University of Toronto Mississauga

Midterm Test

Course: CSC358H5 Winter 2019

Instructor: Larry Zhang

Duration: 90 minutes

Aids allowed: one double-sided 8.5x11 aid sheet

Last Name: Sample

Given Name: Solution

Flip to the back cover and write down your name and student number.

This midterm consists of a total of 86 marks, for 5 questions on 16 pages (including this one). When you receive the signal to start, please make sure that your copy is complete.

Each question is labelled with the suggested amount of time that you should spend on it. You may use it as a reference to better manage your time.

Precise answers will be given higher marks than vague ones. Concise answers will be given higher marks than lengthy ones. Illegible answers will not be given marks.

If you write an answer on a page for rough works, indicate clearly what you want to be marked.

You know more than you think you do!

Question 1: Very Short Answers [2x16 = 32 marks] [15 minutes]

For multiple choice questions, a mark will be deducted for each missing or wrong choice made.

1. Which of the following is an advantage of packet switching over circuit switching? Circle all that apply.
   a. more reliable data transfer
   b. better resource utilization
   c. lower delay
   d. easier connection setup

2. Which of the following types of delay does NOT depend on the size of the packet? Circle all that apply.
   a. transmission delay
   b. propagation delay
   c. queueing delay

3. Which of the following is TRUE about web caches? Circle all that apply.
   a. web cache reduces the workload on the web servers
   b. web cache increases the utilization of access links
   c. web cache acts as both TCP client and server
   d. web cache serves up-to-date web content

4. which of the following is TRUE about DNS? Circle all that apply.
   a. each DNS server keeps up-to-date resource records
   b. root DNS servers are very busy
   c. a local DNS server can directly query the root DNS server
   d. it is a centralized database

5. Which of the following is TRUE about Go-Back-N? Circle all that apply.
   a. it requires buffer on the sender side
   b. it requires buffer on the receiver side
   c. it ACKs every received packet
   d. it keeps a timer for each ACKed packet

6. Which of the following is TRUE about Selective Repeat? Circle all that apply.

a. it requires buffer on the sender side
b. it requires buffer on the receiver side
c. it ACKs every received packet
d. it keeps a timer for each ACKed packet

7. Which of the following is TRUE about TCP handshaking? Circle all that apply.

a. assuming that the client never terminates, a 2-way handshake would suffice
b. assuming that the client never terminates, a 3-way handshake is still necessary
c. assuming that the server can terminate anytime, a 3-way handshake would still suffice
d. assuming that the server can terminate anytime, a 3-way handshake would not be enough

8. Larry received an email in his UTMail inbox yesterday. However, the recipient field of the email says "godzilla@nasa.org". Which of the following could be the reason for this? Circle all that apply.

a. Larry is Godzilla
b. the sender used **RCPT TO: <godzilla@nasa.org>** in the SMTP request
c. the sender used **To: <godzilla@nasa.org>** in the SMTP request
d. the sender used **HELO <godzilla@nasa.org>** in the SMTP request
e. none of the above

9. A UDP server is handling requests from 5 different clients. How many sockets are open on the server? Write the number below.

1

10. Which "Accept-Encoding" should be specified in the HTTP request so that the HTTP response consists of the raw text rather than gzipped data?

Identity

11. Which mechanism in TCP causes an exponential increase of the sender window size? Write the name of the mechanism in the space below.

slow start

12. What is the maximum number of IP addresses can exist inside the subnet **142.100.0.0/25** ?

128

13. How does a DHCP server send a message to an arriving client that does not have an IP address yet? Write the answer in one word.

broadcast

14. In TCP, the sender sends a packet with 80 bytes of data with a sequence number 200, what is the expected ACK number for this packet?

280

15. Consider RTT estimation in TCP, what is the advantage of using the **exponential moving average** compared to simply using the **latest sample RTT**? Be concise.

Smoother

16. Which concept that we learned this course reflects the design phiosophy of "core functionality implemented at the network edge"? Write the name below.

