COL334 Computer Networks Assignment-4

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Part-A

Description of Code

I have created two new files TcpNewRenoPlus.h and TcpNewRenoPlus.cc following the TcpNewReno class in tcp-congestion-ops.cc. I have essentially only modified the slowstart and congestion avoidance functions.

```
// changes to slow start:
    double adder  = (std::pow(static_cast<double>(tcb->m_segmentSize), 1.91)) / tcb->m_cWnd.Get ();
    tcb->m_cWnd +=  static_cast<uint32_t>(adder);
// changes to congestion avoidance:
     double adder = static_cast<double>(tcb->m_segmentSize) * 0.51 ;
     adder = std::max(1.0, adder ) ;
     tcb->m_cWnd += static_cast<uint32_t>(adder) ;
```

These files have to be added to src/internet/model/.
To link these files their names also have to be added to the wscript file in src/model
One can then use TcpNewRenoPlus normally:

```
   std::string congestionControlAlgorithm = "TcpNewRenoPlus" ;
```

The code for part-a is in file ass-4-part-1.cc. Change the congestion control algorithm as required in the above mentioned line.

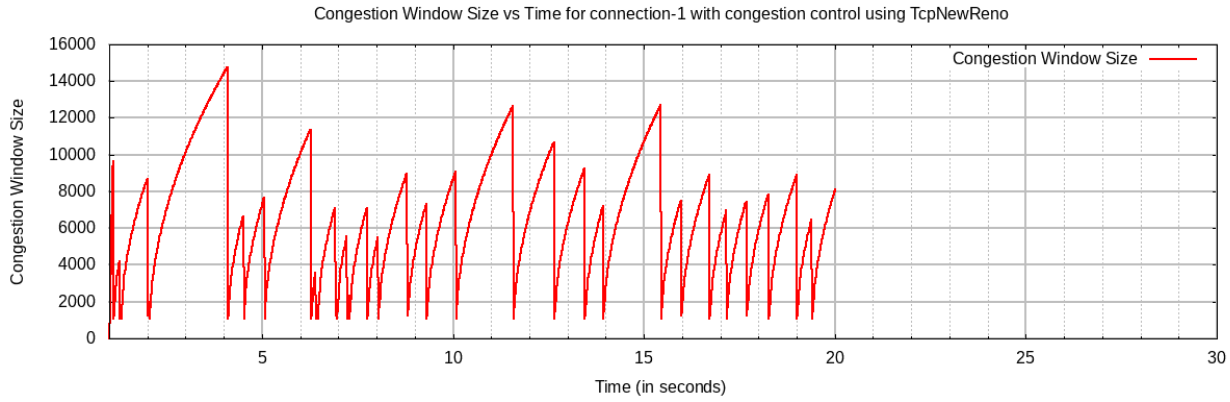
```
 // to run ass-4-part-1.cc =>  ./waf --run scratch/ass-4-part-1
```

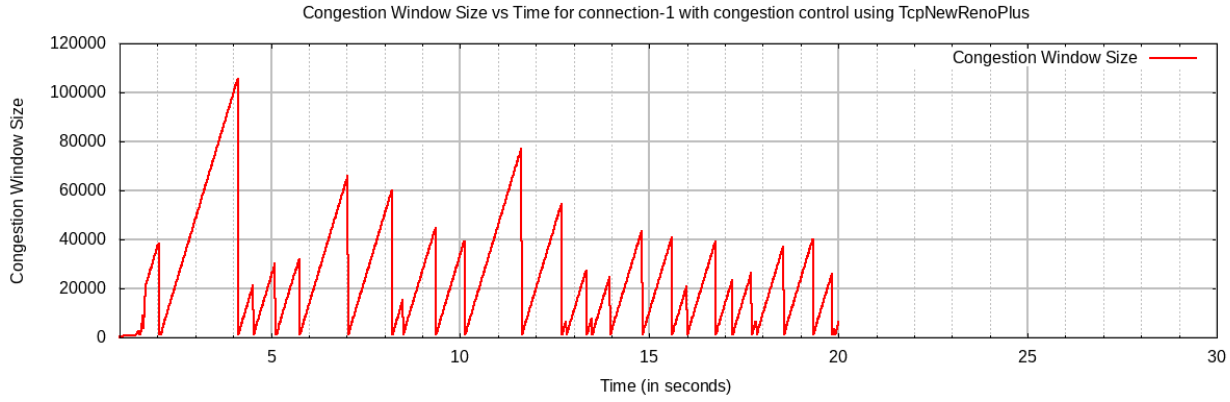
This creates a cwnd file for congestion window vs timesteps for each connection namely connection-1-TcpNewRenoPlus.cwnd etc. This is used by congestion-ass4-part-1.plt to make the corresponding graphs

```
// change these variables appropriately in the .plt file
connection = "connection-3"
protocol = "TcpNewReno"
// to use congestion-ass4-part-1.plt => gnuplot congestion-ass4-part-1.plt
// This creates a png file namely connection-1-TcpNewRenoPlus.png
```

