Tutorial 1 Solutions (Week 3)

Note: Some questions are from past exams

Section I - Multiple Choice, Fill-in Questions

Instructions: Circle the letter beside the choice that is the best answer for each question. For multiple choice, choose ***only ONE answer unless specifically asked to do otherwise***. For Fill-in and Short Answer questions, provide ***ONLY the number of answers requested*** in the spaces indicated.

1. List the four different types of delays encountered in packet switched networks:
   a. processing delay
   b. queuing delay
   c. transmission delay
   d. propagation delay
2. Consider the operation of downloading a Web page consisting of an index page that references 3 JPEG objects. Ignoring latency involved in transferring the objects themselves, fill in the blanks below with the correct values:
   a. Utilizing HTTP/1.0 with no parallel connection capability, the number of RTTs required to download the page is 8RTT.
   b. Utilizing the default mode of HTTP/1.1, 3 RTTs are required to download the page.
3. DNS responses have a TTL field. Why is this necessary?

   a. The TTL field is decremented at each DNS server that the response passes through on its way to the client, and servers drop responses with a TTL of 0, so the TTL field prevents responses from looping indefinitely.
   b. The TTL field allows DNS servers to prevent cache poisoning.
   c. The TTL field is necessary for scalability: if DNS servers could never time out entries, over time they would accumulate infinite state.
   d. The TTL field causes DNS servers to delete entries after some time, so that if the host moves and the underlying address changes, the server will eventually get the correct address.

4. Transport layer may be able to provide reliability by using its own mechanisms, despite working over a reliable network layer.
   a. True.
   b. False.

5. UDP has which of the following characteristics:
   a. Three-way hand shake for connection establishment.
   b. Connection state at the server.
   c. Regulated send rate.
   d. **None of the above.**

Section II – Problem Solving

Instructions: Calculate the values requested and provide a *numeric answer* for each question. You may use a calculator if desired, but problems have been developed in such a way that calculators should not be required. *Show your work* for each problem. Select the numeric result of your calculations from the choices provide, or fill in the blanks where requested.

1. Calculate the *end-to-end delay*, $d_{end\text{-}end}$, between the source host and the destination host in a network with 4 routers between source and destination? Assume that the network is NOT congested (i.e. d_{queue} is insignificant), and that:
   a. all packets are 10,000 bits in length,
   b. each link is 5 kilometers long,
   c. the processing time is 10msec at the source host and at each router,
   d. the transmission rate of each link is 1Mbps,
   e. the propagation speed of each link is 2.5 x 10^8 meters/second.

CALCULATIONS:

The delay along one hop = dproc+dprop+dtrans=10msec+$5\text{x}10^3/2.5\text{x}10^8$ + 10,000/1 x 10^6 = 10 msec + 0.02msec + 10msec = 20.02 msec

The packet will be transmitted along 5 hops (first hop is from the source, and once at each router).

Thus, the end-to-end delay = 5 x 20.02 = 100.1 msec

ANSWER:

1. 88 milliseconds
2. **100.1 milliseconds**
3. 110 milliseconds
4. 1.21 seconds

2. UDP and TCP use 1s complement for their checksums. Suppose you have the following three 8-bit bytes: 01010101, 01110000, 01001100. What is the 1's complement of the sum of these 8-bit bytes? (Note although TCP and UDP use 16-bit words in computing the checksum, for this problem we will only consider 8-bit summands). Show all work. Is it possible that a 1-bit error will go undetected by the checksum? How about a two-bit error?

Answer:

$$
\begin{array}{rr}
 & 0\,1\,0\,1\,0\,1\,0\,1 \\
+ & \underline{0\,1\,1\,1\,0\,0\,0\,0} \\
 & 1\,1\,0\,0\,0\,1\,0\,1 \\
+ & \underline{0\,1\,0\,0\,1\,1\,0\,0} \\
 & 0\,0\,0\,1\,0\,0\,1\,0
\end{array}
$$

The last addition has an overflow so we add it to the above sum resulting in a final result of 00010010. One's complement of this is 11101101 which is the final checksum.

All one-bit errors will be detected by checksum, but two-bit errors can be undetected (e.g. if the last digit of the first word is converted to a zero and the last digit of the second word is converted to a 1).

3. Answer these questions in a concise manner. A few sentences (2-3) should suffice.

(a) List one advantage and one disadvantage of using a text-based header (as in HTTP) instead of a binary format (as in IP and TCP).

Advantages: A text-based header is easier for human beings to read and debug. Text-based headers are also extensible.

