Computer Networks: Homework #2

Due on March 9, 2018 at 11.59pm

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Problem 1

Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose that n DNS servers are visited before your host receives the IP address from DNS; the successive visits incur a RTT of $RTT_1, \ldots, RTT_n$. Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let RTT_0 denote the RTT between the local host and the server containing the object. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object?

Solution

Total time for DNS look up, $time_{dns} = RTT_1 \; + \; RTT_2 \; + \; \ldots \; + \; RTT_n$

time to receive the object, $time_{object}$ = time to establish the connection + time to request and receive the file

$= RTT_0 + RTT_0 = 2RTT_0$

$\therefore$ **Total time elapsed** $= time_{dns} + time_{object}$

$= \mathbf{2RTT_0 \; + \; RTT_1 \; + \; RTT_2 \; + \; \ldots \; + \; RTT_n}$

Problem 2

Referring to Problem 1, suppose the HTML file references eight very small objects on the same server. Neglecting transmission times, how much time elapses with:

(a) Non-persistent HTTP with no parallel TCP connections?
(b) Non-persistent HTTP with the browser configured for 5 parallel connections?
(c) Persistent HTTP?

Solution:

Part A
As there are no parallel connections and all the connections are non-persistent, each of requests will be served serially i.e. one by one which will require $\mathbf{time_{object}}$ (from Problem 1).

$$\begin{aligned}\therefore \text{Total time} &= time_{dns} \ + \ time_{object} \ + \ (8 * time_{object}) \\ &= 2RTT_0 \ + \ RTT_1 \ + \ RTT_2 \ + \ \dots \ + \ RTT_n + (8 * 2RTT_0) \\ &= \mathbf{18RTT_0 \ + \ RTT_1 \ + \ RTT_2 \ + \ \dots \ + \ RTT_n}\end{aligned}$$

Part B
Now there are 5 parallel connections. It means that 5 requests can be served in time for 1 $\mathbf{time_{object}}$ and remaing 3 will be served in next $\mathbf{time_{object}}$.

$$\begin{aligned}\therefore \text{Total time} &= time_{dns} \ + \ time_{object} \ + \ (2 * time_{object}) \\ &= 2RTT_0 \ + \ RTT_1 \ + \ RTT_2 \ + \ \dots \ + \ RTT_n + (2 * 2RTT_0) \\ &= \mathbf{6RTT_0 \ + \ RTT_1 \ + \ RTT_2 \ + \ \dots \ + \ RTT_n}\end{aligned}$$

Part C
As there is a persistent HTTP connection, all of the objects will be served in single TCP connection. First base HTML will be retrieved and then 8 referenced objects will be retrieved.

$$\begin{aligned}\therefore \text{Total time} &= time_{dns} \ + \ time_{object} \ + \ RTT_0 \\ &= 2RTT_0 \ + \ RTT_1 \ + \ RTT_2 \ + \ \dots \ + \ RTT_n + RTT_0 \\ &= \mathbf{3RTT_0 \ + \ RTT_1 \ + \ RTT_2 \ + \ \dots \ + \ RTT_n}\end{aligned}$$

Problem 3

(a) Suppose you have the following 2 bytes 01011100 and 01100101. What is the 1s complement of the sum of these 2 bytes?

(b) Suppose you have the following 2 bytes: 11011010 and 01100101. What is the 1s complement of the sum of these two bytes?

(c) For the bytes in part (a), give an example where one bit is flipped in each of the 2 bytes and yet the 1s complement doesn't change.

Solution

Part A

$$\begin{array}{ccccccccc}
 & {\scriptstyle 1} & {\scriptstyle 1} & {\scriptstyle 1} & {\scriptstyle 1} & {\scriptstyle 1} & & & \\
 & 0 & 1 & 0 & 1 & 1 & 1 & 0 & 0 \\
+ & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 \\
\hline
 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1
\end{array}$$

$\therefore$ **The 1's complement of the sum –> 00111110**

Part B

$$\begin{array}{cccccccccl}
{\scriptstyle 1} & {\scriptstyle 1} & & & & & & & & \\
 & 1 & 1 & 0 & 1 & 1 & 0 & 1 & 0 & \\
+ & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & \\
\hline
 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & \\
+ & & & & & & & & 1 & \textit{WrapAround} \\
\hline
 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 &
\end{array}$$

$\therefore$ **The 1's complement of the sum –> 10111111**

Part C

Suppose 3^{rd} bit from left for both the bytes is flipped.

$$\begin{array}{ccccccccc}
 & {\scriptstyle 1} & {\scriptstyle 1} & {\scriptstyle 1} & {\scriptstyle 1} & {\scriptstyle 1} & & & \\
 & 0 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \\
+ & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 \\
\hline
 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1
\end{array}$$

$\therefore$ **The 1's complement of the sum –> 00111110**

Problem 4

Consider transferring an enormous file of L bytes from Host A to Host B.
Assume an MSS of 536 bytes.

(a) What is the maximum value of L such that TCP sequence numbers are not exhausted? Recall that the TCP sequence number field has 4 bytes.

(b) For the L you obtain in (a), find how long it takes to transmit the file. Assume that a total of 66 bytes of transport, network, and data-link header are added to each segment before the resulting packet is sent out over a 155 Mbps link. Ignore flow control and congestion control so A can pump out the segments back to back and continuously.

Solution

Part A

Maximum segment size, MSS: $536\ bytes = 4288\ bits$
The sequence number indicates the number of bytes sent. As the sequence number field has 4 bytes i.e. 32 bits, the maximum value of L $= 2^{32} = 4294967296\ bits$

Part B

Transport + Network + Data-link header size $= 66\ bytes$
Total data in each segment $= 536 - 66 = 470\ bytes = 3760\ bits$
Total number of packets to send L $= 4294967296/3760 = 1142279\ packets$
Total bits to be sent $= 1142279 * 4288 = 4898092352\ bits$

$\therefore$ Total time to transmit the file $= 4898092352/(155 * 10^6) = \mathbf{31.6005958\ secs}$