CSE3300/CSE5299: Computer Networking

Homework 4

Due Date: **10/11/2025**. Submission through HuskyCT.

Full score: 100 for CSE3300 students; 120 for CSE5299 students (will be normalized to 100 when entering the grade in HuskyCT).

1. **TCP sequence numbers and ACK numbers (20 points).** Hosts A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 2000. Suppose Host A then sends two segments back-to-back to Host B, with 1000 and 500 bytes of data in the first and second segments, respectively. In the first segment, the sequence number is 2001 (for simplicity, we assume the sequence number starts from 0, although it typically starts with a random number in practice), the source port number is 50002, and the destination port number is 80. Host B sends an ACK to A whenever it receives a segment from A.

   a. (6 points) In the second segment from A to B, what is the sequence number, source port number, and destination port number?

      seq #: 3001

      Source port: 50002

      destination port #: 80

   b. (6 points) Suppose the first segment arrives at B earlier than the second segment. In the ACK for the first arriving segment from B to A, what is the ACK number, source port number, and destination port number?

      ACK # is 3001

      Source Port # is 80

      Destination Port #is 50002

   c. (4 points) Now suppose the second segment arrives at B earlier than the first segment (i.e., the two segments arrive out of order). In the ACK for the first arriving segment from B to A, what is the ACK number?

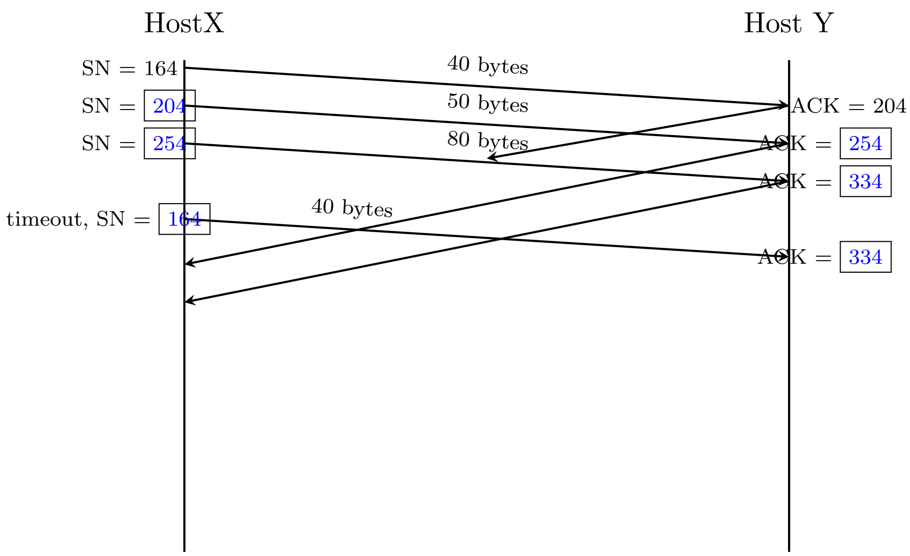
      ACK # is 2001

   d. (4 points) Now suppose the first segment is lost and the second segment arrives at B. In the ACK for the arriving segment from B to A, what is the ACK number?

      ACK # is 2001

2. **Packet Loss in TCP (15 points)** Two hosts X and Y are communicating over a TCP connection, all bytes up through byte 163 being sent by Host X and received by Host Y. Now assume that Host X sends three segments to Host B back-to-back. The first segment contains 40 bytes, the second segment contains 50 bytes, and the third segment contains 80 bytes. In the first segment, the sequence number is 164, the source port number is 105, and

the destination port number is 80. Host Y sends an acknowledgment whenever it receives a segment from Host X. Suppose the two segments sent by X arrive in order at Y. The first acknowledgment is lost, and the second acknowledgment arrives after the first timeout interval. Complete the sequence diagram shown below.



