College of Computing

Georgia Institute of Technology

CS 6250: Computer Networking: Fall 2011

Quiz II

There are 14 questions (and one bonus question) and 12 pages in this quiz booklet (including this page). Answer each question according to the instructions given. You have **85 minutes**.

If you find a question ambiguous, write down any assumptions you make. **Be neat and legible.** If I can't understand your answer, I can't give you credit! There are three pretty challenging questions (clearly marked); you may want to look through the whole quiz and save those for last.

Use the empty sides of this booklet if you need scratch space. You may also use them for answers, although you shouldn't need to. *If you do use the blank sides for answers, make sure to clearly say so!*

Note well: Write your name in the space below AND your initials at the bottom of each page of this booklet.

THIS IS AN "OPEN NOTES, OPEN PAPERS" QUIZ.
LAPTOPS ARE ALLOWED, BUT ONLY FOR REVIEWING PAPERS AND NOTES
NO OTHER MATERIALS, NO PHONES, NO PDAS.
ABSOLUTELY NO EMAIL OR MESSAGING OF ANY KIND!
MAKE SURE YOU'VE READ ALL THE INSTRUCTIONS ABOVE!

Initial here to indicate that (1) you've read the instructions and (2) you agree to abide by the Georgia Tech Honor Code:

The last page has easy bonus questions, which you can answer outside of the allotted time. Rip the last page off of your quiz for five bonus points. Turn it in anonymously if you like.

Do not write in the boxes below

1-5 (xx/20)	6-7 (xx/13)	8-11 (xx/24)	12-14 (xx/13)	Bonus (5+xx)	Total (xx/70)

Name:

I Warmup

1. [4 points]: Which of the following is true about measurements of an ISP access link performed from the home gateway router that is directly connected behind the DSL or cable modem?

(Circle ALL that apply)

A. A single-threaded TCP throughput measurement should be able to accurately measure the full capacity of the access link, if the size of the upload or download is large enough.

B. The router can monitor the network for other activity and only perform measurements when other network traffic is low.

C. Wireless interference inside the home may affect the performance measurements of the access link.

D. When DSL "interleaving" is applied to the access link, the latency to the first router in the upstream ISP's network should be equal to about the propagation delay of the packet.

E. All of the above.

2. [4 points]: Which of the following are true about virtual networks?

(Circle ALL that apply)

A. Virtual networks that share the same physical infrastructure must not have overlapping IP address space.

B. A virtual link in a virtual network can traverse multiple physical routers.

C. An MPLS tunnel is an example of a virtual link.

D. A virtual router that is implemented fully in software must have its forwarding tables in "user space", as described in the VINI paper.

E. None of the above.

3. [4 points]: Which of the following are true of data center networks?

(Circle the BEST answer)

A. Designers of data center networks often aim to address nodes in a "flat" layer two Ethernet topology to make it easier to migrate servers from one part of the network to another.

B. Layer two addressing cannot scale to the size of an entire data center because every switch must store forwarding table entries for every server in the network.

C. In PortLand, servers send broadcast ARP queries to discover the MAC address of a server with a certain IP address.

D. In VL2, servers send broadcast ARP queries to discover the MAC address of a server with a certain IP address.

E. None of the above

Name:

4. [4 points]: Which of the following are true about 802.11 wireless networks?
(Circle ALL that apply)

A. Without RTS/CTS, two senders could send packets that collide at the same receiver.

B. Enabling RTS/CTS could prevent a sender from sending a packet, even if sending the packet would not have caused a collision at the receiver.

C. Losses at the 802.11 link layer might be observed as higher latencies with a tool like ICMP ping.

D. A sender can use a CTS to reserve the data channel for itself.

E. None of the above.

5. [4 points]: Which of the following features have spammers exhibited that are different than legitimate senders?
(Circle ALL that apply)

A. Sending messages of similar sizes to many different recipients

B. Sending messages from hijacked IP address space

C. Sending messages from network ranges that contain a large number of mail servers

D. Sending messages that exhibit some "geographic locality" (i.e., the messages don't tend to travel further than a certain distance to their receiver).

E. All of the above

Name:

II Wireless Networking

6. [6 points]: Consider a device that wants to transmit data over the recently de-regulated wireless spectrum "white space", as in Murty's *White Space Networking with Wi-Fi like Connectivity*.

