IS 504 – Homework #3

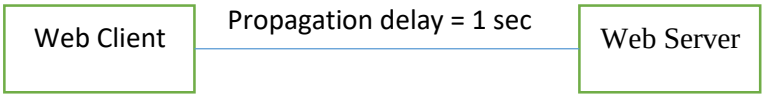
Due: April 26, 2020 Sunday – 23:30

Submission and Grading Policy

- Submit your assignments to the corresponding assignment link in https://odtuclass.metu.edu.tr.
- You can solve the questions on paper and send the pictures of your solutions.
- Solutions should be submitted in a single doc, docx or pdf file named: <metu-username>_HW_3.<extension> (e.g., "e123456_HW_3.pdf").
- Late submissions will be accepted by April 30, 2020, 23:30 with 5% per day penalty.
- This is an individual assignment. You have to adhere to the academic integrity principles.

Questions (3 questions – attempt all questions)

1. (35 pts) Consider the one hop network shown below. In this network, one-way propagation delay over the link is 1 second, the transmission and processing delays for segments are short and can be ignored. Suppose the web client wants to retrieve an image file of 50 Kbytes from the web server using HTTP. Suppose, in TCP connections, TCP Reno is used, MSS=500 bytes, slow start threshold is 64 Kbytes and the receivers allocate 64 Kbyte buffer for the received segments. How long does it take to retrieve the image?



Notes:

- Find the minimum amount of time required.
- Assume that as long as more image data is available, the web server puts a 500-byte (MSS) image chunk into each TCP segment that can contain data.
- Assume that all correctly received TCP segments are acknowledged immediately and as long as the window is not full, data pushed by the application are immediately sent by the senders.
- Do not forget to take into account TCP connection establishment delay.
- Do not forget to take into account TCP congestion control.
- HTTP request and HTTP response headers are short and they can be ignored).

File size is smaller than receiver's buffer (receive window)

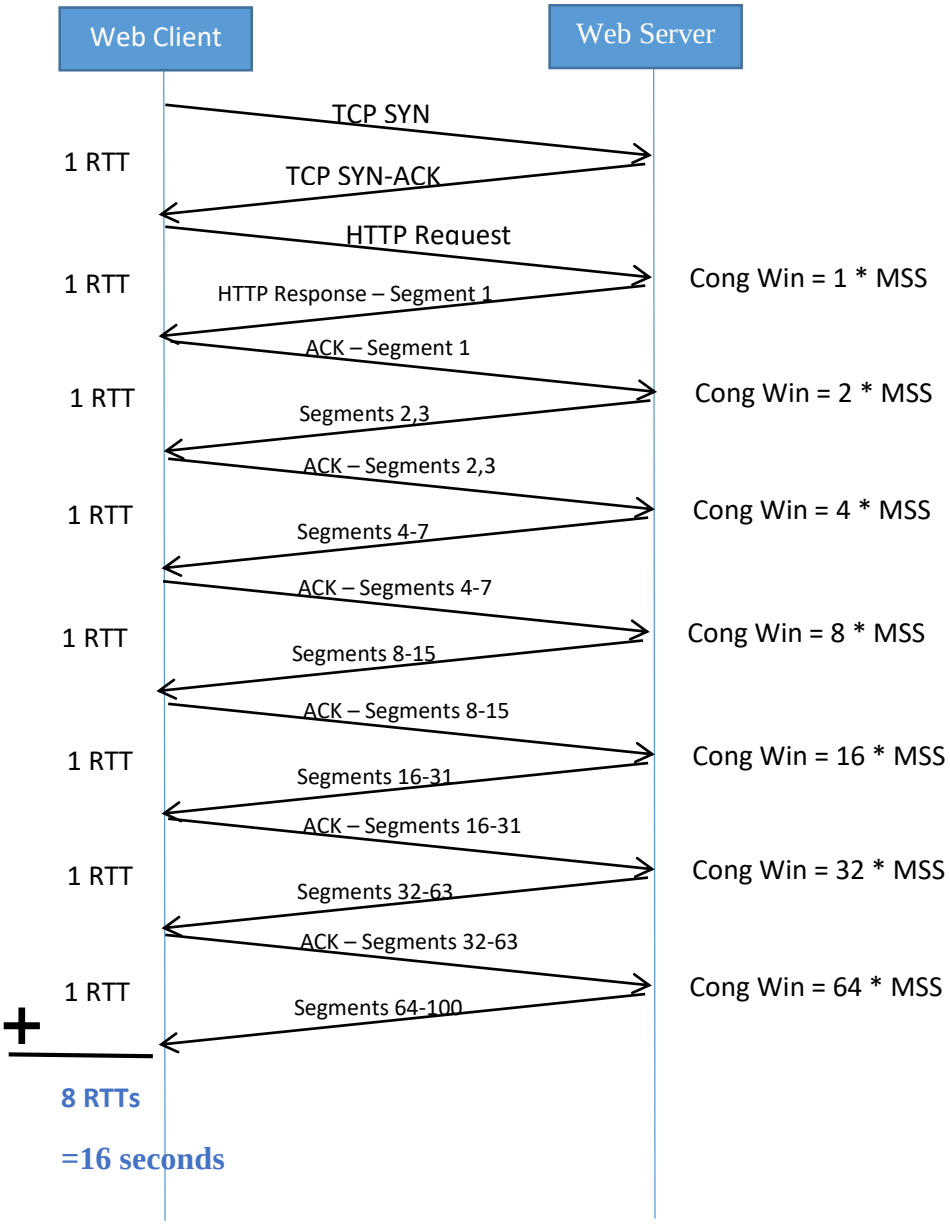
slow start threshold = 64 Kbytes/500 Bytes = 128*MSS