3. **TCP Congestion Control (35 points)**

Fig. 1 plots TCP window size as a function of time. It shows that the congestion window size is 1 MSS in the first round, 2 MSS in the second round, and 4 MSS in the third round, etc. Answer the following questions. For all the questions, please briefly justify your answer. You can conveniently use $[a, b]$ to represent a time interval. For instance, you can say during time interval $[1, 6]$, the TCP flow is in slow start phase. No need to worry about the inclusive or exclusive notation in the time interval. For instance, you can also say during time interval $[1, 6)$, the TCP flow is in slow start phase, where you exclude 6 by using ")" instead of "]", since at the beginning of the 6th round, the TCP flow transits to congestion avoidance phase. The graph can be partitioned into the following intervals: [1,6] [7-16] [17-22], [23,26]

a. (5 points) Identify all the intervals of time when TCP slow start is operating.
[1,6] [23,26]

b. (5 points) Identify all the intervals of time when TCP congestion avoidance is operating.
[7,16] [17,22]

c. (5 points) After the 16th transmission round, is segment loss detected by a triple duplicate ACK or a timeout?
tripe duplicate ACK

d. (5 points) After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or a timeout?
timeout

e. (5 points) What is the initial value of `ssthresh` at the first transmission round?
32MSS

f. (5 points) What is the value of `ssthresh` at the 18th transmission round?
$42/2 = 21$ MSS

