Computer Communications and Networks (COMN) 2021/22, Semester 2

Assignment 2 Results Sheet

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Question 1 – Number of retransmissions and throughput with different retransmission timeout values with stop-and-wait protocol. For each value of retransmission timeout, run the experiments for **5 times** and write down **average number of retransmissions** and **average throughput**.

Retransmission timeout (ms)	Average number of re-transmissions	Average throughput (Kilobytes per second)
5	1849	81
10	975	78
15	99	76
20	96	73
25	98	69
30	94	67
40	102	62
50	97	58
75	93	51
100	91	44

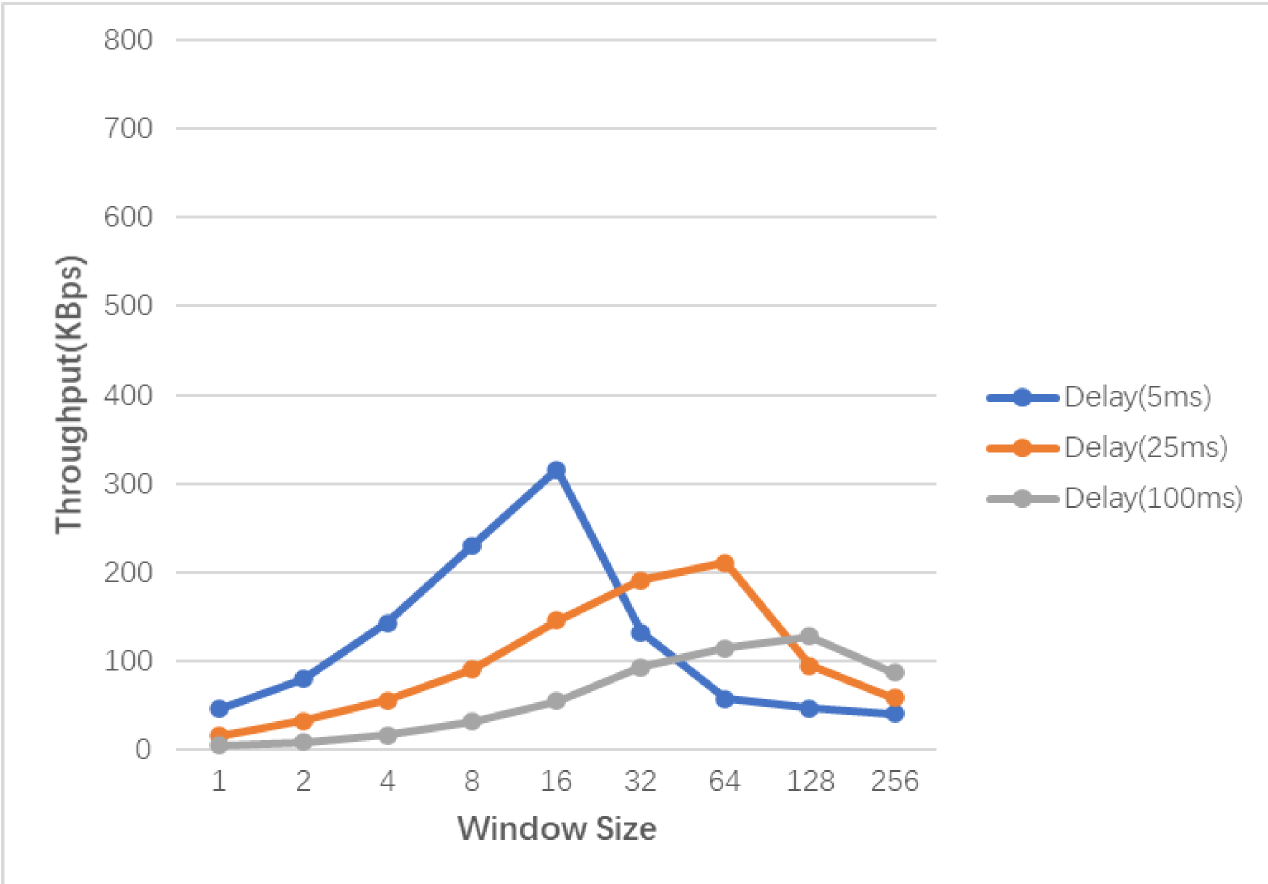
Question 2 – Discuss the impact of retransmission timeout value on the number of retransmissions and throughput. Indicate the optimal timeout value from a communication efficiency viewpoint (i.e., the timeout that minimizes the number of retransmissions while ensuring a high throughput).

