ECE438 Homework 3 Jiadong Hong

Part1

1 Choose all that Apply - 3 × 3 points

Each question may have more than one correct answer. You will only get points if you identify all the correct answers.

1. A TCP socket is an end to end connection between two_.

   (a) processes

   (b) threads

   (c) hosts

   (d) devices

A

A TCP socket is an end-to-end connection between processes.

2. Suppose Host A sends one segment with sequence number 40 and 8 bytes of data over a TCP connection to Host B. In this same segment the acknowledgement number is necessarily 48.

   (a) True

   (b) False

B

The acknowledgement number indicates the next expected sequence number to receive. So if Host A sends a sequence number of 40, and the data length is 8 bytes, then the next expected sequence number Host B should receive is 40 + 8 = 48. Therefore, the correct answer is (a) True.

3. Consider Selective ACK protocol. Choose all that apply

   (a) Receiver's base sequence number can be smaller than transmitter's base sequence number

   (b) Receiver's base sequence number can be smaller than transmitter's tail sequence number

   (c) Receiver's base sequence number can be larger than transmitter's tail sequence number.

   (d) Receiver's base sequence number can be larger than transmitter's tail sequence number plus one.

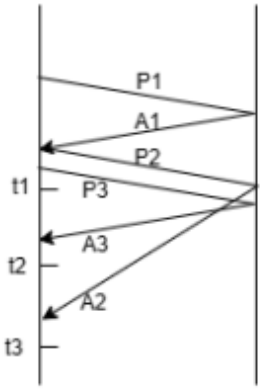
CD

In the Selective ACK protocol, the receiver's base sequence number can be larger than the transmitter's tail sequence number. So the correct answers are (c) and (d).

Part 2

2 TCP examples 1 - 2 × 3 + 3 points

Assume TCP is at slow start phase from CW = 1



(1) CW at time t1 = 2

(2) CW at time t2 = 4

(3) CW at time t3 = 4

(4) How should the TCP transmitter react after receiving A3? Please give CW head, CW tail, and Send.

CW increase by 2

Send P4-7 since ACK3 indicates 3 has arrived.

CW_Head = 4, CW_tail = 7, Send = [4,5,6,7]

(5) How should the TCP transmitter react after receiving A2? Please give CW head, CW tail, and Send

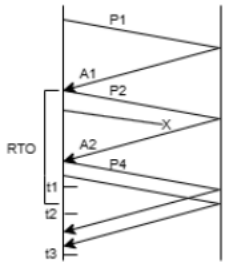
There is no change for CW and there is no package send

CW_Head = 4, CW_tail = 7, Send = []

Part 3

3 TCP example 2 - 2 x 3 + 4 x 3 points

Assume TCP is at slow start phase from CW = 1



1. CW at time t1 =

2. CW at time t2 =

3. CW at time t3 =

4. How should the TCP transmitter react after receiving packet P3's timeout? Please give CW_head, CW_tail, SSthresh and Send

5. How should the TCP transmitter react after receiving the penultimate ACK shown in graph? Please give CW_head, CW_tail, SSthresh and Send

6. How should the TCP transmitter react after receiving the last shown ACK? Please give CW_head, CW_tail, SSthresh and Send

(1) CW = 3

(2) CW = 1

(3) CW = 1

(4) Resend P3, CW_head = 3, CW_tail = 3, SS_thresh = 1.5, send = [3]

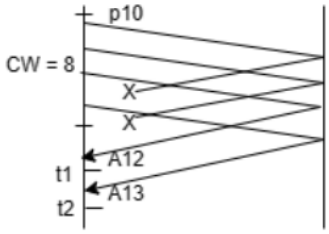
(5) no action, CW_head = 3, CW_tail = 3, SS_thresh = 1.5, send = []

(6) no action, CW_head = 3, CW_tail = 3, SS_thresh = 1.5, send = []

Part 4

4 TCP example 3 - 2 x 2 + 3 points

Assume packets before P10 have already been acknowledged in the past and TCP is in slow start.



1. CW at time t1 =

2. CW at time t2 =

3. How should the TCP transmitter react after receiving A13? Please give CW_head, CW_tail, and Send

(1) CW = 11

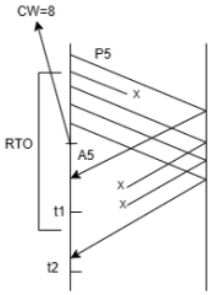
(2) CW = 12

(3) CW++; send P24-25, CW_head = 14, CW_tail = 25, send = [24,25]

Part 5

5 TCP example 4 - 2 x 2 + 3 + 4 points

Assume that the first ACK that is shown to arrive at the TCP transmitter is A5 and TCP is in slow start. Also assume packets before P5 have already been acknowledged in the past.