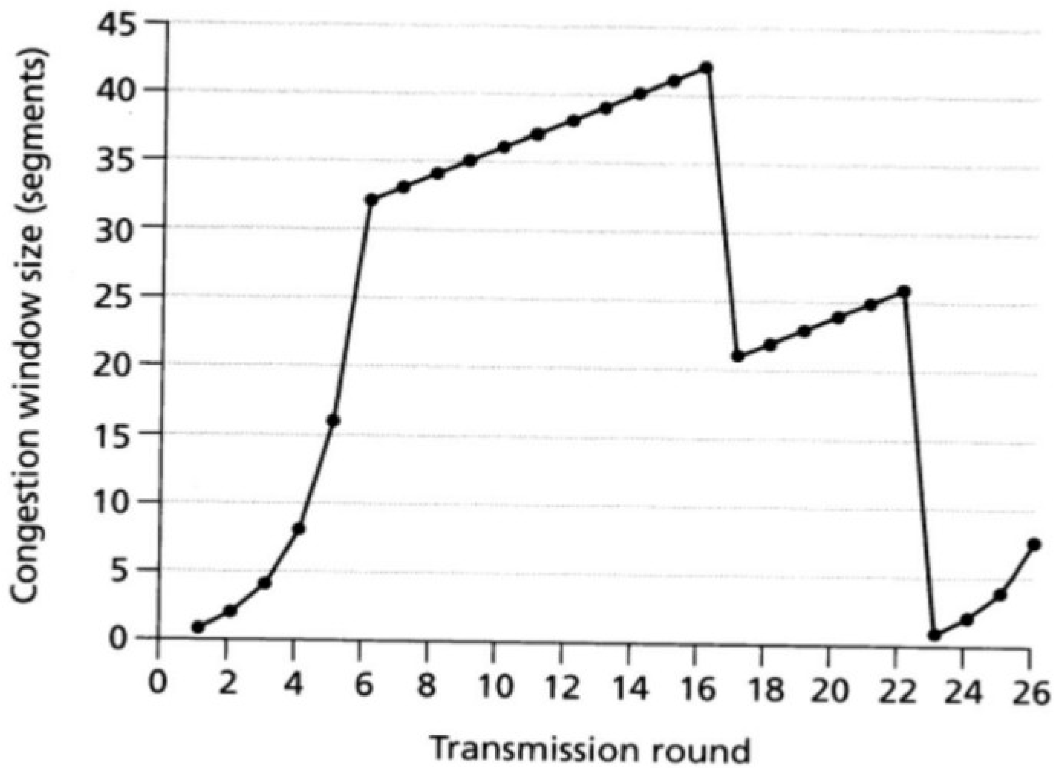


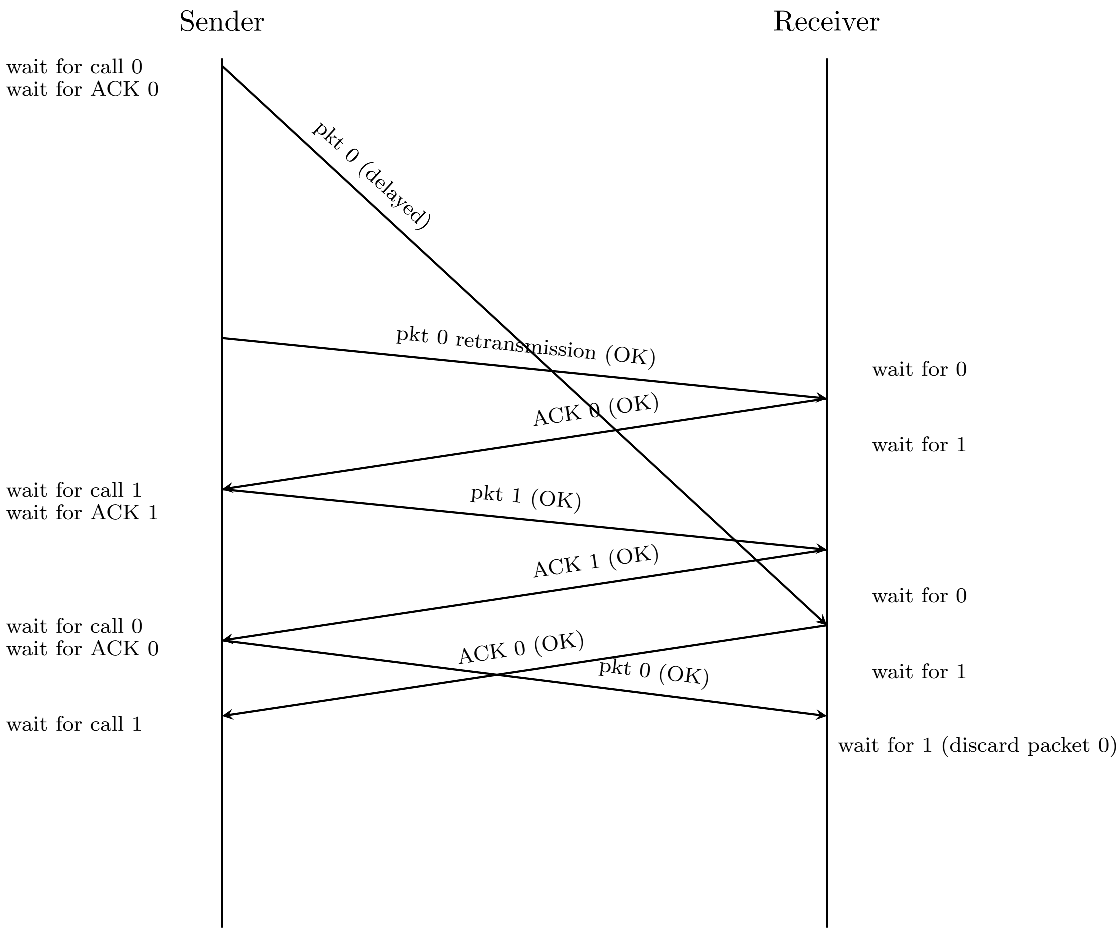
Figure 1: Evolution of TCP congestion window over time.

g. (5 points) What is the value of `ssthresh` at the 24th transmission round?
$26/2 = 13$MSS

4. **TCP in action. (30 points)** Work on TCP wireshark lab (posted in HuskyCT). *You only need to do problems 1-10.*

5. **For CSE5299 students only. rdt3.0 (20 points).** Consider the FSM of rdt3.0 shown in Fig. 2. Recall that rdt3.0 is designed for a channel that can corrupt and lose packets. Now suppose that the channel can also make packets to be out of order (i.e., reorder packets), i.e., if the sender sends packet i followed by packet j, packet j may arrive before packet i at a receiver. Use a time sequence graph to show that in that scenario, rdt3.0 will NOT provide reliable data transfer.

   The delayed old Packet 0 could cause the receiver to think it has received the new packet 0, causing it to transition to the wait for 1 state. When the new packet 0 arrives at the receiver, it will be discarded as a result, but it may not be retransmitted as the sender might move to the wait for call 1 state already.


Sender
Receiver
wait for call 0
wait for ACK 0
pkt 0 (delayed)
pkt 0 retransmission (OK)
wait for 0
ACK 0 (OK)
wait for 1
wait for call 1
wait for ACK 1
pkt 1 (OK)
ACK 1 (OK)
wait for 0
wait for call 0
wait for ACK 0
ACK 0 (OK)
pkt 0 (OK)
wait for 1
wait for call 1
wait for 1 (discard packet 0)

