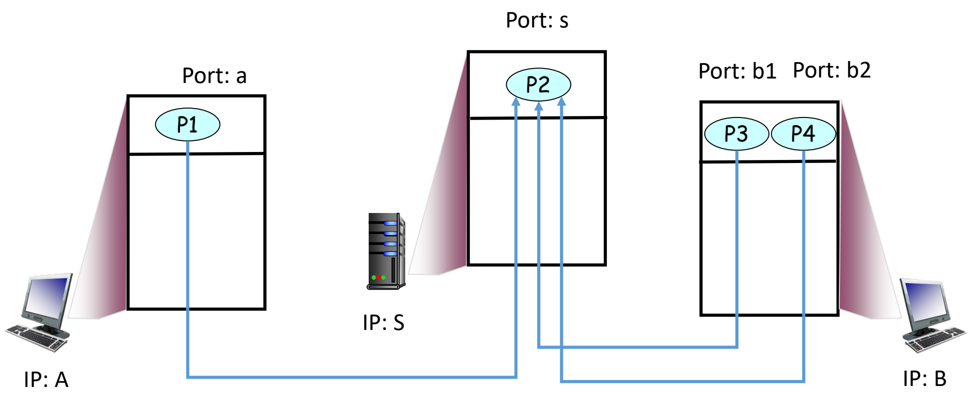
CMPEN/EE 362 - HW3

Student Name: ___________________________

Problem 1

Suppose web clients with IP addresses A and B are connecting to a web server with IP address S. Client A opens one connection listened to by process P1 on port a. Client B opens two connections listened to by processes P3 and P4, respectively, on ports b1 and b2, respectively. The server runs a single process P2 listening on port s.



a) Use the following table to give the header fields of packets between the nodes.

	Source IP	Destination IP	source port#	destination port#
P1 → P2				
P3 → P2				
P4 → P2				
P2 → P4				

b) Can port a be the same as port b1?

c) Can port b2 be the same as port b1?

d) How many sockets the server needs to create? Of what type?

Problem 2

Lookup the 8-bit ASCII codes for “Hello world!”.

a) Compute the checksum.
b) Is it possible that a 1-bit error is undetected?
c) Is it possible that a 2-bit error is undetected? If so, give an example.

Problem 3

Consider rdt2.1. What will happen if the receiver always responds NAK as long as the received packet is not the expected packet, i.e., it responds NAK if the received packet is corrupted or has the wrong sequence number (i.e., has_seq0 in “Wait for 1 from below” or has_seq1 in “Wait for 0 from below”)? Explain.

Problem 4

Complete the FSM for receiver C in the multi-to-one rdt by giving the event-action list for each of the remaining edges (edges (7)-(12)).

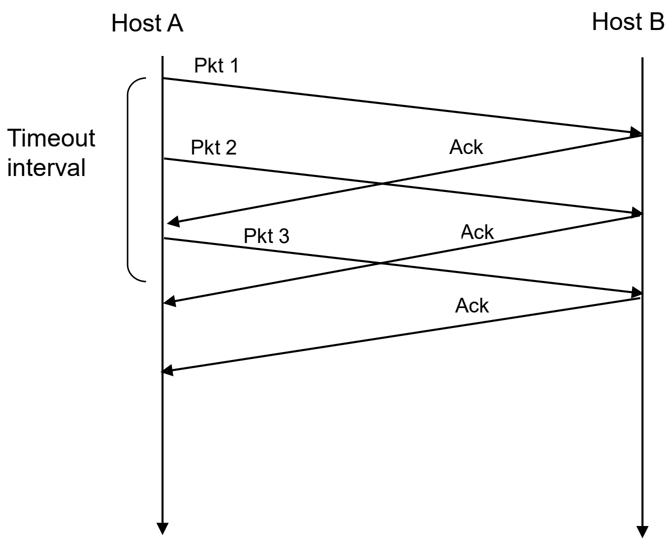
Problem 5

Complete the FSM for sender A in the one-to-multi rdt by giving the event-action list for each of the remaining edges (edges (9)-(20)).

