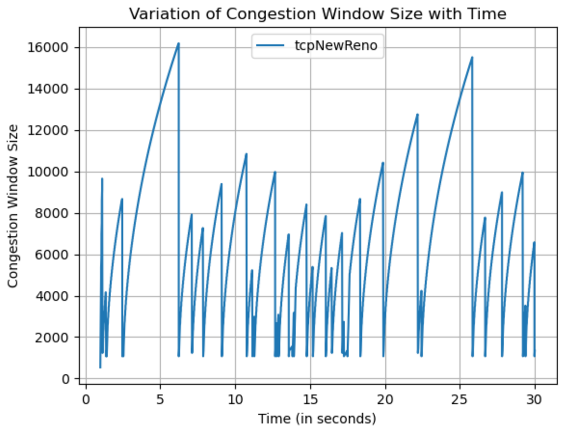
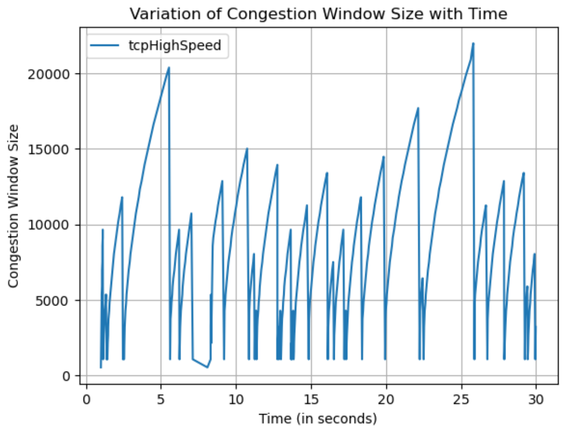
COL334 : Computer Networks
Assignment 3

Gaurav Jain : 2019CS10349

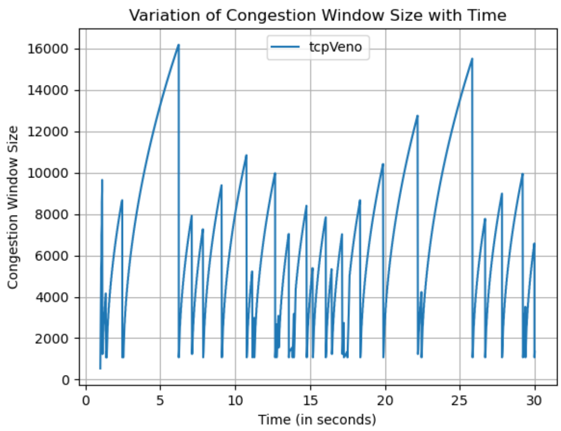
1 Part 1 : TCP Congestion Protocols



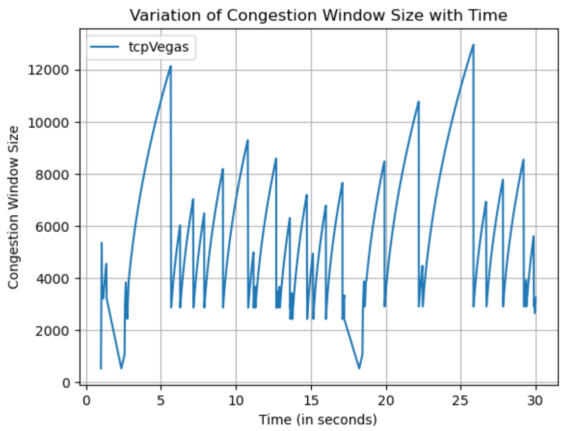
(a) TCP NewReno



(b) TCP HighSpeed



(c) TCP Veno



(d) TCP Vegas

Figure 1: Variation of Congestion Window with Time for different TCP Congestion Protocols

Number of packets dropped for different TCP congestion protocols:

TCP Congestion Protocol	**No. of Packets Dropped**
TCP NewReno	38
TCP HighSpeed	38
TCP Veno	38
TCP Vegas	39

Observations:

- All TCP congestion protocols have similar performance on the given network topology. This fact is supported by similar number of dropped packets for different protocols.

- The exponential increase in congestion window size and sharp decrease in window size when size becomes too large is visible in the plots for all TCP congestion protocols.

