

SYSC 5201 Fall 2012 Assignment #1

1.

Design and describe an application-level protocol to be used between an automatic teller machine and a bank's centralized computer. Your protocol should allow a user's card and password to be verified, the account balance (which is maintained at the centralized computer) to be queried, and an account withdrawal to be made (that is, money disbursed to the user). Your protocol entities should be able to handle the all-too-common case in which there is not enough money in the account to cover the withdrawal. Specify your protocol by listing the messages exchanged and the action taken by the

automatic teller machine or the bank's centralized computer on transmission and receipt of messages. Sketch the operation of your protocol for the case of a simple withdrawal with no errors, using a diagram similar to that in Figure 1.2. Explicitly state the assumptions made by your protocol about the underlying end-to-end transport service.

Messages from ATM machine to Server

Msg name	purpose
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HELO <userid>	Let server know that there is a card in the ATM machine ATM card transmits user ID to Server
PASSWD <passwd>	User enters PIN, which is sent to server
BALANCE	User requests balance
WITHDRAWL <amount>	User asks to withdraw money
BYE	user all done

Messages from Server to ATM machine (display)

Msg name	purpose
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PASSWD	Ask user for PIN (password)
OK	last requested operation (PASSWD, WITHDRAWL) OK
ERR	last requested operation (PASSWD, WITHDRAWL) in ERROR
AMOUNT <amt>	sent in response to BALANCE request
BYE	user done, display welcome screen at ATM

Correct operation:

client		server
HELO (userid)	----->	(check if valid userid)
	<-----	PASSWD

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PASSWD <passwd> -----> (check password)
                    <----- OK (password is OK)
BALANCE           ----->
                    <----- AMOUNT <amt>
WITHDRAWL <amt>  -----> check if enough $ to cover
                    withdrawl
                    <----- OK
ATM dispenses $
BYE              ----->
                    <----- BYE

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In situation when there's not enough money:

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HELO (userid)    -----> (check if valid userid)
                    <----- PASSWD
PASSWD <passwd>  -----> (check password)
                    <----- OK (password is OK)
BALANCE          ----->
                    <----- AMOUNT <amt>
WITHDRAWL <amt> -----> check if enough $ to cover
withdrawl
                    <----- ERR (not enough funds)
error msg displayed
no $ given out
BYE             ----->
                <----- BYE

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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.

- Express the propagation delay, d_{prop} , in terms of m and s .
- Determine the transmission time of the packet, d_{trans} , in terms of L and R .
- 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 $t = d_{\text{trans}}$, where is the last bit of the packet?
- e. Suppose d_{prop} is greater than d_{trans} . At time $t = d_{\text{trans}}$, where is the first bit of the packet?
- f. Suppose d_{prop} is less than d_{trans} . At time $t = d_{\text{trans}}$, 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} .

Solution:

a) $d_{\text{prop}} = m / s$ seconds.

b) $d_{\text{trans}} = L / R$ seconds.

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

d) The bit is just leaving Host A.

e) The first bit is in the link and has not reached Host B.

f) The first bit has reached Host B.

g) Want

$$m = \frac{L}{R} s = \frac{120}{56 \times 10^3} (2.5 \times 10^8) = 536 \text{ km.}$$

3.

Consider the queuing delay in a router buffer (preceding an outbound link). Suppose all packets are L bits, the transmission rate is R bps, and that N packets simultaneously arrive at the buffer every LN/R seconds. Find the average queuing delay of a packet. (*Hint: The queuing delay for the first packet is zero; for the second packet L/R ; for the third packet $2L/R$. The N th packet has already been transmitted when the second batch of packets arrives.*)

Solution:

It takes LN/R seconds to transmit the N packets. Thus, the buffer is empty when a batch of N packets arrive.

The first of the N packets has no queuing delay. The 2nd packet has a queuing delay of L/R seconds. The n^{th} packet has a delay of $(n-1)L/R$ seconds.

The average delay is

$$\frac{1}{N} \sum_{n=1}^N (n-1)L/R = \frac{L}{R} \frac{1}{N} \sum_{n=0}^{N-1} n = \frac{L}{R} \frac{1}{N} \frac{(N-1)N}{2} = \frac{L}{R} \frac{(N-1)}{2}.$$

4.

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 both 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?

Solution:

The first end system requires L/R_1 to transmit the packet onto the first link; the packet propagates over the first link in d_1/s_1 ; the packet switch adds a processing delay of d_{proc} ; after receiving the entire packet, the packet switch connecting the first and the second link requires L/R_2 to transmit the packet onto the second link; the packet propagates over the second link in d_2/s_2 . Similarly, we can find the delay caused by the second switch and the third link: L/R_3 , d_{proc} , and d_3/s_3 .

Adding these five delays gives

$$d_{end-end} = L/R_1 + L/R_2 + L/R_3 + d_1/s_1 + d_2/s_2 + d_3/s_3 + d_{proc} + d_{proc}$$

To answer the second question, we simply plug the values into the equation to get $6 + 6 + 6 + 20 + 16 + 4 + 3 + 3 = 64$ msec.

5.

Suppose there is a 10 Mbps microwave link between a geostationary satellite and its base station on Earth. Every minute the satellite takes a digital photo and sends it to the base station. Assume a propagation speed of $2.4 \cdot 10^8$ meters/sec.

- What is the propagation delay of the link?
- What is the bandwidth-delay product, $R \cdot d_{prop}$?
- Let x denote the size of the photo. What is the minimum value of x for the 74 microwave link to be continuously transmitting?

Solution:

Recall geostationary satellite is 36,000 kilometers away from earth surface.

- 150 msec
- 1,500,000 bits
- 600,000,000 bits