New York University
Computer Science Department
Courant Institute of Mathematical Sciences

Course Title: Data Communications & Networks
Course Number: g22.2662-001
Instructor: Jean-Claude Franchitti
Session: 6

Assignment #6-1

I. Due

Thursday, November 18 2021 at the beginning of class.

II. Objectives

1. Learn transport layer concepts.

III. References

1. Slides and handouts posted on the course Web site
2. Textbook chapter 3

IV. Software Required

1. Microsoft Word.
2. Win Zip as necessary.

V. Assignment

Problem 1: Assume that host A sends three segments in sequence to host B. The first segment has a sequence number 80 and second has a sequence number 92 and third has a sequence number 110.

a. How much data is in first segment?

b. Suppose that the second segment was lost while the first and third segments arrived at host B. What would be the acknowledgement number that host B will send to host A at the end of these three segments?

c. Suppose that the size of the data in 3rd segment is 20 bytes. Also assume that all three segments arrived at host B successfully. What would be the acknowledgement number host B will send to host A?

Problem 2: Someone posting to comp.protocols.tcp-ip complained about a throughput of 120 kpbs on a 256-kbps link with a 128-ms round-trip delay between the United States and Japan, and a throughput of 33 kbps when the link was routed over a satellite.

a. What is the utilization over the two links? Assume a 500-ms round-trip delay for the satellite link.

b. What does the window size appear to be for the two cases?

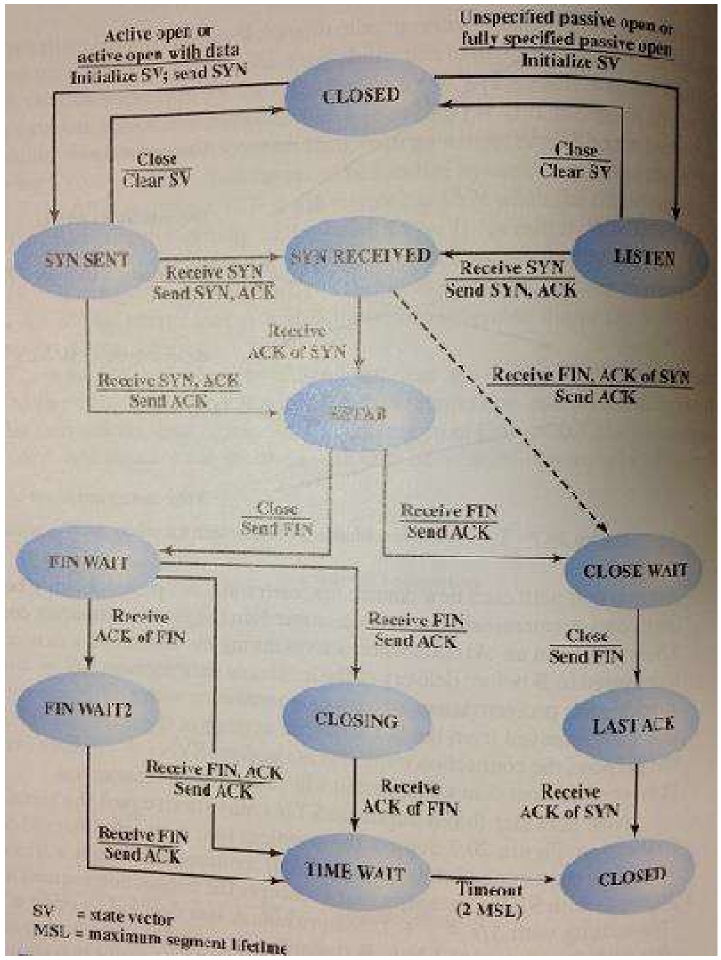
c. How big should the window size be for the satellite link?

Problem 3: When using pipelined protocols operation, senders allow multiple "in-flight", yet-to-be-acknowledged packets.

a. Explain two differences between Go-Back-N and Selective Repeat pipelined protocols.

b. Explain why one timer may not be suffice in Selective Repeat pipelined protocol?

Problem 4: In discussing connection termination with reference to the TCP entity state diagram below, it was stated that in addition to receiving an acknowledgement of its FIN and sending an acknowledgement of the incoming FIN, a TCP entity must wait an interval equal to twice the maximum expected segment lifetime (the TIME WAIT state). Receiving an ACK to its FIN assures that all of the segments it sent have been received by the other side. Sending an ACK to the other side's FIN assures the other side that all its segments have been received. Give a reason why it is still necessary to wait before closing the connection.



Problem 5: In TCP, we use the following formula to calculate the Estimated RTT:

$$\text{EstimatedRTT} = (1- \alpha)*\text{EstimatedRTT} + \alpha*\text{SampleRTT}$$

Assume the following data:

Time #	Estimated RTT (milliseconds)	Sample RTT (miliseconds)
1	200	300
2	?	400
3	?	500

a. Assume that □ = 0.125. What would be the estimated RTT at time 3?

b. Assume that □ = 0.75. What would be the estimated RTT at time 3?

c. What is the implication of increasing α in Estimated RTT calculation?

