Concordia University
Department of Computer Science & Software Engineering

Comp 6461, Fall 2014
Instructor: Aiman Hanna
Time: 60 minutes

Mid-term Exam

Keep your answers organized and clean.
This exam has **5** pages. Answer all questions.
Exam will be marked out of 20.

Name: _____

ID #: _____

Question 1 (5 marks)

a) Assume you are hired by a large software firm to develop an application that will mainly be used by the firm's clients over the Internet. As part of the negotiated terms, clients will allow all packages from the application to pass through their firewalls without being filtered out. The application strictly requires reliability yet it must provide high timing performance. Further, the company has a very high capacity link between its edge router and the Internet. One of your teammates proposed that reliability should be implemented as part of the application itself and showed that this can be done with an acceptable cost in terms of both time and money. Consequently, he further suggested that the application should use UDP instead of TCP. You have categorically refused this proposal. Is there any validity behind such proposal? Explain clearly the main reasons behind your refusal.

b) Now, assume the same exact scenario in question (a) above, with the exception that reliability is no longer required by the application, but it can be tolerated. Will you still object to the proposal? If *yes*, explain why the proposal is still invalid/deficient. If *no*, explain why the proposal makes sense under these new conditions.

Question 2 (3 marks)

Assume a 100 Mbps link is shared between n users. Each of these users requires 4 Mbps when active; however it is found that users are only active at different times and for small period of time. Further, based on their activities, it was found that the probability that 50 of them can be active at the same time is 0.00022. This probability goes smaller for a smaller number of users, but it exponentially grows bigger once the number of users exceeds 50.

i) How many users can be supported by this network if *circuit switching* is used?

ii) Under the above described conditions, and considering different factors such as cost and performance, would you use *packet switching* instead of *circuit switching*? If *yes*, explain clearly the reasons behind your choice. If *no*, explain why packet switching should never be used in that network.

iii) Is there any way that the utilization of *circuit switching* in this network can actually harm user's performance? Explain *why* or *why not*. (Note: You should only consider performanee when you answer this question).

Question 3 (4 marks)

a) Assume a TDM network, with 192 channels, and a bit rate of 6.144 Mbps. Further assume 400ms is needed for end-to-end circuit establishment. How much time is needed to send a file of size 2.88 Mbits over this network?

b) Assume a sender and a receiver are connected through 3 identical routers. The total distance between the two ends is 20KM and the signal propagates at a speed of 500meters/microsecond. Further, all links in the network have a bit rate of 40 Mbps, and all sent packets have the size of 10Mbit. The processing speed of a router is 20 microsecond and in average, the queuing delay is 30 microseconds.

i) What is the total delay to send one packet from the sender to the receiver?

ii) Assume the network has been modified, where the link between the sender and the first router was replaced by a higher rate link of 80 Mbps, and the link between the last router and the receiver was replaced by a lower rate link of 20 Mbps; the other links have not been changed. What is the total delay to send one packet from the sender to the receiver under these new configurations?

Question 4 (5 marks)

a) Assume a reliable communication is needed between a sender and a receiver where the sender has only two packets to send each time the communication is established. The network is assumed to be unreliable that any type of corruption is possible, however loss is not possible. Under these particular conditions, the following protocol is proposed:

A sequence number will be given to transmitted packets; consequently the sent packets are always P_0 and P_1.

The sender sends a packet then waits either for an ACK_i (indicating successful receipt) or a NAK_i (indicating unsuccessful receipt), where *i* is either 0 or 1. An ACK will result in the sender sending the next packet or terminating (if ACK_1 is received).

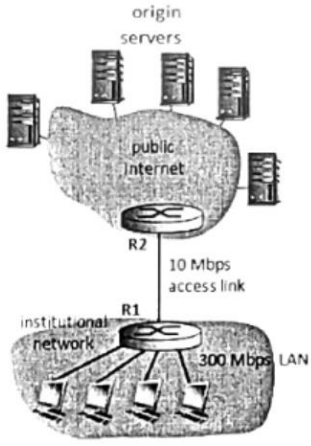
The receiver waits for a packet with the proper sequence number to arrive. The receiver then responds with either an ACK_i if reception is successful, or NAK_i if reception is either corrupt or if a packet with an incorrect/unexpected sequence number is received.

Under the given particular conditions, will the protocol work? If *yes*, explain why the protocol is robust under these conditions, if *no*, provide a detailed scenario that shows how the protocol would fail.

b) Now, assume some changes to the conditions given in question (a) above. In particular, it is now assumed that loss is possible. Further, it is assumed that the sender always has 4 packets to send (P_0, P_1, P_2 and P_3) and that the sequence number, in both sent packets as well as ACK/NAK packets, is immune to corruption. Under these new conditions, will the protocol work? If *yes*, explain why the protocol is robust under these conditions, if *no*, provide a detailed scenario that shows how the protocol would fail.

Question 5 (5 marks)

a) Assume the network shown in the figure, where an institutional network has a speed 300Mbps. The hosts on the network are mainly using HTTP, where the average requests from all hosts is 20Mbps. The link between the institution router, R1, and the router connecting it to the Internet, R2, has a rate of 10Mbps. Further, Internet delay (to obtain HTTP objects from the web servers to R2) is 3 seconds. The round trip delay between R1 and R2 is 50 milliseconds when the traffic intensity on the link is below 70%. The delay averages to 8 minutes when traffic intensity exceeds 70%. Finally, the round trip delay between the hosts and R1 is 2 milliseconds. All other delays are negligible.



Under these conditions, what is the total delay needed for the hosts to receive their HTTP requests?

b) Now, assume that the institution installed a local web cache and that in average, 60% of the requests are handled by the cache. Requests from the cache take an average of 1 millisecond. This time is considered negligible for cache misses (i.e. lost time due to cache misses can be discarded).
Under these conditions, what is the total delay needed for the hosts to receive their HTTP requests?