- **TCP NewReno:** TCP NewReno is a modified version of TCP Reno congestion protocol. Similar to TCP Reno, TCP NewReno uses a slow start phase with exponential increase in congestion window size. It also reduces the congestion window size by a large factor when it encounters a packet drop.
  TCP NewReno is better compared to TCP Reno as it is able to detect multiple packets drop and removes the problem of multiple window size changes present in TCP Reno.

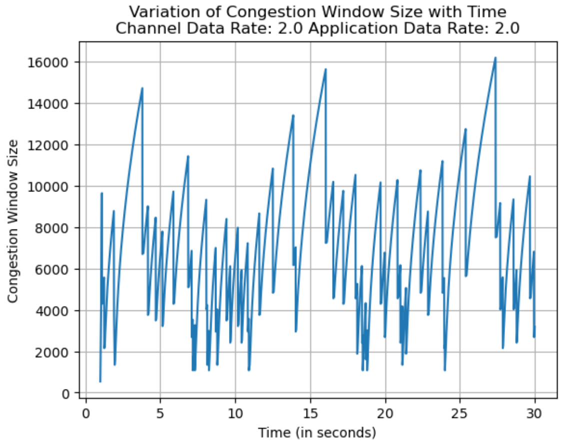
- **TCP HighSpeed:** The maximum congestion window size is largest for this protocols compared to all other protocols. This means that TCP HighSpeed is able to utilize larger bandwidth present in high bandwidth networks.
  TCP HighSpeed behaves similar to other protocols for small congestion window size but after a certain threshold the increase in congestion window size is large compared to other protocols. This allows TCP HighSpeed to use large bandwidths and provides faster recovery.

- **TCP Veno:** TCP Veno is optimized for wireless networks with larger number of packet drops due to bit errors. For this wired topology, there is no visible difference between TCP Veno and TCP NewReno and they behave almost similarly.

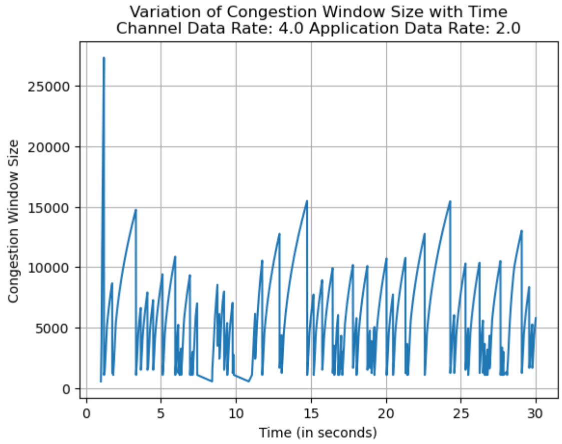
- **TCP Vegas:** Compared to all other protocols, the maximum congestion window size is smallest for this protocol. The reason behind this is TCP Vegas doesn't continue to increase cwnd size till a packet is dropped. Instead, it enters congestion avoidance phase when it encounters lower throughput compared to expected throughput.

2 Part 2: Channel and Application Data Rate

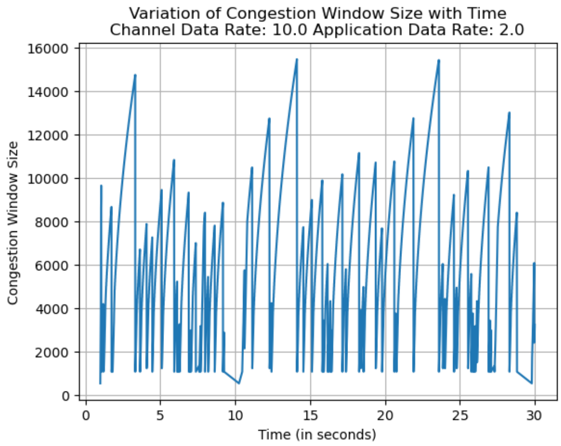
2.1 Variation of Congestion Window Size for different Channel Data Rates



