Q1 Choose all the correct answers
12 Points

Q1.1
3 Points

Assume TCP is in the Slow Start phase, with SSThreshold as 32. Assume TCP is ACKing all packets and that no ACKs are getting lost. At some time instant, the congestion window is 16.

Claim: When the congestion window increases the next time, it becomes 32.

- ○ True
- ○ False

Q1.2
3 Points

A TCP socket is an end-to-end connection between two ___

- ☐ threads
- ☑ processes
- ☐ devices
- ☐ hosts

Q1.3
3 Points

Flow control regulates the congestion window, i.e., the congestion window is not increased when the receiver does not have adequate buffer space.

- ○ True
- ○ False

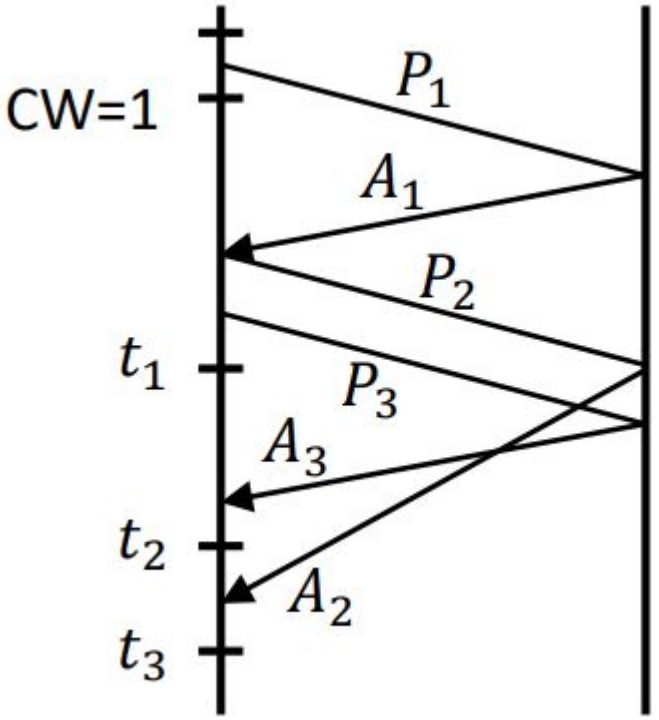
Q1.4
3 Points

In Selective Repeat, the lower end of the transmitter's window can be ____ the lower end of the receiver's window.

- [ ] greater than
- [x] equal to
- [x] smaller than

Q2 TCP example 1
10 Points

Assume TCP is at slow start phase.



NOTE:

(1)
For all succeeding questions that ask how TCP reacts, the following fields are defined as:

• CW_head: Congestion Window Head (also called Base);
Enter an integer unless specified otherwise

• CW_tail: Congestion Window Tail; **Enter an integer**

e.g.,: If CW=[4,5,6,7,8], then you should answer CW_head as 4 and CW_tail as 8.

• SSthresh: Slow Start Threshold;
Enter a numeric value rounded to 1 decimal place

• Send: The packets that need to be transmitted by the TCP transmitter.
Enter a sequence of integers comma-separated, no spaces e.g., 1,2,3
If it's a single value enter an integer
When nothing is to be sent, write - (hyphen).

(2)
Each subquestion (e.g., 2.4,3.3,...) is graded as a whole i.e., if any one of CW_head, CW_tail, SThresh, or Send is wrong then the subquestion will be graded as incorrect. There is no partial credit.

Q2.1
2 Points

CW at time t1

2

Q2.2
2 Points

CW at time t2

4

Q2.3
2 Points

CW at time t3

4

Q2.4
2 Points

How should the TCP transmitter react after receiving A3?
CW_head:

4

CW_tail:

7

Send:

4,5,6,7

Q2.5
2 Points

How should the TCP transmitter react after receiving A2?
CW_head:

4

CW_tail:

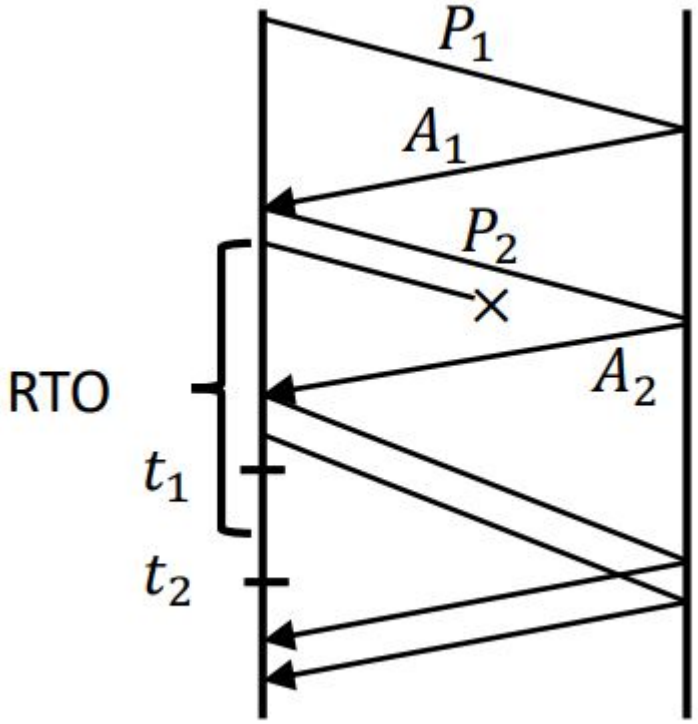
7

Send:

