Name of Candidate: _____

Student ID: _____

Signature: _____

# THE UNIVERSITY OF NEW SOUTH WALES

## COMP3331/93331 T3, 2019

## Computer Networks and Applications

## Mid-term Examination

## INSTRUCTIONS TO CANDIDATES:

(1) Time allowed: 1 hours 15 minutes (there is no separate reading time).
(2) Total number of pages: 5 (including this cover page).
(3) Total number of questions: 5. You must answer all questions. Questions are of different value. Marks are as indicated. This examination makes up **20 marks** of your final mark for this course.
(4) Do not write your answers on this paper. This paper *must be returned* at the end of the examination.
**(5) IMPORTANT: There are two versions of Question 5, one for COMP3331 (undergraduate) students and the other for COMP9331 (postgraduate) students. Please attempt the correct version. You may lose all marks for the question if you solve the incorrect version.**
(6) Note that if the question asks you to derive a result or perform some calculations, it is important for you to show us your intermediate steps and tell us the arguments that you have made to obtain the result. You need to note that both the intermediate steps and the arguments carry marks. Please note that we are **not** just interested in whether you can get the final numerical answer or conclusion right, but we are **more** interested to find out whether you understand the subject matter. We do that by looking at your intermediate steps and the arguments that you have made to obtain the answer. Thus, if you can show us the perfect intermediate steps and the in-between arguments but got the numerical values wrong for some reason, we will still award you marks for having understood the subject matter.
If the question asks you to give an explanation, you should aim to give a succinct and to the point answer.
(7) This is a closed book exam. UNSW approved calculators are allowed.
(8) Write all answers in **ink** except where they are expressly required. Pencils may be used only for drawing, sketching or graphical work.
(9) **Tear off the last page of this booklet and provide anonymous feedback.**
(10) For **Questions 2 – 5**, if you do not wish your answer for a question to be marked, write **0.5 SYMPATHY MARK PLEASE** in the answer booklet for the question. If you do this you will be awarded 0.5 sympathy mark and your answer for that question will not be marked. **Sympathy marks apply for the entire question and not sub-parts.**

**GOOD LUCK AND MAY THE FORCE BE WITH YOU**

**Question 1 Hodge-Podge: Answer in 2-3 sentences at most (4 marks: 1 mark for each)**

a) A Content Distribution Network (CDN) replicates the same content in many locations throughout the world. A CDN typically directs clients to the appropriate replica by returning customized answers to DNS queries (e.g., by controlling the response to a request for the IP address of www.cnn.com). Give two reasons why a CDN would return different IP addresses in response to the same DNS query, from different clients?

b) Why isn't SMTP used by a user agent to *retrieve* e-mail from the local e-mail server? What is typically used instead?

c) A local DNS server typically discards cached name-to-address mappings when the time-to-live expires. Alternatively, the local DNS server could optimistically issue a new query for the cached domain name. Given one advantage and one disadvantage of that approach?

d) Suppose every link in the network carries two classes of traffic – voice over IP calls and e-mail messages, with a separate queue for each class. When deciding which packet to send next, the router first selects the head of the queue containing the voice traffic, and only sends an e-mail packet if the voice queue is empty. Does the e-mail traffic have *any* effect on the performance experienced by the voice calls? If so, what can be done to minimize the effects?

**Question 2 Delays and Throughput (4 marks)**

Consider the scenario in the figure to the right, in which (from the bottom up), three hosts and a local logging server (that stores information that is sent to it) are connected to a router and to each other by a 100 Mbps link, with negligible propagation delay. That router in turn is connected to another router over a 30 Mbps link with a 50ms one-way propagation delay, and the latter router is connected to remote logging servers, each over a 20 Mbps link with a 10ms one-way propagation delay.

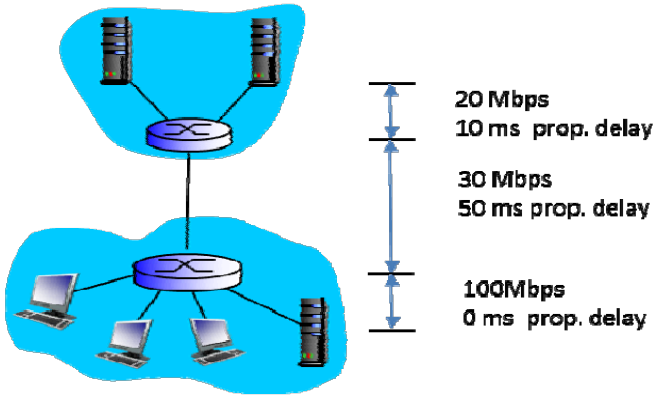



**Figure 1: Figure for Question 2**

(a) Suppose a host sends a logging message directly to one of the remote logging servers. The logging message is 10K bits long. What is the end-to-end delay from when the logging message is first transmitted by the host to when it is received at the remote server? Assume that the request goes directly to the server, that there are no queuing delays, and that node (router) packet-processing delays are also zero.

(b) Assume that each of the three hosts generate logging messages at the same rate; each host is equally like to send a logging message to either of the two remote servers. No traffic is directed to the local logging server. What is the maximum rate at which the clients can send logging messages to the remote servers?

(c) Now assume that the local logging server is ON and only one host is active (generating) logging messages and that host is only sending messages to one of the remote logging servers. Suppose that 50% of the logging messages are directed locally and the other 50% directed to this remote server. What is the maximum rate at which this host can generate and send logging messages (both local and remote combined, given there is a 50/50 ratio of local/remote transmissions) in this scenario?