DNS

Question 2: Short Answers [24 marks] [25 minutes]

1. Recall the proxy server that you implemented in Assignment 1. Which header fields of the HTTP request from the browser did the proxy server need to modify before forwarding it to the web server? Name **two** of them in the space below. [4 marks]

#1 URL

#2 Host / Accept Encoding

2. Suppose you are an ordinary user (not a system admin) within the UofT network, and you want to know if anyone from the UofT network has recently accessed the website **`memegenerator.net`**. Which Unix command would allow you to check that? Write the command below and describe **concisely** how you can tell from the output of the command if someone accessed the website recently. [4 marks]

Unix command: dig memegenerater.com

How to tell: If query time is small, then it's accessed recently.

3. Consider a host A that is sending packets to host B using the **Go-Back-N** protocol. The bandwidth of the link between A and B is 100 Mbps, and the size of each packet is 20 Kbits. The RTT of the link is 100 milliseconds. In order to reach a link utilization of 50%, what is the required minimum size of the sender window size (in terms of the number of packets)? Write your final answer in the blank, and show your calculation in the space below.. [4 marks]

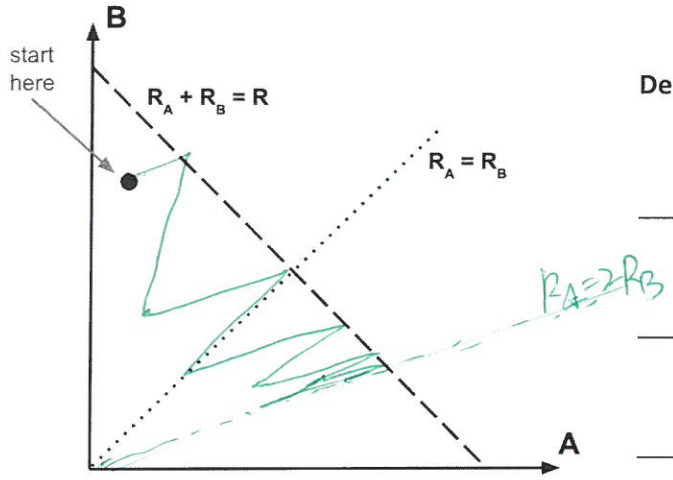
Minimum window size = 250 / 251 **packets**

Transmission Delay $= \frac{20K}{100M} = 2 \times 10^{-4}$ sec

$W \times \frac{2 \times 10^{-4}}{0.1 \text{ sec} + 2 \times 10^{-4}} = 0.5$

$W \approx 250$

4. Suppose we apply the following **"biased AIMD"** in TCP congestion control. With two TCP connections A and B sharing the same link with bandwidth **R**, when performing the **additive increase**, we increase the window size of A **twice as fast** as increasing the window size of B, i.e., we increase the window size of A by 2 while increasing the window size of B by 1. The **multiplicative decrease** is the same as before, i.e., we cut the window size by half for both A and B. In the following diagram, starting from the black dot, illustrate the change of the bandwidth allocated to A and B and where the allocation converges. In addition to drawing in the diagram, give a brief description of the bandwidth allocation between A and B after a long time. [4 marks]



Description of the allocation after a long time:

$R_A = 2R_B$

5. Suppose we change the multiplicative decrease in AIMD to cutting the window size to **one third (1/3)** of it, i.e., every time the window size decreases, it changes from **W** packets to **W/3** packets. What is the packet loss rate (fraction of packets lost) in this case? Write your final answer (in terms of W) in the blank, and show your calculation in the space below. [4 marks]

Packet loss rate = $\frac{9}{4W^2 + 6W}$

$$\frac{1}{\frac{W}{3} + \left(\frac{W}{3}+1\right) + \cdots + W}$$

6. Given the following forwarding table in a router. For each of the following destination IP address, choose the link interface that it should be forwarded to. [4 marks]

Prefix	Link Interface
10000000 0110	0
10000000 01100100 000001	1
10000000 01100100 0001	2
10000000 01100100 001	3
otherwise	4

IP addresses:

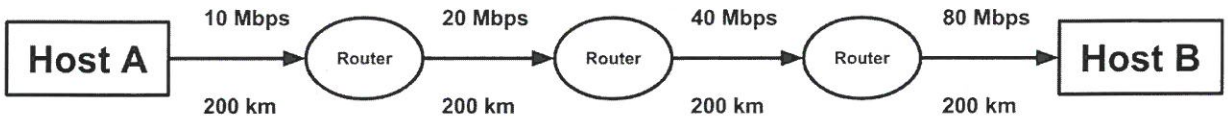
(a) 128.100.33.40 will be forwarded to link interface 3

(b) 128.101.15.50 will be forwarded to link interface 0

Question 3: Delays [12 marks] [10 minutes]

You'll get 1 out of 12 marks for leaving this question completely blank.