-

Q3 TCP example 2
8 Points

Assume TCP is at slow start phase from CW=1.



Q3.1
2 Points

CW at time t1

3

Q3.2
2 Points

CW at time t2

1

Q3.3
2 Points

How should the TCP transmitter react after packet P3's timeout (shown in the figure)?
CW_head:

3

CW_tail:

3

Sthresh:

1.5

Send:

3

Q3.4
2 Points

How should the TCP transmitter react when each of the last two ACKs (shown in the figure) arrive?
CW_head:

3

CW_tail:

3

Sthresh:

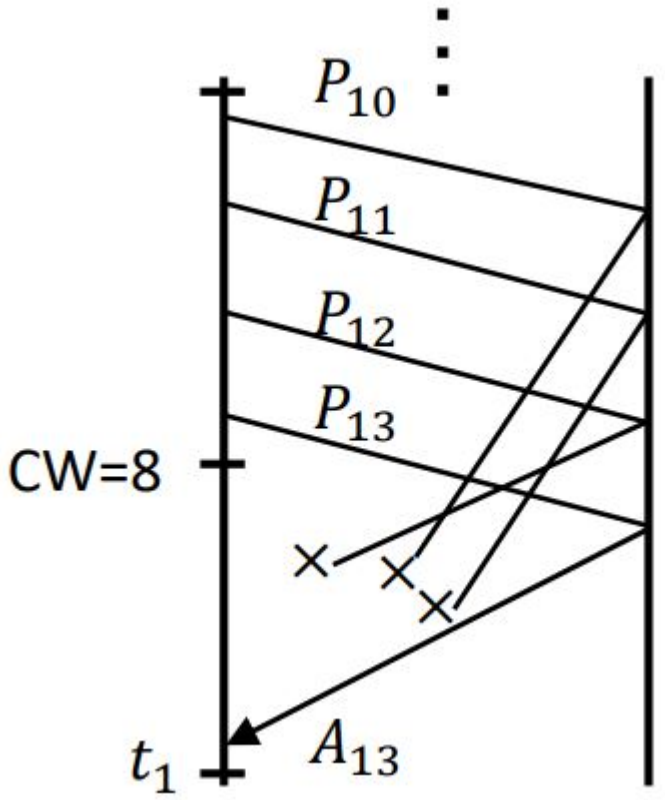
1.5

Send:

-

Q4 TCP example 3
6 Points

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



Q4.1
3 Points

CW at time t1

12

Q4.2
3 Points

How should the TCP transmitter react upon receiving A13?
CW_head:

14

CW_tail:

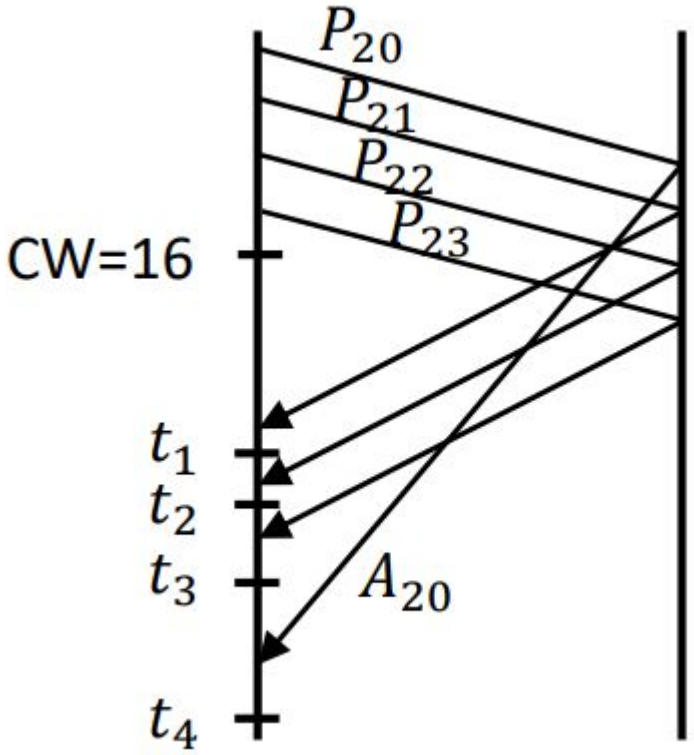
25

Send:

14,15,16,17,18,19,20,21,22,23,24,25

Q5 TCP example 4
16 Points

Assume packets before P20 have already been acknowledged in the past and TCP is in slow start.