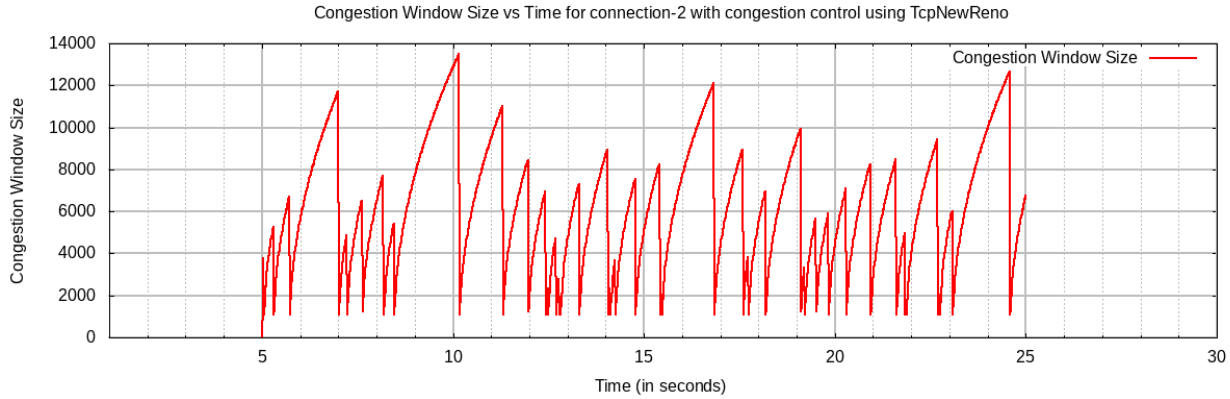
Question-1 (Graphs)