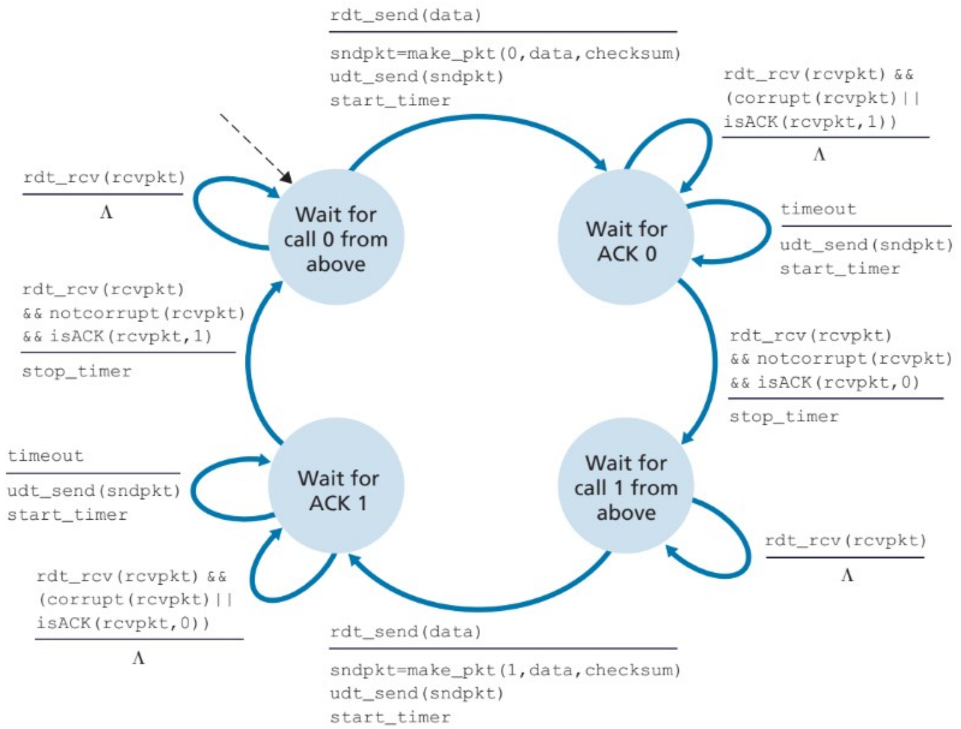


Figure 3.15 ♦ `rdt3.0` sender

(a) rdt 3.0 sender from the textbook

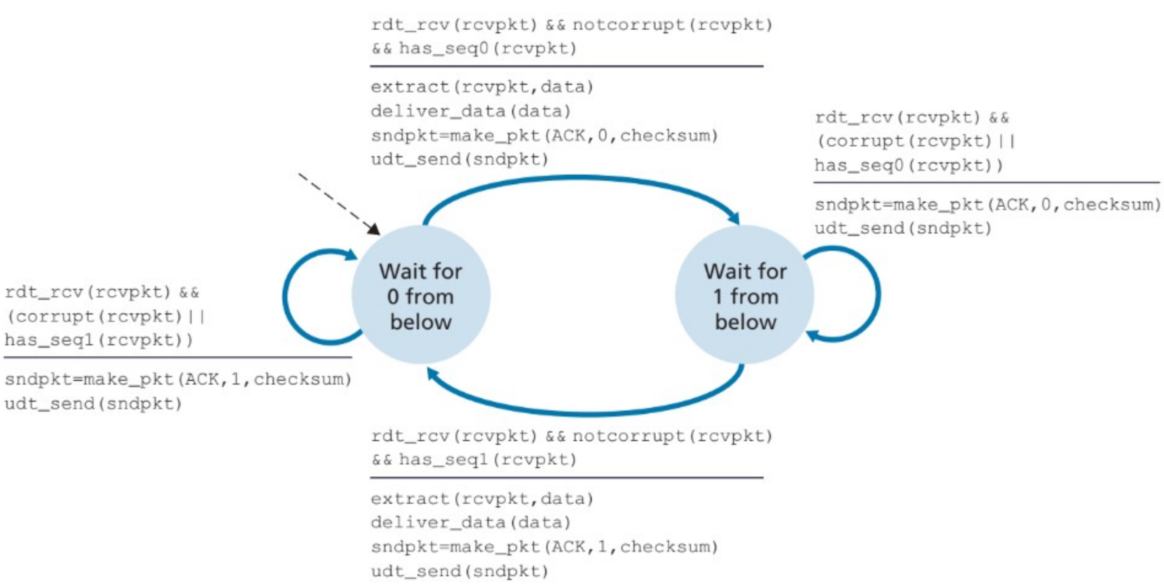


Figure 3.14 ♦ `rdt2.2` receiver

(b) rdt 2.2/3.0 receiver from the textbook

Figure 2: rdt 3.0 protocol diagrams