

ECE3076, Computer Networks, QUIZ 2 Answers Fall 2010

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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).

Question 1 – Transport Protocols

- a. **Transport** protocol that delivers a reliable stream of data: a. _____ **TCP** _____
- b. **Transport** protocol that does not require a connection setup phase: b. _____ **UDP** _____
- c. **Network** protocol that only provides “best effort” delivery of packets: c. _____ **IP** _____
- d. **Network** protocol that has several classes of service, including guaranteed constant bit rate: : d. _____ **ATM** _____

Question 2 – Data Throughput. If the data in a pipeline is less than a "Window" size, the transfer rate is "transmission rate limited" (limited by the data rate of the path), and the Utilization factor is 1.0 (to first order) . Otherwise it is "Window Limited."

If the round-trip-time, RTT, is 48 ms and the rate, R, is 10 Mb/s:

- a. What is D ("data in the pipeline", in bytes). $D = 0.048 \text{ s} * 10,000,000 \text{ b/s} / 8 \text{ b/B}$ a. 60,000 bytes
- b. When the Window is 10,000 bytes, is this connection Window Limited (yes/no) ? $T = W / RTT = 10,000 \text{ B} * 8 \text{ b/B} / 0.048 \text{ s} = 1.67 \text{ Mbps}, < R \text{ or } W < D$ b. Yes (Window Limited)
- c. What is the Utilization factor? $U = W / D = 0.167 < 1 \text{ implies "Window Limited"}$ c. 0.167 or 16.7 %
- d. What is the throughput, T (bits/s)? **If Window Limited, $T = U * R = 1.67 \text{ Mbps}$** d. 1.67 Mbps
- e. If RTT to a local server is 3 ms, what would the throughput to the local server be? **Not Window Limited, so $T = R$ (not W/RTT)** e. 10 Mbps

Question 3 – TCP Slow Start. A 20 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** is 6000 bytes. MSS is 1200 bytes. Show how many bytes are sent in each period below:

Time Period	No. Bytes sent
Start (ms)	
0	(SYN-ACK)
100 1 MSS	a. <u>1200 bytes</u>
200 1 MSS	b. <u>2400 bytes</u>
300 1 MSS	c. <u>4800 bytes</u>
400 RcvrWin	d. <u>5000 bytes</u>

- e. What is the average transmission rate during the first 300 ms (0-299 ms)? (bits/s) $3600 * 8 / 0.3$ e. 96,000 bps
- f. What is the ultimate maximum transfer rate (bits/second)? $RcvrWin / RTT = 6000 * 8 / 0.1 =$ f. 480,000 bps
- g. At what time does the connection become "rate limited" ? (ms, or “never”) $RcvrWin / RTT < R$ g. never

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Question 4 – TCP Fast Recovery

Please show calculations under these questions and answers (integers for (a) through (e) in blanks at right.

The sender buffer SendBase is 1000. Six TCP segments have been sent with sequence numbers 1000, 1500, 2000, 2500, 3000, 3500 with 500 bytes of data.

A segment is received with TCP acknowledgement number 2500 and window 7000. The CongWin is now 11,000. MSS is 1420. Until another ACK is received:

- a. What is the new value of SendBase? **Sendbase = ACK = 2500** (if \geq old value) a. 2500
- b. What is the last byte (number) that can be sent with certainty that the receiver's buffer will not overflow? **ACK + Window = 2500 + 7000** b. 9500
- c. What is the last byte (number) that could be sent without violating Congestion Control rules? **ACK + CongWin = 2500 + 11000** c. 13,500

Three more TCP segments are received with TCP acknowledgement number 2500.

- e. What is the new value of CongWin. $\frac{1}{2} * 11000$ d. 5500
- f. What is the next TCP segment's Sequence Number? **(resend 2500, then send 4000)** e. 2500

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

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

Average RTT (EstimatedRTT) : 24 ms

Average Deviation (devRTT): 8 ms

Timeout Interval (RTO): 60 ms

A new measured Round Trip Time (SampleRTT) occurs : 40 ms

- a. What is the new value of Estimated RTT (round results up to 1 ms) ? **$\frac{7}{8} * 24 + \frac{1}{8} * 40$** a. 26 ms
- b. What is the new value of Average Deviation (round results up to 1 ms)? **$\frac{3}{4} * 8 + \frac{1}{4} * |40 - 24|$** b. 10 ms
- c. What is the new value of RTO (round results up to 1 ms)? **$26 + 4 * 10 = 74$ ms** c. 66 ms
- d. If a timeout occurs next, what is the temporary new value of RTO? **2x old value** d. 132 ms
- e. What might happen if there were no RTO timer? **Sender could wait forever for an ACK. Connection would stop (freeze, "lock up", halt, ...).** e. Connection would stop

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.