CNT-5008 Midterm 1 Grading Key

Date: Thursday October 7, 2019

Name: ……

Instructions:

- This exam is open book and open notes. Textbooks and notes on tablet devices are acceptable but they must be put into airplane mode. No device with a keyboard is acceptable.
- It is recommended that you use a pencil, such that you can make corrections. Do not use highlighters, and don't use red colored pens.
- Allotted time is 180 minutes.
- Note that the points add up to 100 + 20 bonus points.

Problem 1 Packet transmission (20 pts)

Suppose that there is exactly one packet switch between a sending host and a receiving host. The transmission rates between the sending host and the switch and the switch and receiving host are R1 and R2 respectively. Assuming the switch uses store-and-forward packet switching, what is the total end-to-end delay to send a packet of length L? (Ignore queuing, propagation delay, and processing delay).

At time t0 the sending host begins to transmit. At time t1=L/R1 the sending host completes transmission and the entire packet is received at the router (no propagation delay). Because the router has the entire packet at time t1 it can begin to transmit the packet to the receiving host at time t1. At time t2=t1+L/R2 the router completes transmission and the entire packet is received at the receiving host (again, no propagation delay). Thus, the end-to-end delay is L/R1 + L/R2.

Problem 2 Circuit switched vs packet switched (20pts)

What advantage does a circuit switched network have over a packet switched one?

A circuit-switched network can guarantee a certain amount of end-to-end bandwidth for the duration of a call. Most packet-switched networks today (including the Internet) cannot make any end-to-end guarantees for bandwidth.

What advantage does packet switched network have over a circuit switched one?

More efficient use of the network. Nodes in the core do not need to be aware of the connections. Allows communication without setting up a connection.

Problem 3 Multiplexing (20 pt)

Suppose users share a 2Mbps link. Also suppose each user transmits continuously when transmitting, but each user transmits only 20 percent of the time.

a) Let us assume circuit switching is used. How many users can be supported.

2 users can be supported because each user requires half of the link bandwidth.

b) For the remainder of this problem, assume that packet switching is used. Why will there be essentially no queuing delay before the link if two or fever users transmit at the same time? Why there will be a queuing delay if three users transmit at the same time.

Since each user requires 1Mbps when transmitting, if two or fewer users transmit simultaneously, a maximum of 2Mbps will be required. Since the available bandwidth of the shared link is 2Mbps, there will be no queuing delay before the link. Whereas, if three users transmit simultaneously, the bandwidth required will be 3Mbps which is more than the available bandwidth of the shared link. In this case, there will be queuing delay before the link.

c) Find the probability that a given user is transmitting.

Probability that a given user is transmitting = 0.2

d) Suppose now that there are three users. Find the probability that at any given time all three are transmitting simultaneously. Find the fraction of time during which the queue grows.

P^3= (0.2)^3 = 0.008. Probability that all three users are transmitting simultaneously. Since the queue grows when all the users are transmitting, the fraction of time during which the queue grows (which is equal to the probability that all three users are transmitting simultaneously) is 0.008.

Problem 4 - Design of an application-level protocol (40 pt)

Design and describe an application-level protocol to be used between an ATM machine and the banks central computer. Your protocol should allow a user's card and password to be verified, the account balance (which is maintained at the central computer) to be queried, and an account withdrawal to be made (money disbursed to the user). Your protocol should be able to handle the case when there is not enough money in the account to cover the withdrawal.