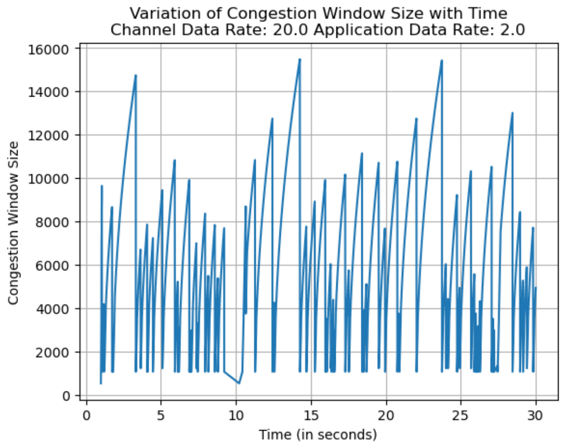
(a) Channel Data Rate: 2Mbps



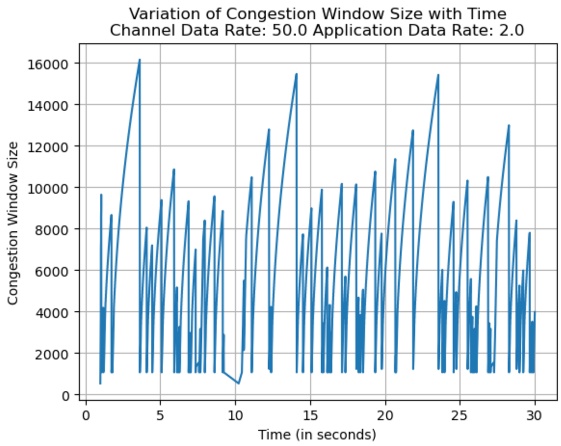
(b) Channel Data Rate: 4Mbps



(c) Channel Data Rate: 10Mbps



(d) Channel Data Rate: 20Mbps



(e) Channel Data Rate: 50Mbps

Figure 2: Variation of Congestion Window with Time for different Channel Data Rates

Number of packets dropped for different channel data rates:

Channel Data Rate	No. of Packets Dropped
2	62
4	72
10	73
20	74
50	75

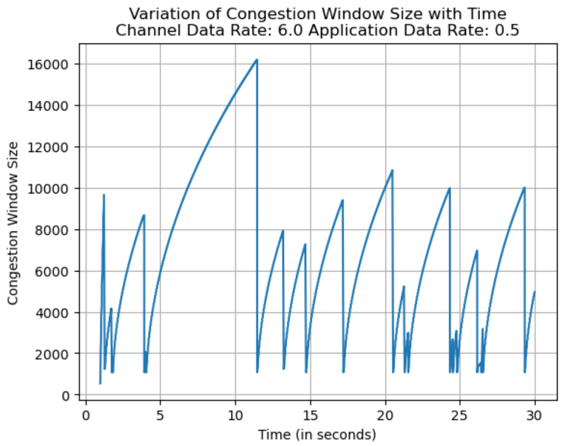
Observations:

- The plots for channel data rates 10, 20 and 50 Mbps are almost similar as the channel data rate is much higher compared to application data rate (2 Mbps).
  This is also the reason for almost same number of packet drops for these channel data rates.

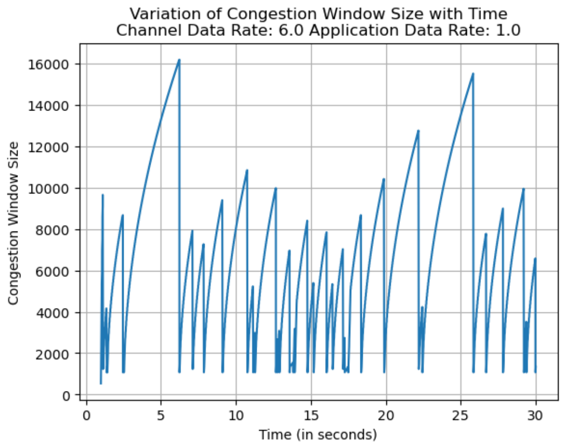
- When the channel data rate is 2 Mbps, the congestion window size go to 1 very few times whereas, for other channel data rates, it reduces to 1 many times. This means that the congestion protocol is going in fast recovery phase which is not observed for other data rates.
  Also for this data rate, the number of peaks observed is low and number of packets drop is low which means that the protocol is in congestion avoidance phase for a large amount of time.

- For channel data rate 4, the highest peak of congestion window size is observed at the start. After that, the peak window size is small which means that the protocol starts at a very large window size and after some packet drops, it adapts to the topology and the maximum window size is reduced.

