

ECE3076, Computer Networks, QUIZ 2 - Answers Fall 2011

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Oct. 7, 2010

RULES.

- i This quiz is **not** open book. Two original sheets of hand-written notes may be used. Calculators are ok.
- ii Answer all questions and show all work to receive full credit. Use back of sheets only if necessary.
- iii All sub-questions have the same weight (4 %), unless noted. Put answers in right-side blank areas.
- iv Please do not ask the proctors any questions during the exam about exam questions. Part of the test is understanding the question, as written, without supplemental information. If you feel additional data is needed to solve the problem, make (and state) an assumption and then work the problem.
- v This is a time-limited test. All papers must be turned in 45 minutes after the start. The Georgia Tech Honor Code applies (see last page).

1. Transport Control Protocol

- a. Fast Retransmission makes TCP more like _____ than Go-Back-N, which is less efficient. a. Selective Repeat
- b. No matter what the TCP receiver receives, the ACK number points to the first _____ byte? b. Not-Received
- c. The RTO timer prevents what bad thing from happening? c. Freezing
- d. Transport protocol that only provides "best effort" delivery of segments: d. UDP
- e. How does the TCP receiver detect duplicate data, and gaps? e. sequence number
- f. Pipelining makes data transfer _____? f. faster

2. Data Throughput. If the data-space in a round-trip path is less than a "Window" size, the transfer rate is "transmission rate limited" (limited by the lowest data rate of the path), and the Utilization factor is 1. Otherwise it is "Window Limited."

If the round-trip-time, RTT, is 60 ms and the rate, R, is 50 Mb/s:

- a. What is D ("data in the pipeline", in **bytes**). a. 375,000 bytes
 $0.060 s * 50 \text{ Mbits/s} / 8 \text{ bits/byte}$
- b. When the Window is 80,000 bytes, is this connection Window Limited (yes/no) ? b. yes
 $80,000 < 375,000 \text{ so yes}$
- c. What is the Utilization factor? c. 0.213
 $80,000 / 375,000$
- d. What is the throughput (**bits/s**)? d. 10.7 Mbits/s
 $0.213 * 50 \text{ Mbps or } 80\text{kB} * 8 / 0.060$
- e. If RTT to a local server is 6 ms, what would the throughput to the local server be? e. 50 Mbits/s
Rate Limited, 50 Mbps < 52Mbps

3. TCP Slow Start. A 10 Mbps network connection has a 100 ms round trip time (RTT). A server begins sending maximum-size packets (after the initial SYN-ACK). The client ACK's every packet, and has a receiver-window which is always 7500 bytes. MSS is 1500 bytes. Show how many bytes are sent in each period below:

	Time Period Start (ms)	No. Bytes sent
Answers a to f count 2% each.	0	(SYN-ACK)
1 MSS, slow-start CongWin limited	100	a. <u>1500 bytes</u>
2 MSS "	200	b. <u>3000 bytes</u>
4 MSS "	300	c. <u>6000 bytes</u>
7500 < 8 MSS, rcvr-window limited	400	d. <u>7500 bytes</u>

- e. What is the average transmission rate during the first 300 ms (0-299 ms)? (**bits/s**) e. 120,000 bits/s
 $(8 \text{ b/B}) * (0 + 1500 + 3000 \text{ bytes}) / 0.300 \text{ s}$
- f. What is the ultimate maximum transfer rate (**bits/second**), assuming no errors? f. 600,000 bits/s

$$(8 \text{ b/B}) * (7500 \text{ bytes}) / 0.100 \text{ s}$$

- g. TCP connections start in Slow-Start mode. What event causes a return to Slow-Start mode? g. RTO, timeout
- h. At what time does the connection become "rate limited" ? (ms, or "never") h. never
- i. When CongWin is 1 MSS, how many 200-byte segments can be sent before stopping and waiting an ACK? i. 7

4. – TCP Fast Retransmit / Fast Recovery

Please show calculations under these questions and answers in blanks at right.

The sender buffer SendBase is 1000. Six TCP segments have been sent with sequence numbers 2000, 2500, 3000, 3500, 4000, 4500 with 500 bytes of data. MSS is 1000.

A segment is received with TCP acknowledgement number 4000 and window 5000. The CongWin is now 8,000.

- a. What is the new value of SendBase? a. 4000
- b. What is the last byte (number) that can be sent with certainty that the receiver's buffer will not overflow? b. 9000
- c. What is the last byte (number) that could be sent without violating Congestion Control rules? c. 12,000

Three more TCP segments are received with TCP acknowledgement number 4000.

- d. What is the new value of CongWin. d. 4000
- e. What is the next TCP segment's Sequence Number? e. 4000
- f. What is the following TCP segment's Sequence Number? f. 5000

5– Running Average for Calculating the Retransmit Time Out (RTO) value.

Start with the following conditions (last values in milliseconds, ms):

Average RTT (EstimatedRTT) : 48 ms

Average Deviation (devRTT): 24 ms

Timeout Interval (RTO): 110 ms

A new measured Round Trip Time (SampleRTT) occurs : 32ms

- a. What is the new value of Estimated RTT (round results up to 1 ms) ? a. 46 ms

$$0.875 * 48 + 0.125 * 32 = 45$$
- b. What is the new value of Average Deviation (round results up to 1 ms)? b. 22 ms

$$0.75 * 24 + 0.25 * |32 - 48| = 22$$
- c. What is the new value of RTO (round results up to 1 ms)? c. 90 ms

$$46 + 4 * 22 = 90$$
- d. If a timeout occurs next, what is the temporary new value of RTO? d. 180 ms

$$2 * 90 = 180$$

Honor Code - I affirm that I have obeyed the rules of the Georgia Tech Honor Code*.

Signature _____

*Basically, I did not cheat, and I reported any observed cheating. A grade will not be recorded if there is no signature.