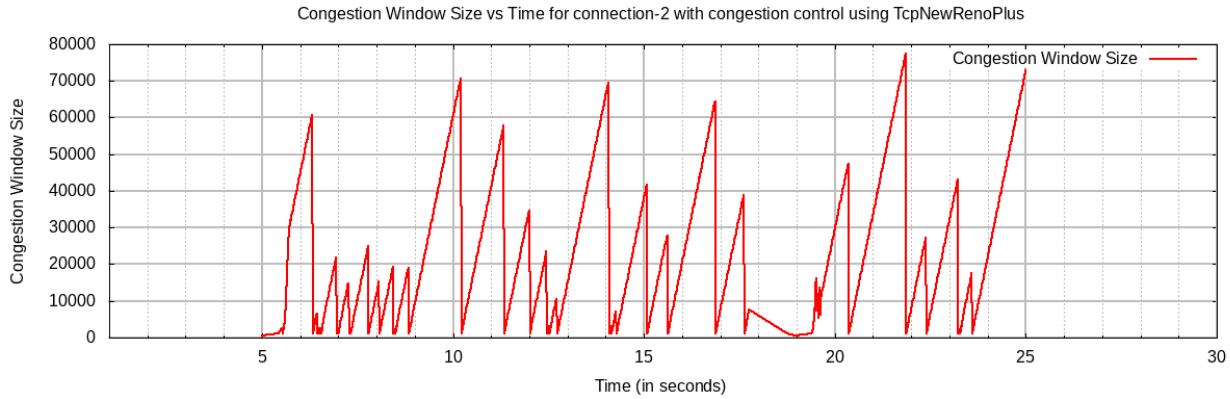
Connection-1



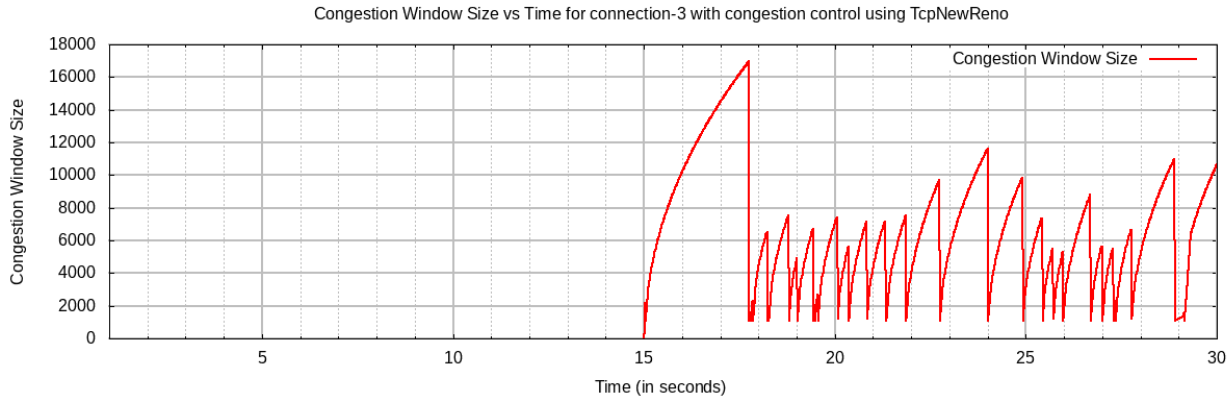


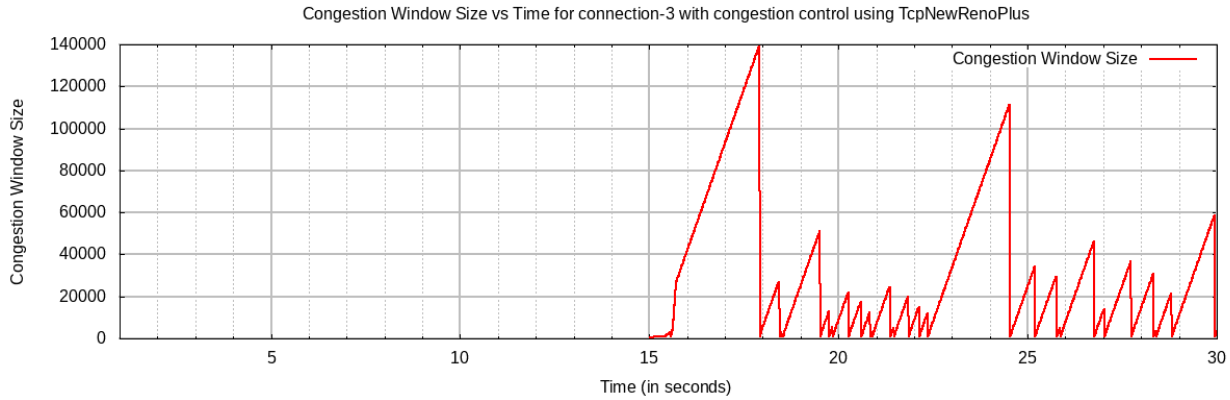
Connection-2





Connection-3





Question-2 (Explanation and Observations)

The application data rate in these cases is much less than the channel data rate thus the channel is never overflooded and no significant queuing occurs at the channel. Any congestion

experienced by the sender is due to timeouts caused for the packets which are randomly dropped by the receiver's rate error model. If we compare the congestion avoidance phase of NewReno and NewRenoPlus the update equations are as follows:

$$Cwnd = Cwnd + (SegmentSize)^2/Cwnd \quad \text{(NewReno)}$$

$$Cwnd = Cwnd + 0.51 * (SegmentSize) \quad \text{(NewRenoPlus)}$$

As we can see from the update equations the increment for each Ack received for NewRenoPlus is independent of the cwnd is a constant amount. For NewReno the increment is inversely proportional to the Congestion window size. So NewRenoPlus keeps linearly increasing the Congestion Window size in congestion avoidance whereas for NewReno the slope of the graph is decreasing in the congestion avoidance phase. This behavior is desired in congestion avoidance since we don't want to overflood the links. Although in this case since the channels are never flooded because of large congestion windows (due to low application data rates) for NewRenoPlus the congestion window keeps rising linearly to large values only falling due to random errors by the rate error model (as seen by the graphs).
Although it doesn't in this case but in general rapidly increasing congestion windows this way can choke the network for every sender neither of whom can then take advantage of the available bandwidth. NewReno on the other hand is more passive in the congestion avoidance phase to prevent choking the network.

The slow start update equations for both the equations are as follows:

$$Cwnd = Cwnd + SegmentSize \quad \text{(NewReno)}$$

$$Cwnd = Cwnd + (SegmentSize)^{1.91}/Cwnd \quad \text{(NewRenoPlus)}$$

Since these equations are invoked after every acknowledgment received it leads to an exponential rise in congestion window in the case of NewReno which can be seen from the graph. This is expected since in slow start NewReno is aggressive and tries to increase the congestion window rapidly. NewRenoPlus on the other hand is passive as seen from the graph and increases its congestion window rather slowly in the slow start period which is not desirable.