[CS-335a] ASSIGNMENT 3

To TCP or to UDP: that is the question

Deadline: **18/11/2024** 12:00 p.m. **(noon)**
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Part 1: Theory (45 points)

Question 1 [30 points]: Below, there are some statements concerning UDP and TCP. Comment on their validity. Provide a precise, clear and brief justification of your answers **[3 points each]**

- TCP guarantees the delivery of data packets in the **correct order.**
- TCP does not provide **error-checking** mechanisms.
- The **closest router** to the TCP sender computes the size of the congestion window of the connection.
- TCP uses the same **port number** for both the source and destination.
- UDP provides **congestion control** mechanisms to prevent network congestion.
- UDP does **not** guarantee the delivery of data packets**.**
- Assuming that there is **no change in the traffic** of the network during a TCP connection, the congestion window will not change during the session.
- The transport layer is responsible for **routing packets** end-to-end.
- The transport layer supports **both** connection-oriented and connectionless communication.
- Describe a scenario that will drive a TCP connection to assign the lowest possible value to the size of the **congestion window**.

Question 2 [15 points]: Provide brief and clear answers to the following questions:

- What is the purpose of TCP's **sequence numbering**, and how does it function? **[5 points]**
- Describe **two** important "cues" that drive the TCP adaptation. Describe one scenario during which the obtained cues do not accurately reflect the network's conditions and the decrease of the data rate of the TCP transmitter has a significant negative impact on the application without alleviating the problem in the network. **[5 points]**

- Describe a scenario of a **premature timeout** in TCP and explain what causes it. **[3 points].** What are the disadvantages of a large timeout value? **[2 points]**

Part 2: Problems on TCP (65 points)

Question 1 [35 points]: Assume two hosts A and B that communicate over a TCP connection. Host B has received all the bytes from Host A until the 435 byte. Afterwards, Host A sends two segments to Host B one after another. The first segment contains a payload of 40 bytes, while the second one contains 100 bytes. The source port from Host's A side is 240 and the destination port is 80. Host B sends an acknowledgment each time it receives a TCP segment.

- Draw the TCP flow diagram between Host A and Host B, assuming that the two segments arrive in the correct order, without any packet lost. You can ignore Host's B sequence number as no relevant information is given. What is the sequence number of the second segment? Explain. **[5 points]**

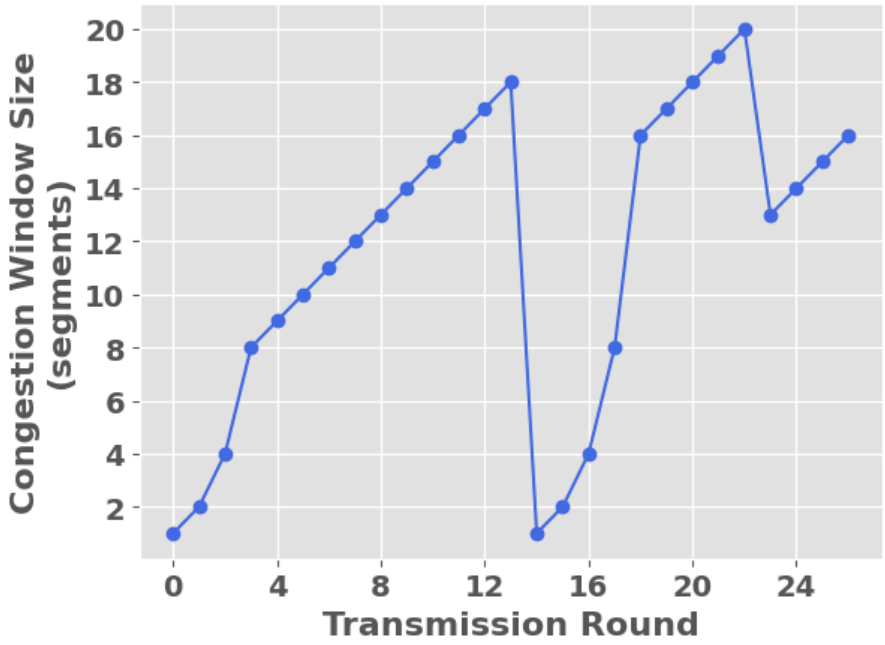
- What are the source and destination port numbers of the ACK segments sent from Host B to Host A? **[5 points]**

- Assume that the second segment reaches Host B before the first segment. What is the acknowledgement number returned by Host B as a response to the arrival of the second segment? explain. **[5 points]**

- Assume that the two segments arrive at Host B in the correct order but both of the responses of Host B are lost. Draw the TCP flow diagram between Host A and Host B, and include the retransmission that will happen in the diagram. Which TCP mechanism will trigger the retransmission? Can Host A be certain about what actually happened? **[10 points]**

- Assume that the two segments arrive in order at Host B. However, the first acknowledgment is lost, while the second one arrives at Host A, after the timer of the first packet has expired. Draw the TCP flow diagram between Host A and Host B. Does Host A retransmit a packet? Is a retransmission actually necessary? Explain. **[10 points]**

Question 2 [30 points]: The diagram below demonstrates an example of the behavior of a specific TCP flow over time. Answer the following questions, with sufficient justification.



- Identify the time intervals when TCP slow start operates. How can we understand that? **[5 points]**
- Identify the time intervals when TCP congestion avoidance operates. How can we understand that? **[5 points]**
- After the 13th transmission round, a severe drop to the size of the congestion window is observed. What could have caused that? Speculate about the traffic in the network at this time period. **[5 points]**
- After the 22nd transmission round, a less severe drop of the size of the congestion window is observed. What could have caused that? Speculate about the traffic on the Internet at this time period? **[5 points]**
- What is the value of cwnd during the 23rd transmission round? Justify your answer. **[5 points]**
- What is the value of ssthresh during the 14th transmission round? Explain. **[5 points]**

Part 3: Hands-on Exercise — Measurements & Analysis (30 points)

Question 1 [30 points]: Here you need to employ Wireshark. Import the following trace file (https://kevincurran.org/com320/labs/wireshark/trace-tcp.pcap) which contains a trace of a TCP flow between a host and a server. Answer the following questions by explaining your answers and providing screenshots from Wireshark.

- What is the IP address of the host initiating the TCP connection? Which are the source and destination port numbers that this host uses on its TCP segments? Provide screenshots to back up your answer. **[5 points]**

- Identify the TCP segments that correspond to the 3-way handshake. Indicate the flags and their values in the header of these segments? Provide screenshots to back up your answer. Do the flags set on these packets agree with what you have learned in theory? **[5 points]**

- Select a random TCP segment. Indicate the sequence number, the ACK number, and its payload size. Provide screenshots to back up your answer. What is the expected ACK number from the other side as a response to this segment? Does it agree with the corresponding response ACK shown in Wireshark? **[5 points]**

- Determine the length (in bytes) of each of the TCP header fields by examining a random TCP segment. Provide screenshots to back up your answer. **[5 points]**