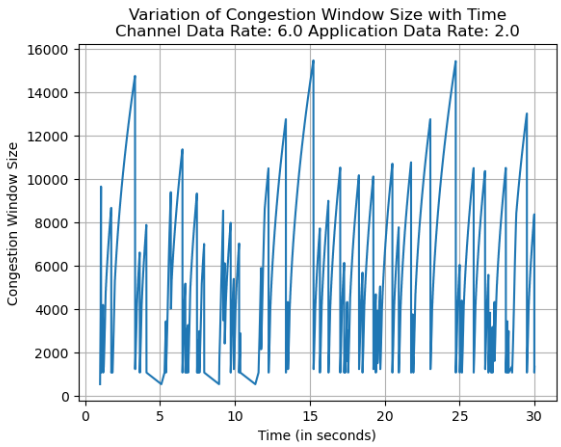
2.2 Variation of Congestion Window Size for different Channel Data Rates



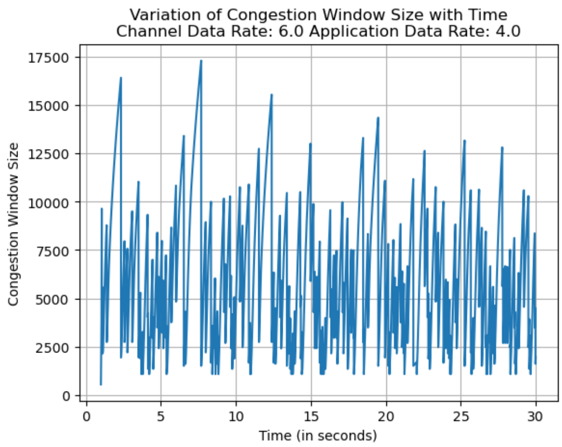
(a) Application Data Rate: 0.5Mbps



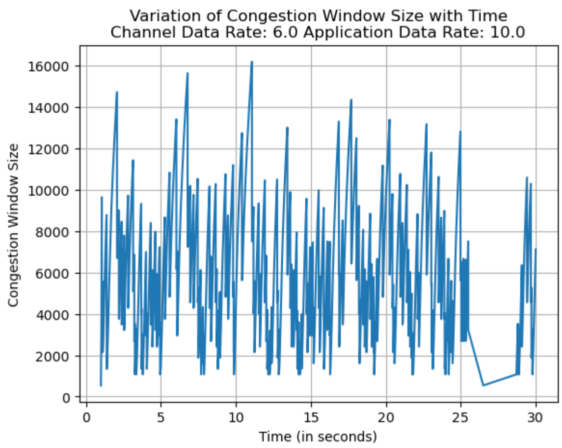
(b) Application Data Rate: 1Mbps



(c) Application Data Rate: 2Mbps



(d) Application Data Rate: 4Mbps



(e) Application Data Rate: 10Mbps

Figure 3: Variation of Congestion Window with Time for different Application Data Rates

Number of packets dropped for different application data rates:

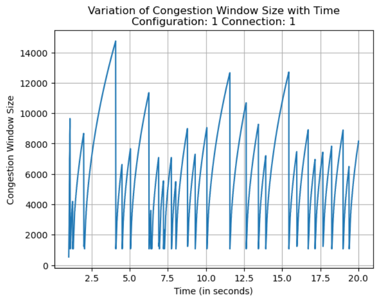
Application Data Rate	No. of Packets Dropped
0.5	22
1	38
2	71
4	156
10	156

Observations:

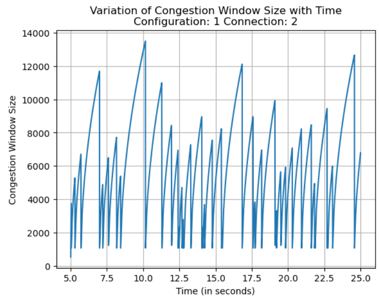
- Since the channel data rate is fixed so if the application data rate increases the number of packet drops should also increase. This is observed in this topology as well.
- The width of the peaks in these plots decreases as we increase the application data rate. The main reason behind this observation is the number of packet drops is small for smaller application data rates and thus, the network remains in congestion avoidance phase for longer duration and thus, the width of peak is large.