Consider the scenario in the picture below: Two hosts A and B that are connected via four hops of links between them. The transmission rates of the links are 10 Mbps, 20 Mbps, 40 Mbps, and 80 Mbps as shown in the picture. The physical length of each hop of the link is 200,000 meters. Assume that the propagation speed over the link is 2×10^8 meters/sec. Currently, we are continuously sending packets of size 40 Mbits from host A to host B. Answer the following questions.



(a) What is the A-to-B transmission delay of a single packet? [2 marks]

$\frac{40}{10} + \frac{40}{20} + \frac{40}{40} + \frac{40}{80} = 7.5$ sec

(b) What is the A-to-B propagation delay of a single packet? [2 marks]

$\frac{800{,}000\ m}{2 \times 10^8} = 4 \times 10^{-3}$

(c) What is the average queuing delay of a packet at the routers? [2 marks]

0 because no queuing up.

(d) What is the maximum A-to-B throughput that can be achieved? [2 marks]

10 Mbps

(e) For the first hop of the link (the one with 10 Mbps transmission rate), what is the maximum number of bits that can be "on the link" (i.e., the number of bits that are in transmission) at any given time? [2 marks]

$$100\text{ Mbps} \times T_{prog\,1}$$
$$= 100\text{ Mbps} \times \frac{200{,}000}{2 \times 10^8}$$
$$= 10\text{K bit}$$

(f) For the first hop of the link, what is the average distance (in meters) between two adjacent bits that are on the link? [2 marks]

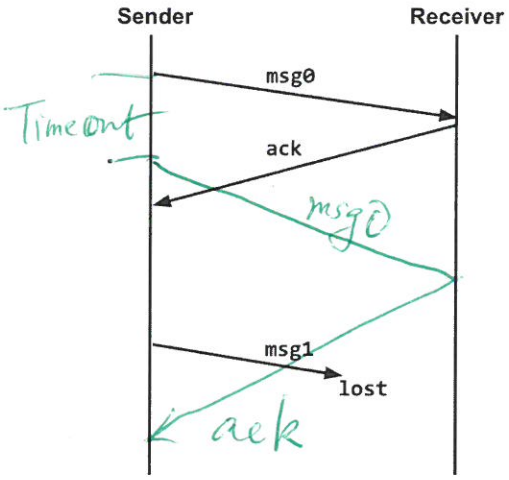
$$\frac{200{,}000\text{ m}}{10\text{K}} = 20\text{ meter}$$

Question 4: Stop-And-Wait [9 marks] [10 minutes]

You'll get 1 out of 9 marks for leaving this question completely blank.

In this question, we will review the Stop-And-Wait protocol (**rdt3.0**) and see why each component of the protocol is necessary by creating examples of "what could go wrong" when we modify the protocol. Answer the following questions.

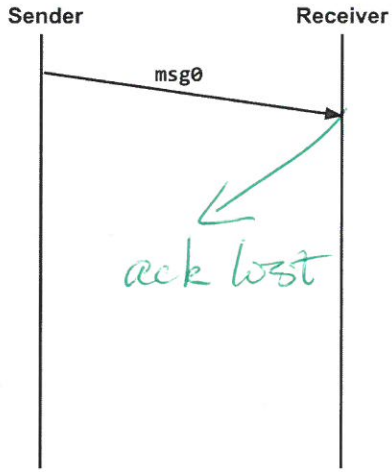
(a) What could go wrong if we modify the **original rdt3.0** in such a way that the ACK does not include the sequence number, the receiver sends ACK if and only if a message is received uncorrupted, and the sender always considers the ACK to be for the most recent message sent? Complete the partially given timing diagram below by turning it into a **simple** case where this modified protocol works **incorrectly**, and provide a brief description (on the right side) of what went wrong. For simplicity, assume that the messages and ACKs are **never corrupted**. [3 marks]