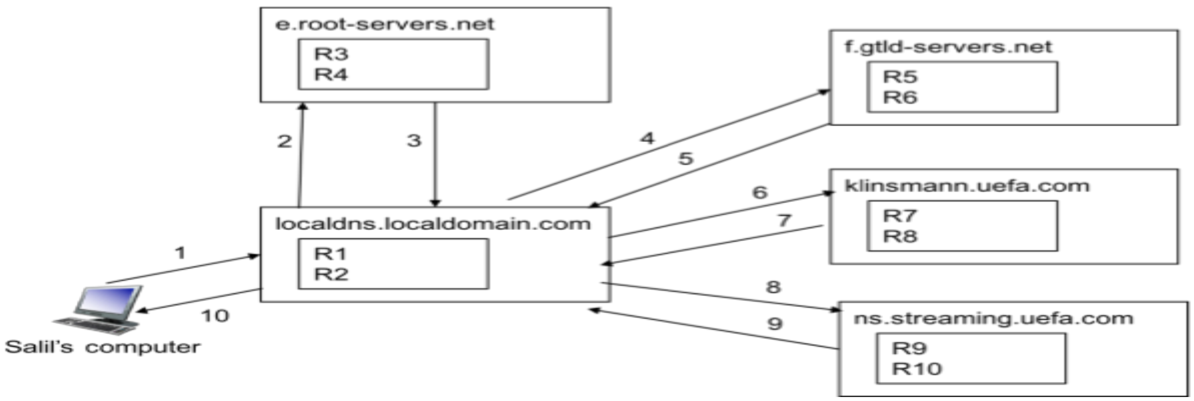
Disadvantages: However, they are verbose (i.e., waste bandwidth) and harder to parse. IP use a binary format to limit the bandwidth consumed by the header, and to simplify parsing at the router, which must process packets very quickly (e.g., within a few nanoseconds on high-speed links). In fact, big-header size needs to be compressed for many low-bandwidth/low-power communication.

(b) Web caches and content distribution networks (CDNs) both reduce the time for a client to download Web pages by moving content closer to the users. Give two reasons why CDNs have been more widely deployed (and successful) than Web caching?

Answer: The content providers can contract with CDNs to deliver their content, which improves performance, reduces cost, and makes their site robust to unexpected surges in demand. In contrast, the content provider cannot require millions of sites throughout the world to deploy proxy servers.

Also, proxies cannot cache all content. Some content is uncacheable because it is dynamically generated. CDNs can run the server software that generates the dynamic content.

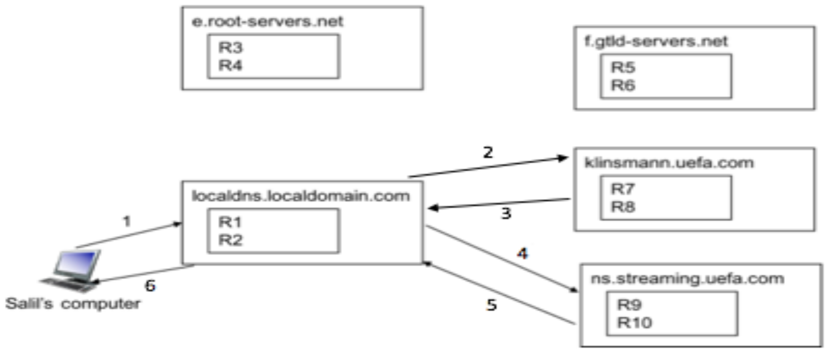
4. (a)



Seq	Type	Data
1	Q	vid1.streaming.uefa.org (A)
2	Q	vid1.streaming.uefa.org (A)
3	R	R3 (NS), R4 (A)
4	Q	vid1.streaming.uefa.org (A)
5	R	R5 (NS), R6 (A)
6	Q	vid1.streaming.uefa.org (A)
7	R	R7 (NS), R8 (A)
8	Q	vid1.streaming.uefa.org (A)
9	R	R9 (CNAME) + R10 (A)
10	R	R9 (CNAME) + R10 (A)

(b)

After 2 minutes, all records other than R7, R8, R9 and R10 would be cached at the local DNS server. This is because R7, R8, R9 and R10 have a TTL of 10 seconds. Hence, the sequence of queries would be as follows:



Seq	Type	Data
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3	R	R7 (NS) + R8 (A)
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5	R	R9 (CNAME) + R10 (A)
6	R	R9 (CNAME) + R10 (A)

5.

a) Here we have a window size of w. Since the receiver is expecting packet k, it has received packet k-1, and has ACKed that and all other preceding packets. If the sender has received all of these ACK's, then sender's window is [k, k+w-1].

Suppose next that none of the ACKs have been received at the sender. In this second case, the sender's window contains k-1 and w packets up to and including k-1. The sender's window is thus [k-w,k-1]. By these arguments, the senders window is of size w and begins somewhere in the range [k-w,k].

b) If the receiver is waiting for packet k, then it has received (and ACKed) packet k-1 and the w-1 packets before that. If none of those w ACKs have been yet received by the sender, then ACK messages with values of [k-w,k-1] may still be propagating back.

Because the sender has sent packets [k-w, k-1], it must be the case that the sender has already received an ACK for k-w-1. Once the receiver has sent an ACK for k-w-1 it will never send an ACK that is less that k-w-1. Thus the range of in-flight ACK values can range from k-w-1 to k-1.

6.

0.98=X (L/R)/(RTT+L/R)
0.98=X ((1500*8)/10^9))/(30*10^-3 + (1500*8)/10^9)=

X=2450 Packets