1. CW at time t1 =

2. CW at time t2 =

3. How should the TCP transmitter react after receiving A5? Please give CW_head, CW_tail, and Send

4. How should the TCP transmitter react after timeout? Please give CW_head, CW_tail, SSthresh and Send

(1) CW = 9

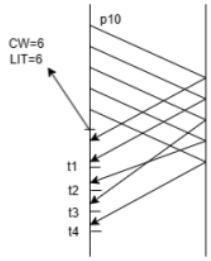
(2) CW = 1

(3) CW would be increased by 1, and the host would send P10-14, CW_head = 6, CW_tail = 14, Send = [10,11,12,13,14]

(4) Stay in slow start state, Resend P6, CW_head = 6, CW_tail = 6, Send = [6], SS_thresh = 4.5

6 TCP example 5 - 4 × 6 points

Assume packets before P10 have already been acknowledged in the past



1. What should the values of CW be at times t1, t2, t3, and t4? (Round to 1 decimal place)

2. How should the TCP transmitter react upon receiving A10? Please give CW_head, CW_tail, SSthresh, and Send

3. How should the TCP transmitter react upon receiving A11? Please give CW_head, CW_tail, SSthresh, and Send

4. How should the TCP transmitter react upon receiving A13? Please give CW_head, CW_tail, SSthresh, and Send

5. How should the TCP transmitter react upon receiving A12? Please give CW_head, CW_tail, SSthresh, and Send

6. How should the TCP transmitter react upon receiving A14? Please give CW_head, CW_tail, SSthresh, and Send

(1) t1: CW = 19/3, t2: CW = 20/3 t3: CW = 20/3 t4: CW = 41/6.

(2) CW += 1/6, send P15-16, CW_head = 11, CW_tail = 16, Send = [15,16], SS_thresh = 6

(3) CW += 1/6, Send P17, CW_head = 12, CW_tail = 17, Send = [17], SS_thresh = 6

(4) CW += 1/3, Send P18-19, CW_head = 14, CW_tail = 19, Send = [18, 19], SS_thresh = 6

(5) NO action. CW_head = 14, CW_tail = 19, Send = [], SS_thresh = 6

(6) CW += 1/6, Send P20, CW_head = 15, CW_tail = 20, Send = [20], SS_thresh = 6

7 T/F Question - 5 + 5 points

Answer true or false of the following questions and briefly justify your answer:

1. With SR protocal, it is possible for the sender to receive an ACK for a packet that falls outside of its current window.

2. With GBN, it is possible for the sender to receive an ACK for a packet that falls outside of its current window.

(1) False, With Selective Repeat (SR) protocol, the sender maintains a window of acceptable sequence numbers for the acknowledgment (ACK) of the received packets. The window represents a range of acceptable sequence numbers, and the sender expects to receive ACKs only for packets within this window.

(2) True. With the Go-Back-N (GBN) protocol, it is possible for the sender to receive an acknowledgment (ACK) for a packet that falls outside of its current window. In GBN, the sender continues to send a sequence of packets without waiting for individual acknowledgments. The receiver, however, can selectively acknowledge correctly received packets.

8 GBN Question - 6 x 2 points

Consider the Go-Back-N protocol with a send window size of N and a large sequence number range. Suppose that at time t, the next in-order packet that the receiver is expecting has a sequence number of k. Assume that, the medium may drop packets but does not reorder messages. Also, "window-base" as taught in class is also called the "window-head".

1. What are the possible set of sequence number inside the sender's window at time t? Justify your answer.

2. What are all possible values of ACK field in all possible message currently propagting back to the sender at time t? Justify your answer.

1. Possible set of sequence numbers inside the sender's window at time t:
At time t, the sender's window contains sequence numbers from the current "window-base" (also called "window-head") up to the sequence number of the last packet that has been sent. Therefore, the possible set of sequence numbers inside the sender's window at time t is `[window-base, window-base + N - 1]`. This is because the window size is N, and it covers N consecutive sequence numbers.

2. Possible values of the ACK field in all possible messages currently propagating back to the sender at time t:
At time t, acknowledgments may be in transit for the packets sent earlier. The acknowledgment number in an ACK message represents the next expected sequence number at the receiver. Therefore, the possible values of the ACK field in ACK messages at time t are `[k, k + N - 1]`, where k is the sequence number of the next in-order packet that the receiver is expecting.

Justification: The receiver acknowledges all correctly received packets up to the next expected sequence number. Since the receiver is expecting the next in-order packet with a sequence number of k, the acknowledgment can acknowledge packets up to `k + N - 1` in case all packets within the window have been correctly received.

Please note that if there are dropped or lost packets, the sender may receive duplicate ACKs for the same sequence number, and the sender would then retransmit the unacknowledged packets in its window.