

ECE3076 Final Exam - answers

August 10, 2006

RULES.

- i This quiz is **not** open book. Three 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 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.
- iv This is a time-limited test. All papers must be turned in 120 minutes after the start. If you find you are taking more than 10 minutes on a particular problem, move on and come back to that problem after finishing the others.
- v The Georgia Tech Honor Code applies (see last page).

Question 1 – Calculating Round-Trip Time (20 points)

Between hosts A in Atlanta and B in Las Vegas there are 2 routers (X,Y). The link between routers (---) is 10 Mbps. The access links (LANs, ===) are 1000 Mbps. The distance from A to B is 2000 km. A starts to send a large file using TCP, sending 1500 byte packets to B. B ACKs with 40 byte packets. There is no other traffic on this network.

A ===X---Y===B

What is the time required to transmit a 1.5 kByte datagram at 10 Mbit/s? _____ **1.2** _____ ms

$$8 * 1500 / 10e6 = 1.2e-3 \text{ seconds} = 1.2 \text{ ms}$$

What is the propagation delay for the round trip in milliseconds (ms): $2 * 2e6 \text{ m} / 2e8 \text{ m/s}$ **20** _____ ms

If the router buffers are empty, what is the total round trip transmission delay (neglect processing delay)? **22.4** ms

[A and Y both take 1.2 ms to transmit the packet. X only takes 0.012 ms, so the total transmission is 2.4 ms]

Note that the time for X to transmit the packet is negligible, as is the time to transmit the short ACK packet on the return trip.

What is the average transport rate for a 5 kByte Window size and this RTT? _____ **1.8 Mbps** _____

How big a Window size would be needed to reach 10 Mbit/s? _____ **28 kByte** _____

$$5 \text{ kBytes} * (10 / 1.8) = 28 \text{ kB}$$

What would happen if the window size was 65 kByte? **Limited to 10 Mbps by X-T link speed.**

{Buffer delay will increase to limit A's transmission rate. If overflow occurs, A's window size will decrease.} _

Other traffic builds up the average level in X's output buffer to 200 kbits. What does this add to the RTT? **20** ms

$$200,000 \text{ bits} / 10,000,000 \text{ bit/s} = 0.02 \text{ s}$$

What is the average transport rate for this new (total) RTT (Window still 5 kByte)? _____ **0.94** _____ Mbits/s

$$8 * 5000 \text{ bits} / (22.5 + 20.0 \text{ ms}) = 40,000 \text{ bits} / 0.0425 = 940,000 \text{ b/s}$$

What will happen to reduce the rate A sends bits if packets start being lost? _____ **Window size decreases** _____

Why is the output buffer delay for router Y not a concern? **It's output is faster than it's input** _____

Question 2 – Running Average for Calculating the Retransmit Time Out (6 points)

Use back of page for calculations. Round results up to 1 ms.

M =Measured Round-Trip Time	A=Average RTT Alpha = 1/8	Deviation (+/-)	D = Average Deviation Beta = 1/4	RTO = A + 4D
90	60	15	10	100
90	64	30	15	124
40	61	-24	18	133

Hints: new Deviation = new M - old A.

Question 3 – Routing Protocols (6 points)

Which routing protocol would most likely be found on:

- a. An Internet backbone connecting Autonomous Systems? _____ **BGP** _____
- b. On the Georgia Tech OIT backbone and within the ECE network? _____ **OSPF** _____
- c. On a small network at home? _____ **RIP (or none)** _____

Hint: These are examples of large, medium, and small networks. The answers should be different.

Question 4 – IP Datagrams (8 points)

- a. When is the ID number used? _____ **When fragmentation occurs.** _____
- b. What field in the IP header changes when a datagram is forwarded by a simple router? _____ **TTL (and checksum)** _____
- c. What other field always changes when a IP datagram if forwarded by a NAT router? _____ **Local (inside) IP** _____
- d. What other field may or may not change, depending on the NAT implementation? _____ **Local port number** _____

Question 5 – IEEE802 Wireless LAN MAC (10 points)

[Wireless Host]----- [WAP]----- [Hub]--- [Switch]----- [Router]--- Internet -> cnn
 Link: 1 2 3 4 5 6

A packet is sent by the Wireless Host to cnn.com. Each unit involved in carrying a MAC layer frame has a MAC address.

- a. What links (1 to 6) see the Wireless Host MAC as the source address? _____ **1,2,3,4** _____
- b. What links (1 to 6) see the Wireless Access Point MAC as a destination address? _____ **1** _____
- c. What links (1 to 6) see the Hub MAC as a destination address? _____ **none** _____
- d. What links (1 to 6) see the Switch MAC as a destination address? _____ **none** _____
- e. What links (1 to 6) see the Router MAC as a destination address? _____ **1,2,3,4** _____

Question 6 – Streaming Media (12 points)

Which transport layer was first used for streaming media? _____ **UDP** _____

Why is TCP problematic for interactive media connections? _____ **Delays due to retransmissions, flow control.** _____

On what 3 parameters does QoS guarantee certain minimum or maximum performance? **Bandwidth, delay, error rate (or jitter)** _____

What technique can make up for missing data due to lost packets? _____ **FEC (better with interleaving)** _____

What technique can make up for occasional delays on the data path? _____ **Receiver buffering** _____

Question 7 – Security (8 points)

What are the four basic services which network security provides?

- a. _____ **Privacy** (encryption) _____
- b. _____ **Authentication** (digital signatures) _____
- c. _____ **Integrity** (data not improperly changed) _____
- d. _____ **Availability** (protection from Denial of Service) _____

Question 8 – Encryption (16 points)

a. What is the main problem with symmetric (secret) key encryption? _____ **Key Distribution** _____

Messages encrypted with RSA and AES can only be deciphered by trying every possible key (a brute force attack).

b. By what factor is the number of possible keys increased if the key length is increased from 32 to 64 bits? _ $2^{32} = 4e9$ _

For asymmetric (public/private) key encryption:

c. What is the longest bit string that can be encrypted with a 512-bit public key? ___ **512 bits** (better if less) _

What are the steps to encrypt a 10,000 byte message with a public key?

d. _ Generate a session key _ e. _ Symmetric encrypt with session key _ f. _ Encrypt session key w public key. _

g. When using HTTPS, how do you know the public key supplied by a merchant is not a fake? _ **He supplies a "certificate"** _

h. How is a "hash" like MD5 or SHA used to provide a digital signature of a message?

_____ **The hash result is encrypted with the sender's private key.** _____

Question 9 – Host Configuration (12 points)

a. What protocol can be used to automatically configure PC's that plug into an Ethernet LAN? ___ **DHCP** _____

What are the three parameters that are needed by a host to operate on an IP network?

b. _____ **IP address** _____ c. _____ **Network mask** _____ d. _____ **Default router** _____ (& DNS Server IP)

e. How does a host find out the 32-bit IP address to use for URL "www.cnn.com"? _____ **DNS Inquiry** _____

f. Given the IP address, how does a host find the right MAC destination address to use? ___ **ARP** _____

Question 10 – IP Addresses (2 points)

a. What two techniques have lead to much more efficient use of the available IP address space?

a. _ **NAT** (Network Address Translation) _____ b. ___ **CIDR** (Classless Interdomain Routing)_

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.