ELEC 3120: Computer Communication Networks

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Homework 2

Due: Oct 29 (Saturday) 1:00 p.m.
Full marks: 60

Notes:

1) This assignment contains five problems, each with several parts. Answer them as clearly and concisely as possible and show how you obtain the answers. Solely giving the final numerical result without showing the procedure on how it is obtained will lead to a deduction of most of your points in the corresponding problem even if the numerical result is correct.
2) You may discuss ideas with others in the class, but your solutions and presentations must be your own. Do not look at anyone else's solutions or copy them from anywhere.
3) Please upload a scanned copy of your solutions to the Canvas System on the due date. No late submission will be accepted.
4) For simplicity, all conversions from Giga to Mega to Kilo vice versa uses base 10, e.g., 1 MB == 1000 MB.

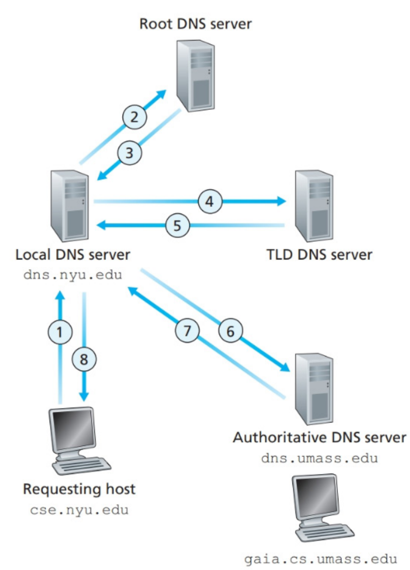
P1. (12 pts.) Consider distributing a file of F = 3 Gbits to N peers. The server has an upload rate of u_s = 60 Mbps, and each peer has a download rate of d_i = 3 Mbps and an upload rate of u. For N = 10, 100, and 1,000 and u = 300 Kbps, 1 Mbps, and 3 Mbps, prepare a table giving the minimum distribution time for each of the combinations of N and u for:

a. Client-server distribution (6 pts.).

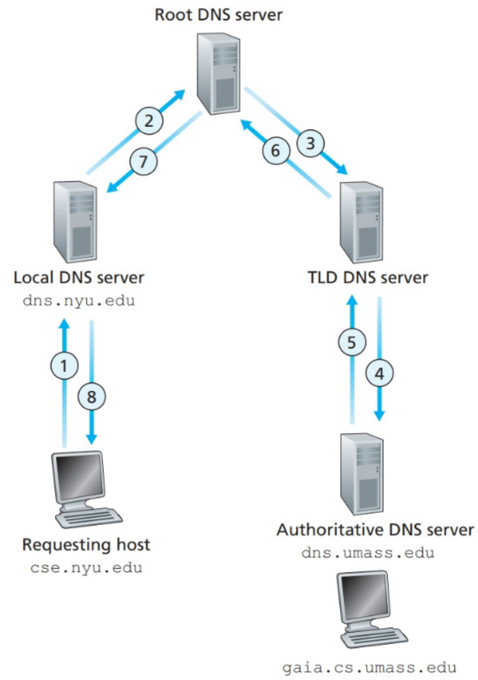
b. P2P distribution (6 pts.).

P2. (8 pts.) Assume that the RTT between a client and the local DNS server is RTT$_l$ = t, while the RTT between the local DNS server and other DNS servers is RTT$_r$ = 2t. Assume that no DNS server performs caching.

a. What is the total response time (in t) for the scenario illustrated as following? (2 pts.)



b. What is the total response time (in t) for the scenario illustrated as following? (2 pts.)



c. Assume now that the DNS record for the requested name is cached at the local DNS server. What is the total response time (in t) for the two scenarios? (4 pts.)

P3. (12 pts.) Assume you request a webpage consisting of one document and five images. The document size is 1 KB, all images have the same size of 50 KB, the download rate is 1 Mbps, and the RTT is 100 ms. How long does it take to obtain the whole webpage under the following conditions? (Assume no DNS name query is needed and the impact of the request line and the headers in the HTTP messages is negligible).

a. Nonpersistent HTTP with serial connections. (2 pts.)

b. Nonpersistent HTTP with two parallel connections. (2 pts.)

c. Nonpersistent HTTP with six parallel connections. (2 pts.)

d. Persistent HTTP with one connection (without pipeline). (2 pts.)

e. Generalize the results obtained for sub-problems a and d to a document size of L_d bytes, N images with size of L_i bytes (for $0 \leq i < N$), a rate of R byte/s and an RTT of RTT_{avg}. (4 pts.)

P4. (12 pts.) UDP and TCP use 1s complement for their checksums. Suppose you have the following three 8-bit bytes: 00101101, 01110000, 11000011.

a. What is the 1s complement of the sum of these 8-bit bytes? (Note that although UDP and TCP use 16-bit words in computing the checksum, for this problem you are being asked to consider 8-bit sums.) (2 pts.)

b. Why is it that UDP takes the 1s complement of the sum; that is, why not just use the sum? With the 1s complement scheme, how does the receiver detect errors? (2 pts.)

c. Is it possible that a 1-bit error will go undetected? (2 pts.)

d. How about a 2-bit error? (2 pts.)

e. Suppose that the UDP receiver computes the Internet checksum for the received UDP segment and finds that it matches the value carried in the checksum field. Can the receiver be absolutely certain that no bit errors have occurred? Explain. (4 pts.)

P5. (16 pts.) Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 127. Suppose Host A then sends two segments to Host B back-to-back. The first and second segments contain 50 and 29 bytes of data, respectively. In the first segment, the sequence number is 128, the source port number is 133, and the destination port number is 100. Host B sends an acknowledgment whenever it receives a segment from Host A.

a. In the second segment sent from Host A to B, what are the sequence number, source port number, and destination port number? (4 pts.)

b. If the first segment arrives before the second segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number, the source port number, and the destination port number? (4 pts.)

c. If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number? (4 pts.)

d. Suppose the two segments sent by A arrive in order at B. The first acknowledgment is lost and the second acknowledgment arrives after the first timeout interval. Draw a timing diagram, showing these segments and all other segments and acknowledgments sent. (Assume there is no additional packet loss.) For each segment in your figure, provide the sequence number and the number of bytes of data; for each acknowledgment that you add, provide the acknowledgment number. (4 pts.)