The result shows that larger retransmission timeout is, smaller the average throughput will be, and the first two timeout value outputs very high average number of re-transmissions. It probably because the transmission delay is 5ms, so the average transmission time should be a little bit more than 2 times 5ms (5ms for send, 5ms for receive ack), which is around 11ms. So, when timeout is 5, after one send and receive process, 2 timeouts passed, it's why the average number of re-transmissions of timeout 5 is a bit more than 2 times of total number of packets. And when timeout=10, it doesn't have enough time to receive ack, so in average every packet needs to retransmit at least once, so the average number of re-transmissions is a bit more than total number of packets. For other timeouts, in general their average number of re-transmissions are smaller when timeout is higher, and their average re-transmissions is around 90 to 100, it's might because of the packet loss rate is 5%, so the loss probability of send and receive ack process is 10%. It means in this case, normally number of retransmissions is at least 87, and some packet will have transmission time higher than timeout, so the total number of retransmissions is a bit higher than 87, the higher the timeout value is, the lower the probability of timeout is, it's why larger timeout value normally have smaller number of retransmissions. And the reason why lager timeout value has lower throughput is larger timeout will waste more time on waiting timeout after packet lose. In conclusion, I think the optimal timeout value is 15ms, since it has the highest rate of throughput/timeout which is 76/99≈0.768. And its throughput is 76, it's very high. Which means it has very small number of retransmissions while ensuring a high throughput.

Question 3 – Experimentation with Go-Back-N. For each value of window size, run the experiments for **5 times** and write down **average throughput**.

	Average throughput (Kilobytes per second)		
Window Size	**Delay = 5ms**	**Delay = 25ms**	**Delay = 100ms**
1	46	16	5
2	80	33	9
4	143	56	17
8	230	91	32
16	316	146	55
32	133	191	93
64	58	211	115
128	47	95	128
256	41	59	87

Create a graph as shown below using the results from the above table:



Question 4 – Discuss your results from Question 3.

General finding: The result shows that in general, lower transmission delay will have better throughput, and both too large and too small window size will result in low throughput. And longer transmission delay has larger optimal window size.

Why I choose these timeouts:
When delay = 5ms, I use the optimal timeout value get from part2 which is 15ms.

When delay = 25ms, since the transmission delay is 25ms, so the normal transmission time should be a bit more than 25+25, and 25ms transmission delay is not very high, the throughput of 1RTT should be sufficient, so I set the timeout value to be a bit higher than 1RTT which is 55ms.

When transmission delay = 100ms, this time I think 105ms is the optimal timeout since this time we have transmission delay of 100ms, if I set the timeout value to be 1RTT, the throughput of timeout = 205ms will be too small, and I think the priority should be to ensure sufficient throughput. So, I pick value a bit higher than 0.5RTT, which is 105ms as the optimal timeout.

Why very small window size has small throughput: Since after sending a window size of packets, it needs to wait the acks, when window size is small, after sending all packets in the window size, it needs to wait the acks to come other than keep sending other packets, it will waste time and make throughput decrease.

Why very large window size has small throughput: When window size is large, the cost of each retransmission will be higher since it needs to resend more packets, it will make the throughput decrease.

Different optimal windows size in different transmission delay: From the graph we can see that the optimal window size shift backward when transmission delay increase. When delay=5ms, it's 16, when delay=25ms, it's 64, when delay=100ms, it's 128. It probably because longer transmission delay will make packet spend more time on the way, it gives more time for receiver to process packets which shifts the optimal windows size.

Other finding: When I run same code on my old laptop, the throughput changed, So I think the throughput also relate to computer processing power, the result I get is run by my current computer and it may change on another computer.

Question 5 – Experimentation with Selective Repeat. For each value of window size, run the experiments for **5 times** and write down **average throughput**.

	Average throughput (Kilobytes per second)
Window Size	**Delay = 25ms**
1	16
2	30
4	56
8	101
16	168
32	285

Question 6 - Compare the throughput obtained when using “Selective Repeat” with the corresponding results you got from the “Go Back N” experiment and explain the reasons behind any differences.

From the result we can see the throughput obtained by “Selective Repeat” is higher than the throughput from “Go Back N”. And the larger window size is, the larger throughput’s increase is. It probably because in Selective Repeat, sender do not need to retransmit every packet in window size if base sequence timeout, it only retransmit those packets that haven’t receive ack after timeout, so the throughput by SR is higher. And when window size is high, GBN needs to retransmit more packets additionally, so the difference of throughput will be more obvious. And for the receiver side, if the received packet is not in order but is in window size, it will store it in cache instead of throwing them. It also will make throughput increase.

Question 7 – Experimentation with *iperf*. For each value of window size, run the experiments for **5 times** and write down **average throughput**.

Window Size (KB)	Average throughput (Kilobytes per second) Delay = 25ms
1	6
2	13
4	31
8	70
16	91
32	121

Question 8 - Compare the throughput obtained when using "Selective Repeat" and "Go Back N" with the corresponding results you got from the *iperf* experiment and explain the reasons behind any differences.

The throughput get from iperf is smaller than SR and GBN. The possible reason of it is because iperf use TCP transmission. TCP has TCP fast retransmit, if sender receives 3 additional ACKs for same data, it with resend unACKed segment with smallest seq, it will make throughput smaller. And in TCP, before exchanging data, sender and receiver need to do handshake to agree to establish connection and agree on connection parameters, it will take extra time. And in TCP's congestion control it has ack clocking, if sender experiences a reduced ack rate, it will reduce, it also is a possible reason that make the throughput smaller.