3 Part 3 : TcpNewRenoCSE : a new TCP Congestion Protocol

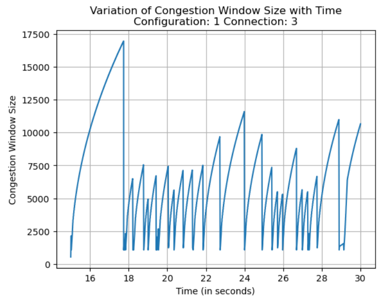
Configuration 1



(a) Connection 1



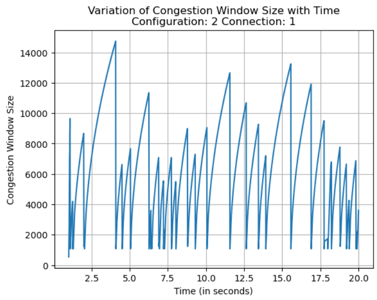
(b) Connection 2



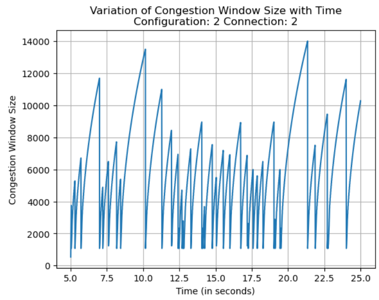
(c) Connection 3

Figure 4: Variation of Congestion Window with Time for Configuration 1

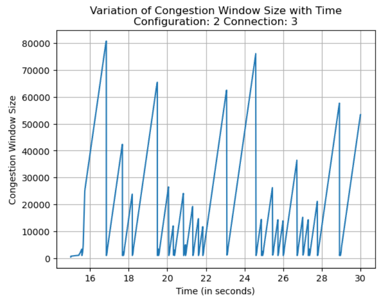
Configuration 2



(a) Connection 1



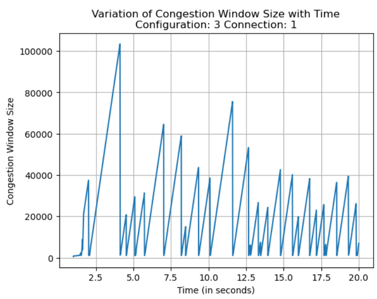
(b) Connection 2



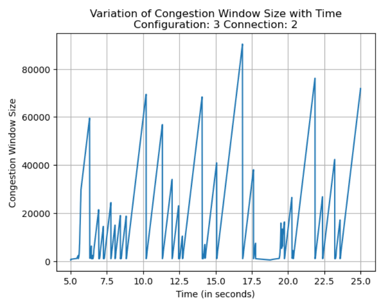
(c) Connection 3

Figure 5: Variation of Congestion Window with Time for Configuration 2

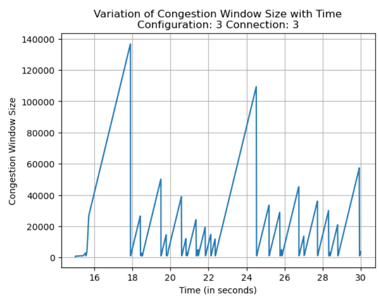
Configuration 3



(a) Connection 1



(b) Connection 2



(c) Connection 3

Figure 6: Variation of Congestion Window with Time for Configuration 3

Number of packets dropped for different configurations:

Configuration	No. of Packets Dropped
1	106
2	110
3	105

Observations:

- The number of packets dropped is almost similar for both protocols. This means that both the protocols have similar behaviour in our network topology.
- Since the application data rate is small compared to the channels data rate so there is very little congestion in the topology and thus, no difference in the performance is present for both the protocols.
- The peak congestion window size is very large for TCP NewRenoCSE compared to TCP NewReno because in congestion avoidance phase, the increase in window size is exponential for TCP NewRenoCSE.
- In configuration 2, no effect of TCP NewRenoCSE is visible on connections 1 and 2 as TCP NewRenoCSE is only used on the receiver node which has no effect on the sender nodes.
- For TCP NewReno, the congestion window is updated as:

  $$cwnd = cwnd + MSS*(MSS/cwnd)$$

  This means that in each RTT, congestion window increases by 1 per RTT i.e. linear increase.
  Whereas for TCP NewRenoCSE, the congestion window is updates as:

  $$cwnd = cwnd + 0.5*MSS$$

  This means that in each RTT, congestion window increases by half the congestion window size per RTT i.e. exponential increase.
- The slow start phase in TCP NewRenoCSE has linear increase compared to exponential increase in TCP NewReno. This is visible in the plots which use TCP NewRenoCSE.