**Question 3 To Persist or Not to Persist (4 marks)**

Consider a web page whose base file is of size S1 = 10 Kbytes. Assume that the web page contains N = 20 inline objects each of size S2 = 100 Kbytes. Assume that the round-trip time between the web client and the web server is T = 100ms and the capacity of the bottleneck link along this path is C = 10 Mbps. Assume that there is no other network traffic flowing along this path. You may ignore any packetization delays and header overheads.

(a) Assume non-persistent HTTP is used (without parallel connections), how long does it take to download the web page?

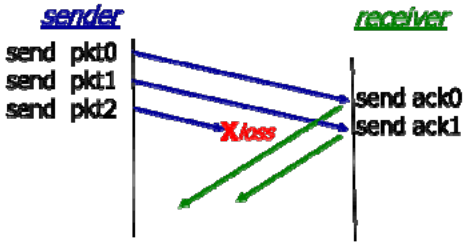
(b) Assume non-persistent HTTP is used with four parallel TCP connections, how long does it take to download the web page? Assume that the parallel connections equally share the total available capacity along the path.

(c) Assuming pipelined, persistent HTTP is used, how long does it take to download the web page?

(d) Assuming non-pipelined, persistent HTTP with two parallel connections is used, how long does it take to download the web page. Assume that the parallel connections equally share the total available capacity along the path.

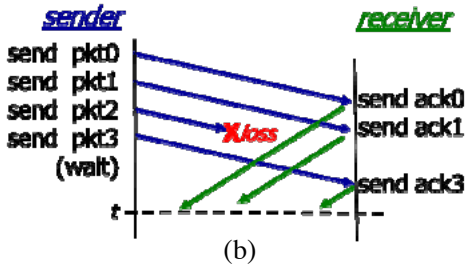
**Question 4 Sliding Windows (4 marks)**

(a) Consider the sliding window protocol in Figure 2(a). Is the protocol being used Go-Back-N or Selective Repeat? Or is there not enough information to tell? Explain your answer briefly.




(a)

(b) Consider the sliding window protocol in Figure 2(b). Is the protocol being used Go-Back-N or Selective Repeat? Or is there not enough information to tell? Explain your answer briefly.




(b)

**Figure 2: Figure for Question 4**

(c) Consider Figure 2(b) again. Suppose the sender and receiver windows are of size N = 4 and suppose the sequence number space goes from 0 to 15. What are the current sequence numbers in the sender and receiver windows?

(d) Consider Figure 2(b) again. Give a list of all possible future events at the sender resulting from the ACKs currently propagating from receiver to sender at time t. For each of these events, indicate the action taken at the sender (only).

**Question 5 Sequences and Acknowledgments (4 marks)**

**SOLVE ONE OF THE FOLLOWING DEPENDING ON YOUR ENROLLMENT. YOU MAY RECEIVE ZERO MARKS IF YOU ATTEMPT THE INCORRECT VERSION.**

**COMP3331 (UNDERGRADUATE VERSION)**

A TCP connection has been established between hosts A and B. Host A receives a packet from host B that has a 52-byte TCP payload and the following TCP header field values shown below: Sequence: 1001, Acknowledgement: 5001, Receiver Window Size: 4000.

Assume that host B has not sent any acknowledgements beyond 5001.

For each of the packets below (for which are listed selected TCP header field values and payload size), indicate whether they are possible valid responses from host A. You are required to explicitly indicate if each of the choices below is valid or invalid and provide a justification for your answer.

a) TCP Header Fields – Sequence: 5001, Acknowledgement: 1053, TCP Payload: 2000 bytes

b) TCP Header Fields – Sequence: 1053, Acknowledgement: 5001, TCP Payload: 2000 bytes

c) TCP Header Fields – Sequence: 6001, Acknowledgement: 1053, TCP Payload: 4000 bytes

d) TCP Header Fields – Sequence: 8001, Acknowledgement: 1053, TCP Payload: 1000 bytes

**COMP9331 (POSTGRADUATE VERSION)**

Host *A* and *B* are communicating over a TCP connection, and Host *B* has already received from Host *A* all bytes up to and including byte 126. Suppose Host *A* then sends two segments back-to-back to Host *B*. The first and second segments contain 80 and 40 bytes of data, respectively. In the first segment, the sequence number is 127, the source port number is 302, and the destination port number is 80. Host *B* sends an acknowledgment as soon as it receives a segment from Host *A* (i.e. neglect delayed ACKs).

(a) In the second segment sent from Host *A* to *B*, what are the sequence number, source port number, and destination port number?

(b) If the first segment arrives before the second segment, in the acknowledgment of the first arriving segment, what are the acknowledgment number, the source port number, and the destination port number?

(c) If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number

(d) Suppose the two segments sent by *A* arrive in order at *B*. The first acknowledgment is lost, and the second acknowledgment arrives after the first timeout interval. Draw a timing diagram, showing these segments and all other segments (i.e. retransmissions if any) and acknowledgments sent. Assume there is no additional packet loss. For each segment in your diagram, provide the sequence number and the number of bytes of data; for each acknowledgment in your figure, provide the acknowledgment number.

## END OF EXAM.

**THIS FEEDBACK IS ANONYMOUS. DO NOT WRITE YOUR NAME. TEAR OFF THIS PAGE AND RETURN SEPARATELY. WE APPRECIATE YOUR COMMENTS.**

List one thing you liked about this course and would like to see more of or see continued (any topic – lectures, labs, assignments, tutorials, tutors, topics covered or not covered, etc., etc.):

List one thing you would like to have changed or have improved about this course:

Any other comments that you may have regarding the course:

**TEAR THIS PAGE AND RETURN IT SEPARATELY**