



3rd Assignment: Network Protocols and Architectures, WS 12/13

Question 1: (10 + 10 = 20 points) *TCP sequence number space*

Consider transferring an enormous file of L bytes from Host A to Host B. Assume a MSS (Maximum Segment Size) of 1460 bytes.

- Assume that the file is transferred in a single TCP connection. What is the maximum value of L such that TCP sequence numbers do not need to wrap around? Recall that the TCP sequence number field is four bytes.
- For the L you obtained in (a), find out 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 frame is sent out over a 100 Mbit/s link. Ignore flow control and congestion control so A can pump out the segments back to back and continuously.

Question 2: (7 + 7 + 7 + 9 = 30 points) *TCP's RTT Estimation*

Consider the TCP procedure for estimating RTT. Suppose that $\alpha = 0.1$. Let SampleRTT_1 be the most recent sample RTT, let SampleRTT_2 be the next most recent sample RTT, and so on. Recall that the formula for RTT estimation in TCP is:

$$\text{EstimatedRTT}_{\text{new}} = (1 - \alpha) \cdot \text{EstimatedRTT}_{\text{old}} + \alpha \cdot \text{SampleRTT} \quad (1)$$

- For a given TCP connection, suppose four acknowledgements have been returned with corresponding sample RTTs SampleRTT_4 , SampleRTT_3 , SampleRTT_2 , and SampleRTT_1 . Express EstimatedRTT in terms of the four sample RTTs!
- Generalize your formula for n sample RTTs.
- For the formula in part (b) let n approach infinity. Comment on why this averaging procedure is called an exponential moving average.
- Why do you think TCP avoids measuring the SampleRTT for retransmitted segments? Explain!

Question 3: (5 + 5 = 10 points) *TCP Sequence Numbers*

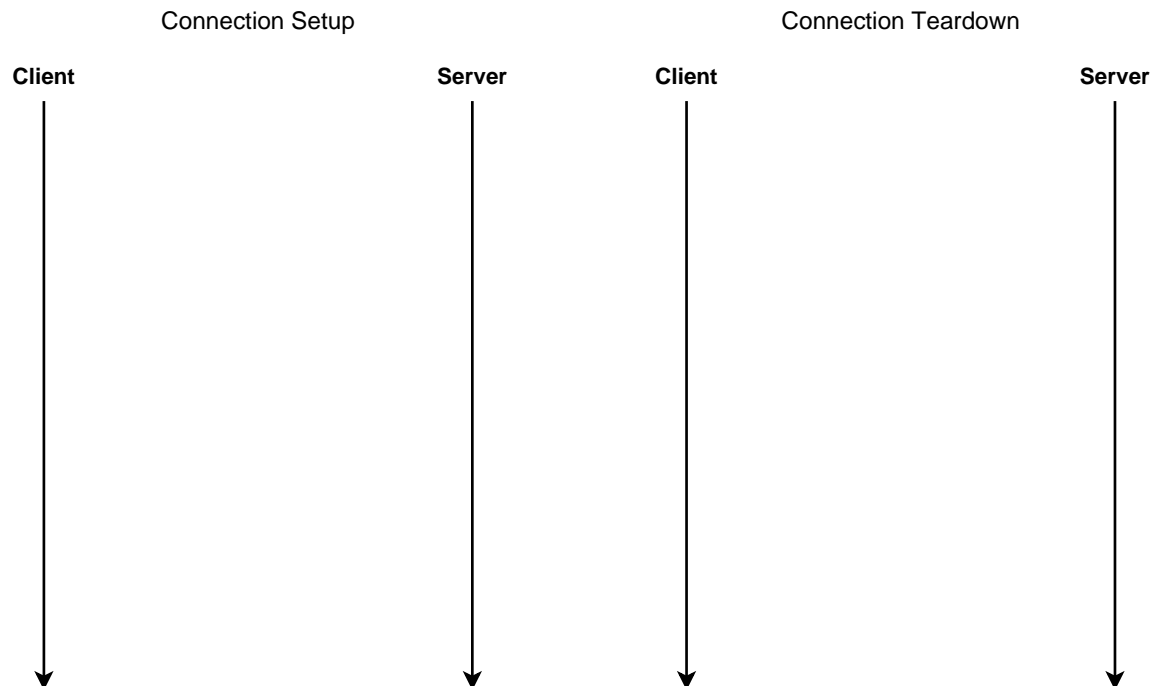
Suppose, Host A sends two TCP segments back-to-back to Host B over a TCP connection. The first segment has sequence number 7858; the second has sequence number 8370.

- How much data (in bytes) is in the first segment?
- Suppose, the first segment is lost but the second segment arrives at B. In the acknowledgment that Host B sends to Host A, what will be the acknowledgment number?

Please turn!

Question 4: (20 + 20 = 40 points) *TCP Handshake and Teardown*

TCP is the number one example for connection-oriented services. In this problem we will have a closer look at TCP's connection management.



- (a) Enter a successful connection setup into a diagram (see above on the left). Label the arrows with the relevant parts of the TCP header (flags, sequence number, acknowledgment number). The initial (randomly chosen) sequence numbers of client and server are: 11500 (Client) and 730 (Server).
- (b) Enter the successful connection teardown into another diagram (see above on the right). Again label the arrows with the relevant parts of the TCP header (flags, sequence number, acknowledgement number). Assume that after the connection setup from part (a) some data was transferred: 540 bytes from client to server, and 15000 bytes from server to client. Consider these values when determining sequence and acknowledgment numbers.

Due Date: Thursday, November, 15th 2012 only until 13:55 h s. t.

- **As PDF files (no MS Office or OpenOffice files):** Uploaded via ISIS (<https://www.isis.tu-berlin.de/course/view.php?id=7028>)
- **On paper:** Postbox in the Telefunkenhochhaus (basement, behind the doorman right)
- Put your name, StudentID number (Matrikelnummer) **and** the name of your tutor on your solution.