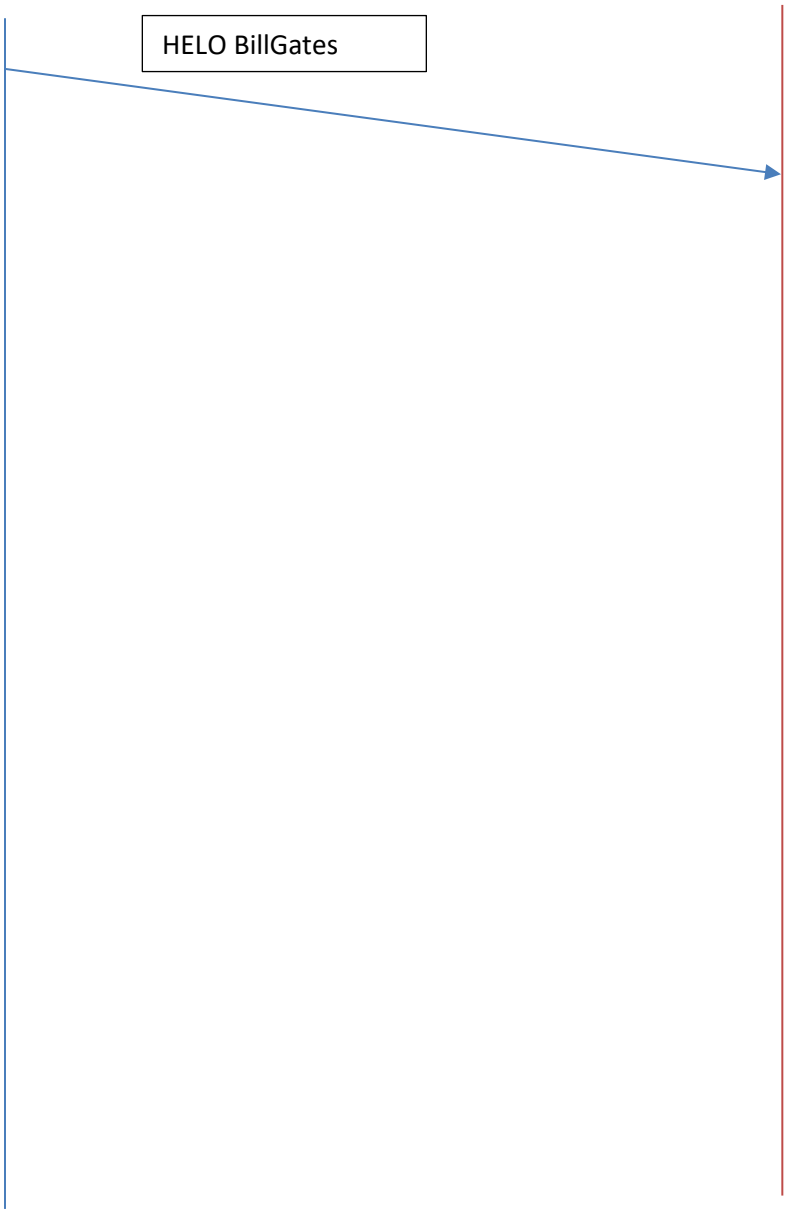
Specify your protocol by listing the messages exchanged and the action taken by the ATM.

Messages sent by the ATM:

HELO <userid> Let server know that there is a card in the ATM machine

Messages sent by the central computer

Sketch the operation of your protocol in the case of a simple withdrawal of $20 with no errors. Explicitly state the assumptions made by the protocol about the underlying end-to-end transport service.



There is no single right answer to this question. Many protocols would do the trick. Here's a simple answer below:

Messages from ATM machine to Server
Msg name -------- purpose -------
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 user all done
BYE

Messages from Server to ATM machine (display)
Msg name -------- purpose -------

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

In situation when there's not enough money:

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

Problem 5: Application layer review questions (20pts)

List five non-proprietary Internet applications and the application layer protocols they use.

1. The Web: HTTP; file transfer: FTP; remote login: Telnet; e-mail: SMTP; BitTorrent file sharing: BitTorrent protocol

For a communication session between a pair of processes, which process is the client and which one is the server?

The process which initiates the communication is the client; the process that waits to be contacted is the server

Why do HTTP, SMTP and POP3 run on top of TCP rather than UDP?

The applications associated with those protocols require that all application data be received in the correct order and without gaps. TCP provides this service whereas UDP does not.