5.b.2) 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? (Second part of Problem P31.b**)**

5.b.2.1	*1 msec*
5.b.2.2	*2 msec*
5.b.2.3	*3 msec*
5.b.2.4	*4 msec*

5.c) How long does it take to move the file from source host to destination host when message segmentation is used? (First part of Problem P31.c**)**

5.c.1	*1.002 sec*
5.c.2	*3.002 sec*
5.c.3	*4.002 sec*
5.c.4	*5.002 sec*