CMPSC 381
Data Communications and Networks
Spring 2016
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Lab 4
18 February 2016
Due via Bitbucket on Thursday, 25 February, 8 a.m.
NOTE THE 8 a.m. DEADLINE!

Summary: More Exam Review

Details:

All answers must include reasons; a simple numerical answer is not sufficient.

If you have problems with some of these, ask questions during the Friday review session!

1. **[Make Up Your Own UDP Checksum Problem.]** **If you're not sure how to add binary numbers, try this website:** http://www.free-test-online.com/binary/add_binary.htm

   Recall from section 3.3: the UDP checksum is formed by adding up all the 16-bit blocks in the UDP segment (other than the 16 bits corresponding to the checksum, that is!) using "wraparound carry": if the sum is ever more than 16 bits long, the leftmost bit is truncated and added to the sum. The final 16-bit sum is then complemented (flip 1s and 0s). See the example in the book. Here's another example using the three 16-bit values:

   `1001 1000 1111 1011`, `1111 0110 1010 1001`, and `0110 1010 0111 1001`

   Add the first two values; since the result has 17 bits, "wrap the extra bit" around and add it:

```
        1001 1000 1111 1011     +---> 1000 1111 1010 0100
        1111 0110 1010 1001     | +------------------->  1
      ---------------------     | |   -------------------
SUM:  1 1000 1111 1010 0100----+ |   1000 1111 1010 0101
      |                          |
      |                          |
      +--------------------------+
```

   Adding in the third value and flipping the final result we get:

```
        1000 1111 1010 0101
        0110 1010 0111 1001
      ---------------------
 SUM:   1111 1010 0001 1110 -----flip bits-----> 0000 0101 1110 0001
```

Thus, the checksum is `0000 0101 1110 0001`.

Create three 16-bit binary values (at least half the bits in each one should be 1s to make the problem non-trivial). Show me the numbers and find their checksum.

To make it easier for me to check your results, please group the bits of each value into four groups of four as in the example.

2. **[Packet-switching.]** Suppose a message consists of 2000 bits and we must transmit it over two links, each with a rate of 1 Mbps. Ignore all sources of delay other than transmission delay (in particular, assume propagation delay is zero).

   (a) How long does it take to deliver a single packet containing all 2000 bits from source to destination? Remember that in a packet-switching network, we must wait for the entire packet to be received before we can begin to transmit it to the next host, so the "middle host" can not begin transmitting until it has received all 2000 bits. Show how you calculated your result.

   (b) Now suppose the message is split into two packets of 1000 bits apiece. How long does it take to deliver all 2000 bits from source to destination? Show how you calculated your result.

   (c) Now suppose the message is split into four packets of 500 bits each. How long does it take? Show how you calculated your result.

3. **[Sources of delay.]** Assume the same conditions as in the previous question, only now assume that each link is 10 kilometers long and the propagation rate is 2×10^8 meters per second. Both links still have rates of 1 Mbps. Ignore all other sources of delay. How long does it take to deliver a single 2000-bit packet, two 1000-bit packets, and four 500-bit packets? Show how you calculated each of your results.

4. **[Persistent and Non-Persistent HTTP.]** Let RTT stand for the round-trip time needed for a message and response to travel back and forth between client and server. Assume that the server allows only one connection at a time with a given client (so there can't be any parallel transfers of data).

   (a) Suppose an HTTP server does not permit persistent connections. How much time, measured in RTTs, is needed to fetch a small web page file from the web server? (Assume that the "`GET`" command is sent as part of the last message in the TCP three-way handshake; assume the file is small enough to fit in a single packet.) Explain your answer. Don't include the time needed to disconnect the TCP session.

   (b) Suppose an HTTP server does not permit persistent connections. How much time, measured in RTTs, is needed to fetch a small web page with four very small embedded images? Explain your answer.

5. **[Throughput.]** Figure 1 shows three client-server connections (A connected to D, B connected to E, C connected to F), all of which equally share the bandwidth of a common link (number 4 in the figure). The transmisssion rates of the seven numbered links are all shown in the figure. What is the maximum achievable throughput for each of the three connections? What is the bottleneck link for each of the three connections?

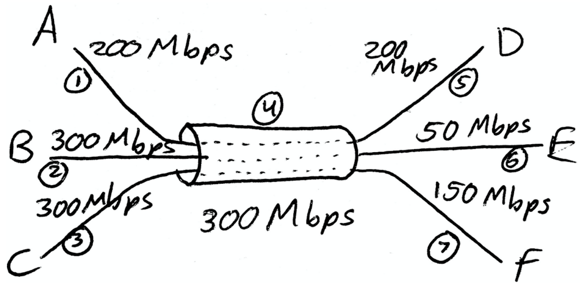

Figure 1: See problem 5

6. **[Queueing and Traffic Intensity.]** A host machine receives packets from 4 hosts, each of which sends an average of 500 packets per second. Each packet contains 1000 bits. For each of the following transmission rates, state the traffic intensity and describe the queueing behavior (one of "almost no queueing delay," "long queueing delay," "guaranteed packet loss—infinite queueing delay").
   (a) 250 Kbps
   (b) 512 Kbps
   (c) 1 Mbps
7. **[DNS.]** A local DNS server is unable to satisfy a query, so it requires access to a root server, a TLD server, and an authoritative server. See, for instance, Figure 2.
   (a) Describe (either with a diagram, which you will have to scan in to your repository, or else in words) the order in which messages are sent in a fully iterative query. (The first and last messages will be between the local server and the requesting host.)
   (b) Same question, but with a fully recursive query.
   (c) Same question, but now assume the root server executes recursive queries and the TLD server executes iterative queries.

[Submit your work.] Make sure you have a PDF document named "*yourlastname*-`lab4.pdf`" in your `lab4` folder. Upload this folder to your Bitbucket repository by the lab deadline.

Make sure your name and the honor code pledge appear at the top of your PDF file.

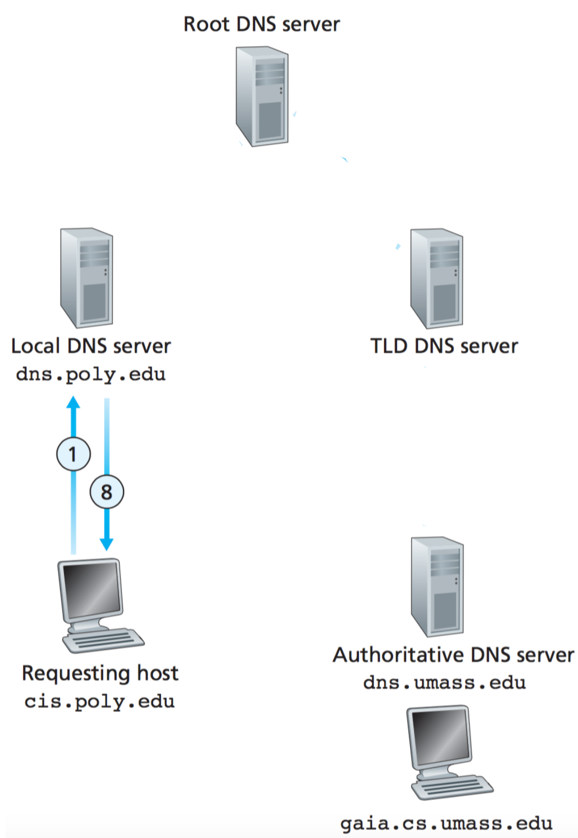

Figure 2: See problem 7.