Problem 6

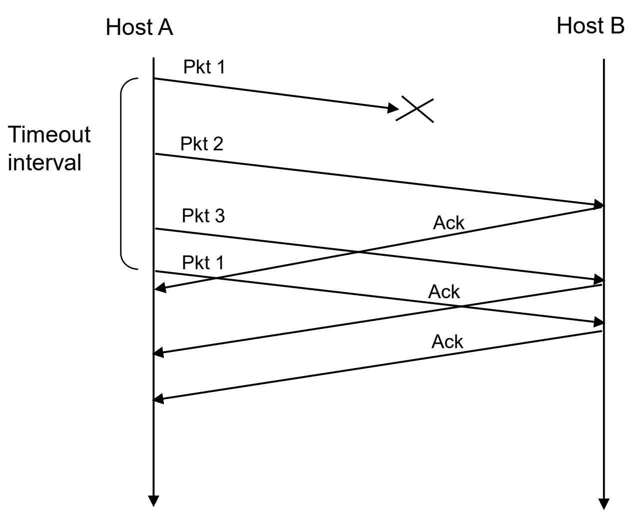
Hosts A and B has established a TCP connection, and Host B has received from A all bytes up to byte 200 (inclusive). Suppose Host A sends three segments to Host B, containing 100, 60, 120 bytes of data, respectively. Assume that out-of-order packets are buffered by the receiver. Give the sequence number of each segment sent by A and the acknowledgement number of each segment received by A, in each of the following scenarios:

a) All transmissions are in-order and successful.



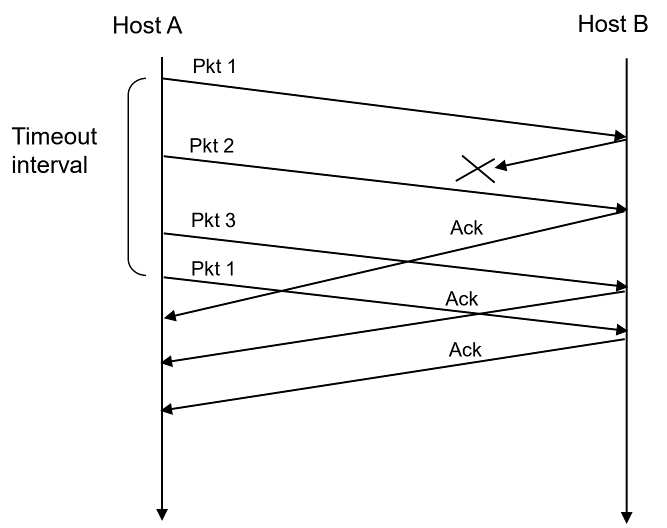
(a) successful

b) The first segment sent by A is lost.



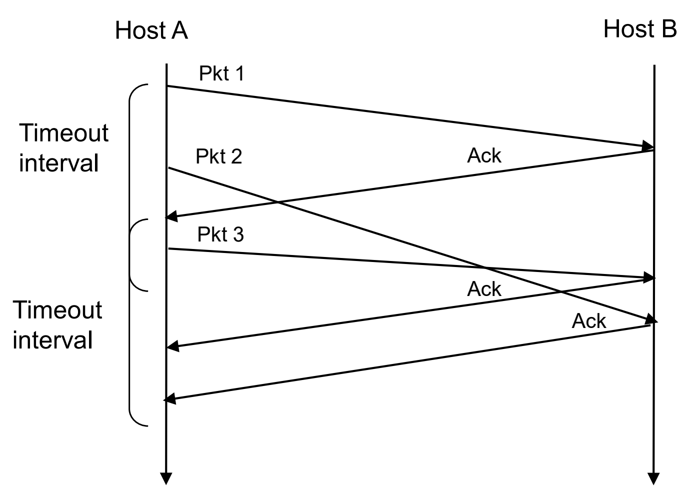
(b) lost packet

c) The first acknowledgement sent by B is lost.



(c) lost ACK

d) The second segment sent by A arrives after the third segment.



(d) out-of-order packet

Problem 7

Suppose that initially, EstimatedRTT=80 ms, and DevRTT=20 ms. Let α=0.12 and β=0.23. Given five measurements of SampleRTT: 70 ms, 110 ms, 102 ms, 90 ms, and 115 ms,

a) Compute the value of EstimatedRTT after each measurement;
b) Compute the corresponding value of DevRTT;
c) Compute the corresponding value of TimeoutInterval.