RTT = 2 * 1 sec = 2 seconds (by ignoring transmission and processing delays)

MSS=500 bytes → Number of segments(by ignoring HTTP header):

$$N = \frac{50\ KBytes}{500\ Bytes} = 100$$

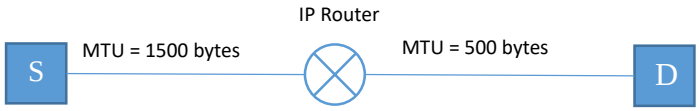
Time space diagram:



8 RTTs

=16 seconds

2. (20 pts) Consider the network given below. In this network, host S is sending an IPv4 datagram to host D through two links with MTUs specified in the figure. The datagram's ID field's value is 12345, length field's value is 1200, fragflag's value is 0, offset's value is 0, and the options field is empty (i.e., there is no options field in the datagram). What are the values of the length, ID, fragflag and offset fields in the IP datagram(s) forwarded to the first and the second link?



Between S and IP Router: 1 fragment

ID: 12345	Length: 1200	FragFlag: 0	Offset: 0

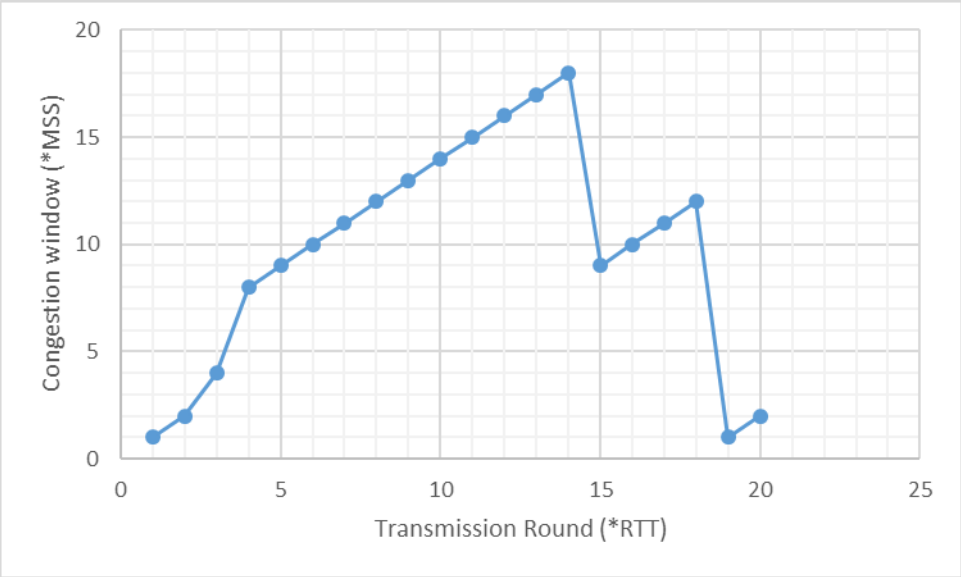
Between S and IP Router: 3 fragments

ID: 12345	Length: 500	FragFlag: 1	Offset: 0

ID: 12345	Length: 500	FragFlag: 1	Offset: 60

ID: 12345	Length: 240	FragFlag: 0	Offset: 120

3. Suppose a host is downloading a very object from a Web server, the server's congestion window evolves in time as shown in the following figure, and TCP Reno is used.



a. (5 pts) Identify the intervals of time when TCP slow start is operating.
[1,4] and [19,20]

b. (5 pts) Identify the intervals of time when TCP congestion avoidance is operating.
[4-14] and [15,18]

c. (5 pts) Identify the transmission rounds in which segment losses occur and indicate how each loss is detected ("triple duplicate ACK" or "timeout").
At round 14: triple duplicate ACK
At round 18: timeout

d. (5 pts) What is the value of slow start threshold (ssthresh) at the 4^{th} transmission round?
8*MSS

e. (5 pts) What is the value of slow start threshold (ssthresh) at the 11^{th} transmission round?
8*MSS

f. (5 pts) What is the value of slow start threshold (ssthresh) at the 17^{th} transmission round?
9*MSS

g. (5 pts) What will be the window size in the 21^{th} round if no loss occurs in the 20^{th} round?
4*MSS