CS305: Computer Networking
2023 Fall Semester Written Assignment # 2

Due: Nov. 22th, 2023, please submit through Blackboard

Please answer questions in English. Using any other language will lead to a zero point.

Q 1 *The UDP checksum provides for error detection. Consider the following word with 32 bits:*

$$01100110011000000101010101010101 \tag{1}$$

(a) Compute the checksum. (Recall that UDP computes checksum based on 16-bit word.) Break the 32-bit word into two 16-bit words, and sum their up.

(b) How does the receiver check whether the message was transmitted with errors?

(c) If the receiver does not detect any error using the checksum, does it mean that the message was transmitted without any error? Please explain the reason and provide an example.

Solution:

(a) Break the 32-bit word into two 16-bit words, and sum their up:

$$\begin{array}{r} 0110011001100000 \\ 0101010101010101 \\ \hline 1011101110110101 \end{array} \tag{2}$$

Compute the 1s complement of 1011101110110101. The checksum is 0100010001001010.

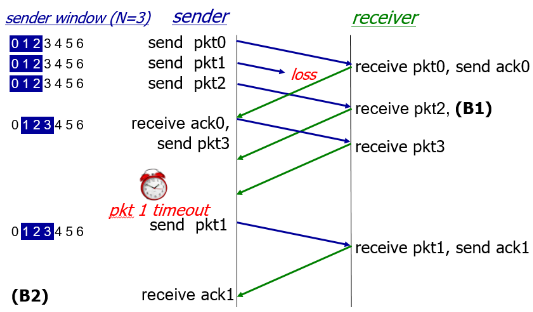
(b) Add up all 16-bit word, including the checksum. If the sum is equal to 1111111111111111, then no error detected.

(c) No. For example, if a zero was flipped to one and another one was flipped to zero, then the sum of all 16-bit word of the received segment is still 1111111111111111. In this example, there exists bit error, but such an error cannot be detected.

Q 2 *Fill in the blanks (B1) and (B2) in the below figure for go-back-N and selective repeat? Note that (B1) should be fill in with the action of the receiver, and (B2) corresponds to the sender window. In the figure, all packets are transmitted successfully without error except pkt1.*

(a) (B1) and (B2) for go-back-N

(b) (B1) and (B2) for selective repeat



Solution:

discard, (re)send ack0; 0123456; buffer, send ack2; 0123456

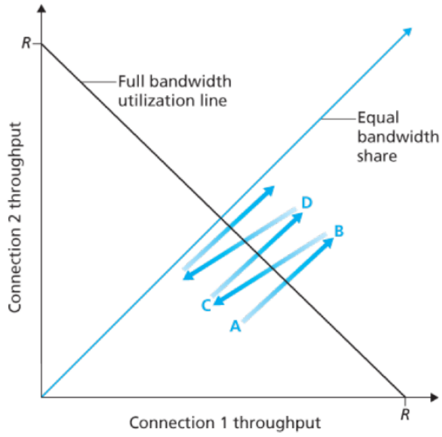


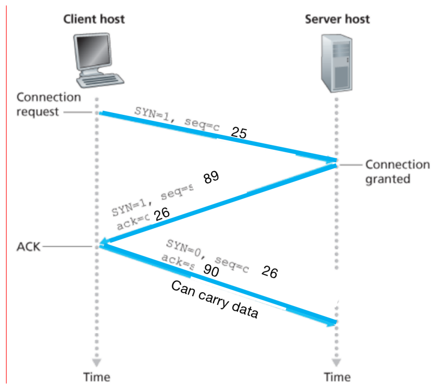
Figure 3.55 Throughput realized by TCP connections 1 and 2

Q 3 *The following figure illustrates the convergence of TCP's additive-increase multiplicative-decrease (AIMD) algorithm. Suppose that instead of a multiplicative decrease, TCP decreased the window size by a constant amount. Would the resulting additive-increase additive-decrease (AIAD) algorithm converge to an equal share algorithm? Justify your answer using a diagram similar to the above figure. (Note: Simply draw the diagram is not sufficient. You need to explain what the diagram shows.)*

Solution: No. If the window size is decreased by a constant amount, then at point B (i.e., when packet loss occurs), the window size will be reduced along the line defined by points A and B. As a result, the window size will keep remaining along the aforementioned line, which will not get closer to the equal bandwidth share line across time.

Q 4 *Draw the TCP connection-establishment procedure (that is, TCP three-way handshaking) between a client host and a server host. Suppose the initial sequence number of the client host is 25, and that of the server host is 89. For each segment exchange between the client and server, please indicate (1) the SYN bit, sequence number, acknowledgement number (if necessary); (2) whether the segment can carry data in the segment payload (that is, in the segment data filed).*

Solution:



Q 5 *Consider the TCP procedure for estimating RTT. Suppose that $\alpha = 0.1$, and EstimatedRTT is initialized as $EstimatedRTT_0$. Recall that*

$$EstimatedRTT = (1 - \alpha)EstimatedRTT + \alpha SampleRTT. \tag{3}$$

(a) *For a given TCP connection, suppose four acknowledgments have been returned in sequence with corresponding sample RTTs: $SampleRTT_1$, $SampleRTT_2$, $SampleRTT_3$, and $SampleRTT_4$. Express EstimatedRTT in terms of $EstimatedRTT_0$ and the four sample RTTs.*

(b) *Generalize your formula for n sample RTTs.*

Solution:

When SampleRTT_1 was received,

$$\text{EstimatedRTT} = 0.1\text{SampleRTT}_1 + 0.9\text{EstimatedRTT}_0.$$

When SampleRTT_2 was received,

$$\text{EstimatedRTT} = 0.1(\text{SampleRTT}_2 + 0.9\text{SampleRTT}_1) + 0.9^2\text{EstimatedRTT}_0.$$

When SampleRTT_3 was received,

$$\begin{aligned}\text{EstimatedRTT} &= 0.1(\text{SampleRTT}_3 + 0.9\text{SampleRTT}_2 + 0.9^2\text{SampleRTT}_1) \\ &\quad + 0.9^3\text{EstimatedRTT}_0.\end{aligned}$$

When SampleRTT_4 was received,

$$\begin{aligned}\text{EstimatedRTT} &= 0.1(\text{SampleRTT}_4 \\ &\quad + 0.9\text{SampleRTT}_3 + 0.9^2\text{SampleRTT}_2 + 0.9^3\text{SampleRTT}_1) \\ &\quad + 0.9^4\text{EstimatedRTT}_0\end{aligned}$$

$$\text{EstimatedRTT} = 0.1 \times \sum_{k=1}^{n} 0.9^{n-k}\text{SampleRTT}_k + 0.9^n \times \text{EstimatedRTT}_0$$