Problem 6: One difficulty with the original TCP SRTT estimator is the choice of an initial value. In the absence of any special knowledge of network conditions, the typical approach is to pick an arbitrary value, such as 3 seconds, and hope that this will converge quickly to an accurate value. If this estimate is too small, TCP will perform unnecessary retransmissions. If it is too large, TCP will wait a long time before retransmitting if the first segment is lost. Also, the convergence may be slow, as this problem indicates.

a. Choose $\alpha = 0.85$ and SRTT(0) = 3 seconds and assume all measured RTT values = 1 second and no packet loss. What is SRTT(19)? (hint: consider the fact that the following formula: SRTT (K + 1) = α * SRTT (K) + (1 – α) * RTT (K + 1) can be rewritten to simplify the calculation using the expression (1 – αn) / (1 – α)

b. Now let SRTT (0) = 1 second and assume measured RTT values = 3 seconds and no packet loss. What is SRTT (19)?

Problem 7: TCP implements end-to-end guaranteed delivery via a combination of mechanisms.

a. Explain the difference between TCP Flow control and TCP Congestion Control.

b. A poor implementation of TCP's sliding-window scheme can lead to extremely poor performance. There is a phenomenon known as the Silly Window Syndrome (SWS), which can easily cause degradation in performance by several factors of 10. As an example of SWS, consider an application that is engaged in a lengthy file transfer, and that TCP is transferring this file in 200-octet segments. The receiver initially provides a credit of 1000. The sender uses up this window with 5 segments of 200 octets. Now suppose that the receiver returns an acknowledgement to each segment and provides an additional credit of 200 octets for every received segment. From the receiver's point of view, this opens the window back up to 1000 octets. However, from the sender's point of view, if the first acknowledgement arrives after five segments have been sent, a window of only 200 octets becomes available. Assume that at some point, the sender calculates a window of 200 octets but has only 50 octets to send until it reaches a "push" point. It therefore sends 50 octets in one segment, followed by 150 octets in the next segment, and then resumes transmission of 200-octet segments. What might now happen to cause a performance problem? State the SWS in more general terms.

Problem 8: TCP mandates that both the receiver and the sender should incorporate mechanisms to cope with SWS.

a. Suggest a strategy for the receiver (hint: let the receiver "lie" about how much buffer space is available under certain circumstances). State a reasonable rule of thumb for this.

b. Suggest a strategy for the sender (hint: consider the relationship between the maximum possible send window and what is currently available to send).

Problem 9: Consider a large file being sent from one host to another over a TCP connection that has no loss.

a. Suppose TCP uses AIMD for its congestion control without slow start. Assuming cwnd increases by 1 MSS every time a batch of ACKs is received and assuming approximately constant round trip times, how long does it for cwnd increase from 6 MSS to 12 MSS?

b. What is the average throughput in terms MSS and RTT for this connection up through time 6 RTT?

Problem 10: Although slow start with congestion avoidance is an effective technique for coping with congestion, it can result in long recovery times in high-speed networks as this problem demonstrates.

a. Perform you own research to document the Jacobson's algorithm for RTT variance estimation.

b. Assume a round-trip time of 60 ms (about what might occur across a continent) and a link with an available bandwidth of 1 Gbps and a segment size of 576 octets. Determine the window size needed to keep the pipe full and the time it will take to reach that window size after a timeout using Jacobson's approach.

c. Repeat (a) for a segment size of 16 Kbytes.

Homework Submission Guidelines:

1. Save the file as a Word document.

2. Name the file "**firstname_lastname_hw_6.doc**" (e.g., "john_doe_hw_6.doc").

3. Submit your assignment electronically via NYU Brightspace by the due date.

   Use the following naming convention in the subject line of the eMail: "**DCN - firstname lastname - homework 6"**
   (e.g.: "DCN – John Doe - homework 6").

   In the case source code is submitted, include your name as a comment at the top of each file.

(Note: all files submitted should include your name).

VI. <u>Deliverables</u>

1. Electronic:

   Your assignment file must be submitted via NYU Brightspace. The file must be created and sent by the beginning of class. After the class period, the homework is late. The email clock is the official clock.

2. Cover page and other formatting requirements:

   The cover page supplied on the next page must be the first page of your assignment file.

   Fill in the blank area for each field.

   <u>NOTE</u>:

   The sequence of the hardcopy submission is:

   1. **Cover sheet**
   2. **Assignment Answer Sheet(s)**

   Assignment Layout (5%)

   - o Assignment is neatly assembled on 8 1/2 by 11 page layout.
   - o Cover page with your name (last name first followed by a comma then first name), username and section number with a signed statement of independent effort is included.
   - o Answers to Questions 1 to 10 are correct.
   - o File name is correct.

   Answers to Individual Questions:

   - o 100 points total, all questions weighted equally)

   - o Assumptions provided when required.

<u>VII. Sample Cover Sheet:</u>

Name ________________________   Date: ____________
(last name, first name)
Section: ___________

Assignment 6-1

Total in points (100 points total): ___________________

Professor's Comments:

Affirmation of my Independent Effort: _____________________________
(Sign here)