Q5.1
2 Points

CW at time t1

18

Q5.2
2 Points

CW at time t2

19

Q5.3
2 Points

CW at time t3

20

Q5.4
2 Points

CW at time t4

20

Q5.5
2 Points

How should the TCP transmitter react upon receiving A21?
CW_head:

22

CW_tail:

39

Send:

24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39

Q5.6
2 Points

How should the TCP transmitter react upon receiving A22?
CW_head:

23

CW_tail:

41

Send:

40,41

Q5.7
2 Points

How should the TCP transmitter react upon receiving A23?
CW_head:

24

CW_tail:

43

Send:

42,43

Q5.8
2 Points

How should the TCP transmitter react upon receiving A20?
CW_head:

24

CW_tail:

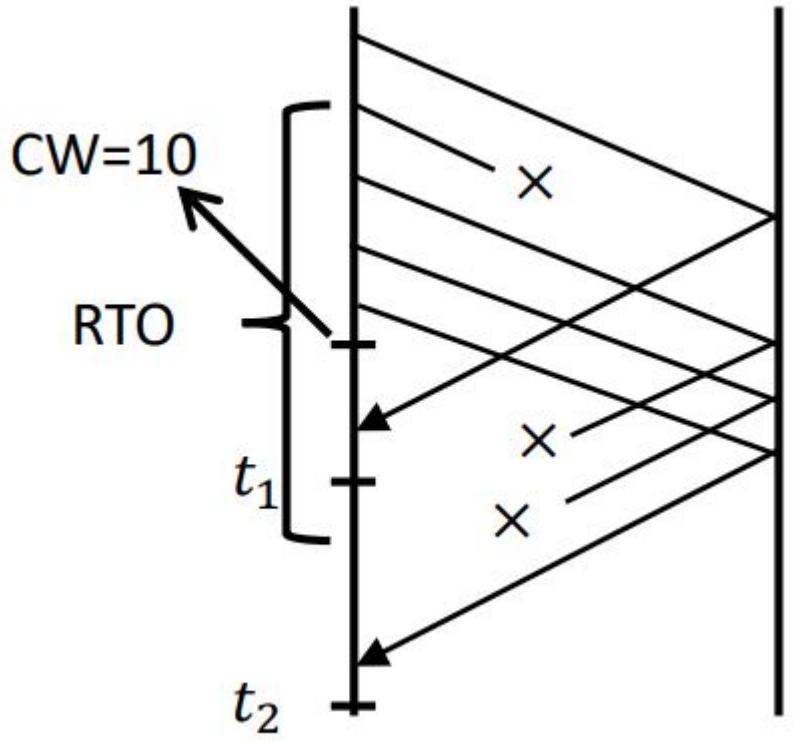
43

Send:

-

Q6 TCP example 5
10 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.



Q6.1
2 Points

CW at time t1

11

Q6.2
2 Points

CW at time t2

1

Q6.3
2 Points

How should the TCP transmitter react upon receiving A5, right before the timeout occurs?
CW_head:

6

CW_tail:

16

Send:

10,11,12,13,14,15,16

Q6.4
2 Points

How should the TCP transmitter react after timeout: ?
CW_head:

6

CW_tail:

6

Sthresh:

5.5

Send:

6

Q6.5
2 Points

How should the TCP transmitter react after receiving last shown ACK:
CW_head:

6

CW_tail:

6

Sthresh:

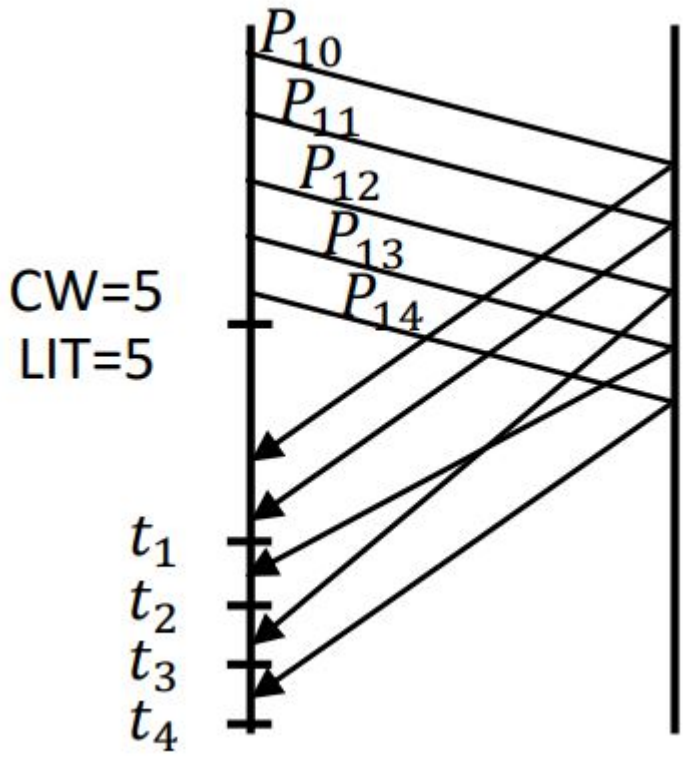
5.5

Send:

-

Q7 TCP example 6
14 Points

SSThresh is also sometimes known as "linear increase threshold (LIT)". The LIT shown in the figure means SSThresh. Assume packets before P10 have already been acknowledged in the past.



Q7.1
1 Point

Round to 1 decimal place

CW at time t1

5.4

Q7.2
1 Point

Round to 1 decimal place

CW at time t2

5.8

Q7.3
1 Point

Round to 1 decimal place

CW at time t3

5.8

Q7.4
1 Point

Round to 1 decimal place

CW at time t4

6.0

Q7.5
2 Points

How should the TCP transmitter react upon receiving A10?
CW_head:

11

CW_tail:

15

Sthresh:

5.0

Send:

15

Q7.6
2 Points

How should the TCP transmitter react upon receiving A11?
CW_head:

12

CW_tail:

16

Sthresh:

5.0

Send:

16

Q7.7
2 Points

How should the TCP transmitter react upon receiving A13?
CW_head:

14

CW_tail:

18

Sthresh:

5.0

Send:

17,18

Q7.8
2 Points

How should the TCP transmitter react upon receiving A12?
CW_head:

14

CW_tail:

18

Sthresh:

5.0

Send:

-

Q7.9
2 Points

How should the TCP transmitter react upon receiving A14?
CW_head:

15

CW_tail:

20

Sthresh:

5.0

Send:

19,20

Q8 T/F Question
12 Points

Considering the Selective ACK protocol, please answer the following questions

Q8.1
3 Points

Can Receiver’s base sequence number be smaller than transmitter’s base sequence number?

- True
- False

Q8.2
3 Points

Receiver’s base sequence number can be smaller than transmitter’s tail sequence number?

- True
- False

Q8.3
3 Points

Receiver’s base sequence number can be larger than transmitter’s tail sequence number

- True
- False

Q8.4
3 Points

Receiver’s base sequence number can be larger than transmitter’s tail sequence number plus one.

- True
- False

Q9 Sequence Number Space

12 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”.

Note: Answers are case-sensitive k and K, n, and N are not interchangeable

Q9.1
3 Points

What is the lower bound of sequence number (inclusive) for the head of the sender’s window at time t?

k-N

Q9.2
3 Points

What is the upper bound of sequence number (inclusive) for the head of the sender’s window at time t?

k

Q9.3
3 Points

What is the upper bound of the ACK sequence number field (inclusive) in the message currently propagating back to the sender at time t?

k-1

Q9.4
3 Points

With the Go-Back-N protocol, is it possible for the sender to receive an ACK for a packet that falls outside of its current window?

- ◯ Yes
- ◯ No

Q10 Self-practice Question (0 points)
0 Points

These questions are for you to think and answer but has no points associated to them. The solutions to these questions will be released with the HW solutions.

Please identify if each statement is true or false and use one sentence within 20 words to justify your reason.

Q10.1
0 Points

Although small, the TCP ACKs still consume some bandwidth. It would be better if the TCP receiver only sends NACKs upon receiving an out-of-order (or corrupted) packet.

- ◉ True
- ○ False

You would only know about a shitty packet until the next packet. So if your traffic is infrequent, then you will take a long time to resend. So, it depends on whether you expect errors to be frequent.

Q10.2
0 Points

he TCP sender has packets 20 to 30 in its congestion window (CW), all waiting for ACKs, when a timeout occurs. The sender will cut down CW to 1 and will have to gradually retransmit each of these packets (from 20 to 30).

- ○ True
- ◉ False

Yes, see state machine

Q10.3
0 Points

TCP can cope with any amount of losses, and hence, TCP should work without modifications on lossy wireless networks.

- ◯ True
- ◯ False

Techinically it would work, but it would be inefficient. For example, A dropped packet is interpreted as heavy congestion when it is not, so you would not get the full bandwidth.

Q10.4
0 Points

The Selective Repeat receiver need not send an ACK if the received packet is less than its lower end of the (current) receive window.

- ◯ True
- ◯ False

An ack is sent for every single packet.