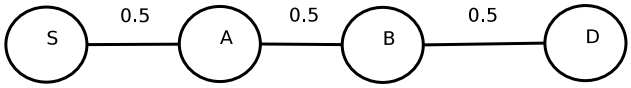
A. What are the benefits to transmitting data in the white space spectrum, as opposed to the 2.4 Ghz or 5 GHz ISM bands that current WiFi devices use today?

B. Give two reasons why transmission in white spaces is more complicated than trasnmission in the ISM bands, in comparison to the ISM bands.

C. Explain the tradeoff between performance and contention that the access point faces when selecting the width of spectrum to reserve for communication with the device.

(Answer legibly in the space below.)

7. [7 points]: Consider the figure below, which shows packet *loss rates* for each wireless "link". *Show your work below.*



A. (3 points) Assuming that each packet is transmitted hop-by-hop, what is the *total* expected number of transmissions for a packet to reach node D from node S?

B. (4 points) Suppose that, with probability 0.5 node B hears the *initial* transmission from node S, and that node B will re-transmit the packet from node S if it hears it (as in the ExOR paper). What is the expected number of transmissions for the packet to reach node B, and what is the total expected number of transmissions for the packet to reach node D? (*Hint:* You must consider two cases when considering your probabilities: the case where the transmission from node S reaches B and the case where it does not.)

(Answer legibly in the space below.)

Name:

III Performance and Security

8. [5 points]: Explain the difference between *persistent* HTTP connections and *pipelined* HTTP connections. Explain how each of these optimizations can reduce the overall page load time for a Web page.

(Answer legibly in the space below.)

9. [5 points]: Describe one advantage and one disadvantage of using *content filters* for spam filtering. Describe one advantage and one disadvantage of using *IP blacklists* for spam filtering.

Name:

10. [8 points]: In Problem Set 2, you studied the mechanics of traffic shaping. *PowerBoost* is a feature advertised by cable ISPs such as Comcast. Customers with PowerBoost enabled get a burst of traffic at a rate higher than the service plan rate for a limited duration.

Token bucket filters, such as the one you studied in Problem Set 2, are commonly used to implement PowerBoost. Each customer has a dedicated token bucket filter that regulates traffic to that customer. Consider a Comcast customer whose connection is capable of a maximum rate of 20 Mbits/s.

A. This customer purchases a basic 6 Mbits/s plan *without* PowerBoost. What is the configured token rate and bucket size?

B. The customer upgrades to a 12 Mbits/s plan, with the capability for PowerBoost at line rate (20 Mbits/s). PowerBoost rates apply for the first 10 MBytes (80 Mbits) of traffic. What is the duration of PowerBoost? What is the configured token rate and bucket size?

C. Due to a misconfiguration at the headend, the token rate is set to 25 Mbits/s. The bucket size is unchanged. What is the burst size, burst duration, and the long-term average throughput that this customer obtains?

(Answer legibly in the space below.)

Name:

11. [6 points]: Consider the following DNS lookup, issued from a machine at Georgia Tech, output from running `dig` on `static.ak.fbcdn.net`, the domain name for Facebook's content distribution network:

```
;; ANSWER SECTION:
static.ak.fbcdn.net. 7185 IN CNAME static.ak.facebook.com.edgesuite.net.
static.ak.facebook.com.edgesuite.net. 21586 IN CNAME a749.g.akamai.net.
a749.g.akamai.net. 15 IN A 208.44.23.43
a749.g.akamai.net. 15 IN A 208.44.23.34
a749.g.akamai.net. 15 IN A 208.44.23.50
a749.g.akamai.net. 15 IN A 208.44.23.48
a749.g.akamai.net. 15 IN A 208.44.23.35
a749.g.akamai.net. 15 IN A 208.44.23.27
a749.g.akamai.net. 15 IN A 208.44.23.64
;; Query time: 4 msec
;; SERVER: 8.8.8.8#53(8.8.8.8)
;; WHEN: Wed Nov 30 15:59:35 2011
;; MSG SIZE  rcvd: 224
```

A. How long would the IP address corresponding to this domain name remain in a DNS resolver's cache?

B. Why does the query return multiple "A" records to a single client?

C. A ping to these IP addresses indicates that these servers are approximately 2 milliseconds away from Georgia Tech. A similar DNS lookup from a machine at MIT in Boston, Massachusetts returns IP addresses in `18.7.20/24`, less than a millisecond away from the machine at MIT that issued the query.