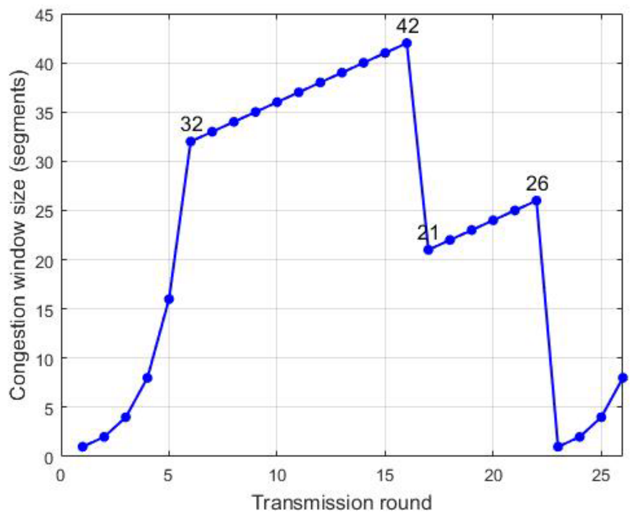
Problem 8

Suppose Host A sends 6 consecutive segments to Host B using a window size of 6. Suppose the 1st segment is lost (when transmitted for the first time) and there is no further loss. Suppose that the sequence number starts from 1 and increments by 1 per segment (each segment has 1 byte in payload). Further suppose that under Go-Back-N (GBN) or Selective-Repeat (SR) protocol, the acknowledgement number is the sequence number of the segment it acknowledges (initially 0), and under TCP, the acknowledgement number is the sequence number of the next segment it expects (initially 1). In the case of TCP, suppose that the sender uses fast retransmission, the receiver buffers out-of-order segments, and the sender finishes transmitting the 6th segment before receiving any ACK.

a) Under each of GBN, SR, and TCP: How many segments will Host A send in total? How many ACKs will Host B send in total?
b) Give the sequence number of each segment sent by A, and the acknowledgement number of each ACK sent by B, under each protocol.
c) Suppose that the timeout values of all three protocols are longer than the time to send 6 segments and receive their ACKs (if not lost). Which protocol delivers all the segments fastest? Why?

Problem 9 (optional, not graded)

Assume TCP Reno is used, and the congestion window exhibits the following evolution. Answer the following questions, each with a short explanation of your answer.



a) Identify the intervals of time when TCP slow start is operating.

b) Identify the intervals of time when TCP congestion avoidance is operating.

c) After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?

d) After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?

e) What is the initial value of ssthresh at the first transmission round?

f) What is the value of ssthresh at the 18th transmission round?

g) What is the value of ssthresh at the 24th transmission round?

h) During what transmission round is the 70th segment sent?

i) Assuming that the first three ACKs received in the 26th round are all duplicate ACKs, what will be the values of the congestion window size and of ssthresh upon receiving the third duplicate ACK?

j) Suppose TCP Tahoe is used (instead of TCP Reno), and assume that a triple duplicate ACK is received at the 16th round. What are the ssthresh and the congestion window size at the 19th round?

k) Again suppose TCP Tahoe is used, and there is a timeout event at the 22nd round. How many packets have been sent out from 17th round till 22nd round (inclusive)?

Problem 10 (optional, not graded)

Suppose that the congestion window of a TCP connection starts from W/2 bytes, grows as specified in the congestion avoidance state until reaching W bytes, and then resets to W/2 bytes upon detecting a lost segment. Assume each segment contains MSS bytes of data, and each round takes RTT seconds. Assume W/(2MSS) is an integer.

a) Give the number of rounds it takes for the window to grow from W/2 to W.
b) Give the total number of bytes transmitted in a period, i.e., the period from the time the window is W/2 to just before the next time it becomes W/2 again.
c) Give the loss rate L (fraction of lost segments in the long run).
d) Show that for W >> MSS (>>: much larger than), the average throughput is approximately

$$\frac{1.22 \cdot MSS}{RTT \cdot \sqrt{L}}$$