What went wrong (brief description):

msg1 is ACKed by mistake

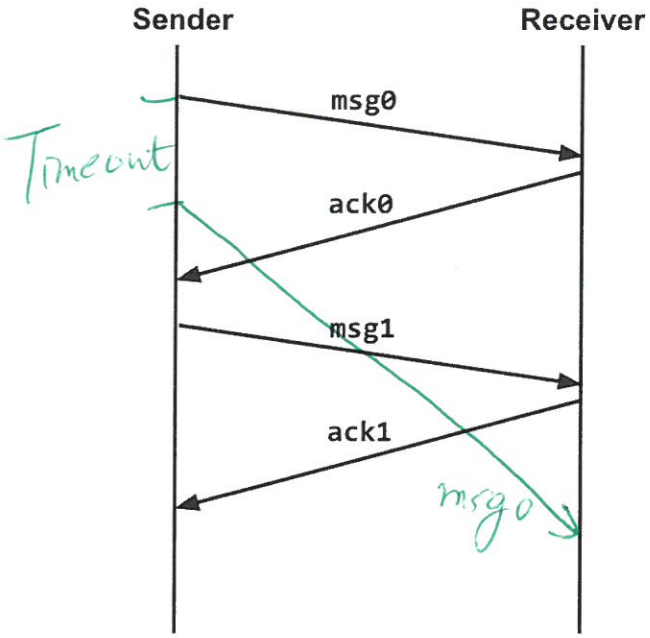
(b) What could go wrong if we modify the **original rdt3.0** such that the sender doesn't have a timeout? Complete the timing diagram below by turning it into a **simple** case where this modified protocol works **incorrectly**, and provide a brief description (on the right side) of what went wrong. [3 marks]



What went wrong (brief description):

Sender never resends

(c) What could go wrong if the network connection between the sender and the receiver can **reorder** the packets? For example, a sender sends **msg0** then **msg1**, but **msg1** could arrive earlier than **msg0** at the receiver. Complete the timing diagram below by turning it into a **simple** case where the **original rdt3.0** protocol works **incorrectly**, and provide a brief description (on the right side) of what went wrong. [3 marks]



What went wrong (brief description):

Old msg0 treated as a new one.

Question 5: P2P vs Client-Server [9 marks] [10 minutes]

You'll get 1 out of 9 marks for leaving this question completely blank.

Consider file distribution over a network. The files are originally located on a server that has an upload rate is 10 Mbps and a download rate of 100 Mbps. We want to distribute the files to **N** peers each of which has an upload rate of 100 Kbps and a download rate of 2 Mbps. We need to decide whether it is better to use the **client-server** architecture or the **P2P** architecture. Assume that the file distribution scheme is always optimal so that the minimum possible distribution time is reached.

(a) When N = 5, which architecture (client-server or P2P) has a smaller file distribution time? Justify your answer and show your work. [3 marks]

Same time.

P2P: $\max\left(\frac{F}{10M}, \frac{5F}{(10+5\times0.1)M}, \frac{F}{2M}\right) = \frac{F}{2M}$

C-S: $\max\left(\frac{5F}{10M}, \frac{F}{2M}\right) = \frac{F}{2M}$

(b) When N = 1000, which architecture (client-server or P2P) has a smaller file distribution time? Justify your answer and show your work. [3 marks]

P2P is smaller.

P2P: $\max\left(\frac{F}{10M}, \frac{1000F}{(10+1000\times0.1)M}, \frac{F}{2M}\right) = \frac{1000F}{110M}$

C-S: $\max\left(\frac{1000F}{10M}, \frac{F}{2M}\right) = \frac{100F}{M}$ ← Larger

(c) Find the smallest **N** such that P2P has a smaller file distribution time than client-server. Show your work. [3 marks]

When $N \leq 5$, both are the same.

When $N > 5$

P2P: $\frac{NF}{(10 + 0.1N)M}$ ①

C-S $\frac{NF}{10M}$ ②

① < ② is true always

So smallest $\boxed{N = 6.}$

Use the space below for rough work. This page will not be marked, unless you clearly indicate the part of your work that you want us to mark.

Use the space below for rough work. This page will not be marked, unless you clearly indicate the part of your work that you want us to mark.

Last Name: _____

Given Name: _____

Student Number: _____

Q1: _____ / 32

Q2: _____ / 24

Q3: _____ / 12

Q4: _____ / 9

Q5: _____ / 9

TOTAL: _____ / 86

END OF TEST