- Why do different DNS clients receive different A record answers for the same DNS lookup?

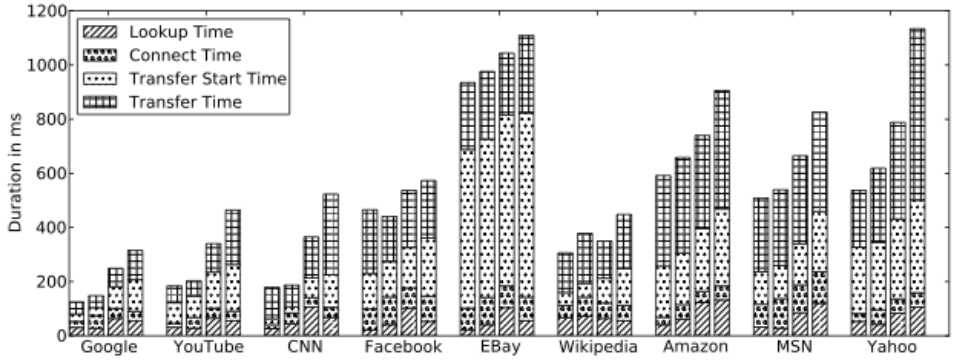
(Answer legibly in the space below.)

Name:

IV Accelerating Web Performance

George Burdell has been noticing that his Web performance to many popular Web sites is slower than he would like. For some sites, he's noticed that download times can be more than half a second, even for relatively small Web pages. He has asked three of his friends to compare download times to nine popular Web sites, as well. The download times in milliseconds are shown in the stacked bar plot below. Each bar represents one of the four users, and the time is divided into the following components:

- *Lookup Time:* The time to resolve the DNS name for the site.
- *Connect Time:* The time to complete the TCP three-way handshake.
- *Transfer Start Time:* The time until the first byte is received at the client.
- *Transfer Time:* The time for the transfer to complete.



12. [3 points]: George notices that, in many cases, the transfer time is not the only significant contributor to the overall page load time. He looks at this data and says: "Upgrading to a higher service plan would be a waste of money: Simply adding more throughput isn't going to reduce some of the significant bottlenecks that are slowing down my Web downloads." Is he right? Why or why not? (Which components of the overall transfer time could be reduced with higher throughput?)

(Answer legibly in the space below.)

Name:

George "pings" `www.facebook.com` and notices that round-trip times to the Facebook server are about 30 milliseconds. Suppose that the Facebook page size is about 30 Kilobytes, that packet MTUs are 1 Kilobyte, that the initial TCP congestion window for Facebook is 4 packets, that the connection leaves TCP slow start and starts AIMD congestion control when window size is 8 packets, and that there is no packet loss or buffering. (Assume no parallel HTTP connections.)

13. [5 points]: How many roundtrips and how many milliseconds will it take to download the Facebook page? *Show your work.*

(Answer legibly in the space below.)

14. [5 points]: George says: "30 milliseconds is really far away. The Facebook page would load much more quickly if I enabled a Web cache on my home router, which is only 1 millisecond away." Suppose, for simplicity, that half of the content on the Facebook page is cacheable, so that 15 Kilobytes can be fetched from the home router cache (1 millisecond round trip) and 15 Kilobytes must be fetched from the Facebook server (30 milliseconds round trip). (Assume no parallel HTTP connections.)

- How many milliseconds will it take to fetch the cached content from the router?
- How many milliseconds will it take to fetch the remaining content from the Facebook server?

(Answer legibly in the space below.)

Name:

15. [5 points]: Bonus. George realizes that, while caching some content will help improve the performance for various Web sites, his Netflix performance may still suffer. Which performance metrics would be most relevant for streaming, and what possible optimizations could George consider on his home router to improve *streaming* performance? (Keep in mind that George only controls the client side of the connection.)

(Answer legibly in the space below.)

Name:

V Bonus: Anonymous Course Feedback

This page is anonymous. Rip this off from your exam, and turn it in separately if you like. You'll get five points for simply ripping off the last page of the exam, but I'd prefer if you fill it out and hand it in in a separate stack.

What were the things you liked most about the course? Anything is fair game here (topics, course structure, board technique, etc.).

What are the things you liked least about the course? Again, anything is fair game.

If you could change one thing about the course in a future offering, what would it be?

If you could keep one thing about the course in a future offering, what would it be?

Name: