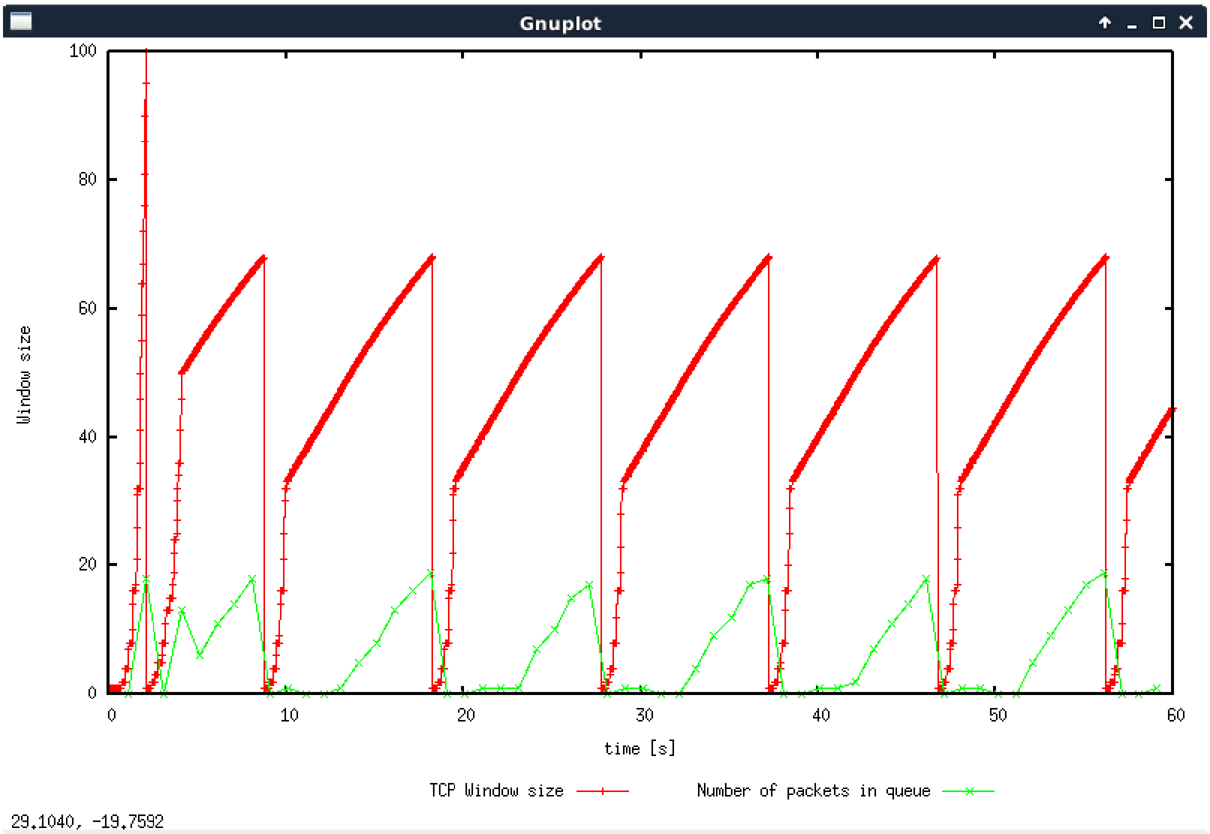
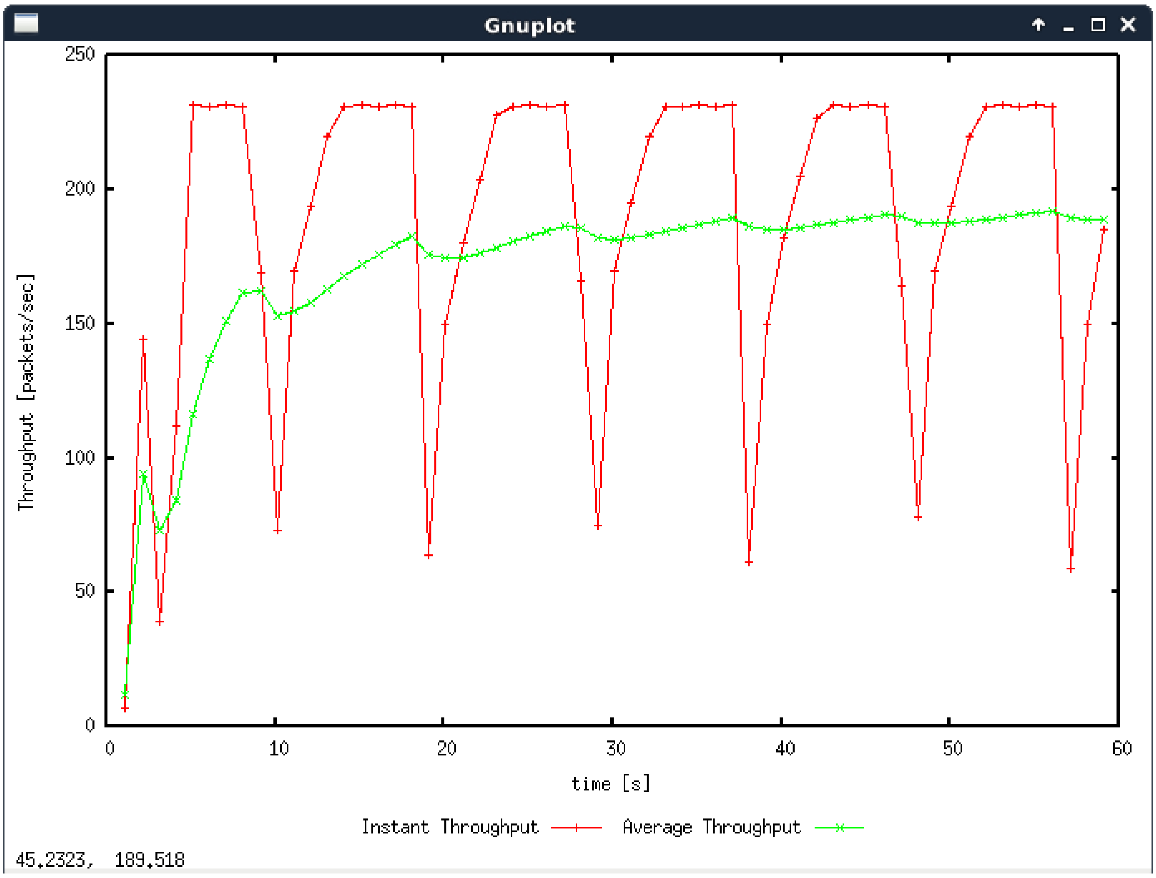
Exercise 1:

Q1:



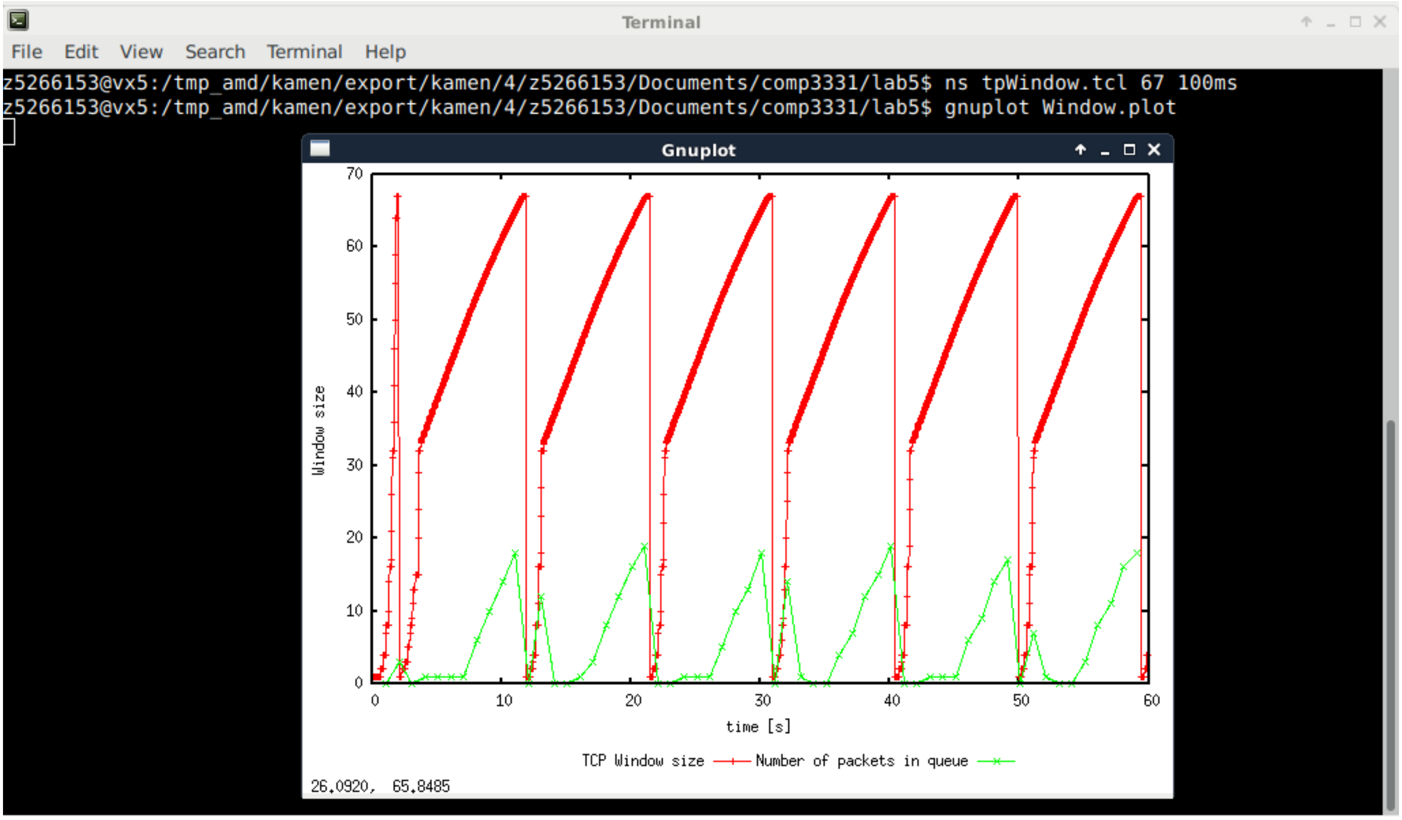
In this case, the maximum size of the congestion window that the TCP flow reaches is 100. Since this is TCP Tahoe, the TCP flow reset the congestion window size to 1 and update the ssthresh to half of the max size reached. Next, it enters slow start phase and change to additive increase when the congestion window size reach the new ssthresh.

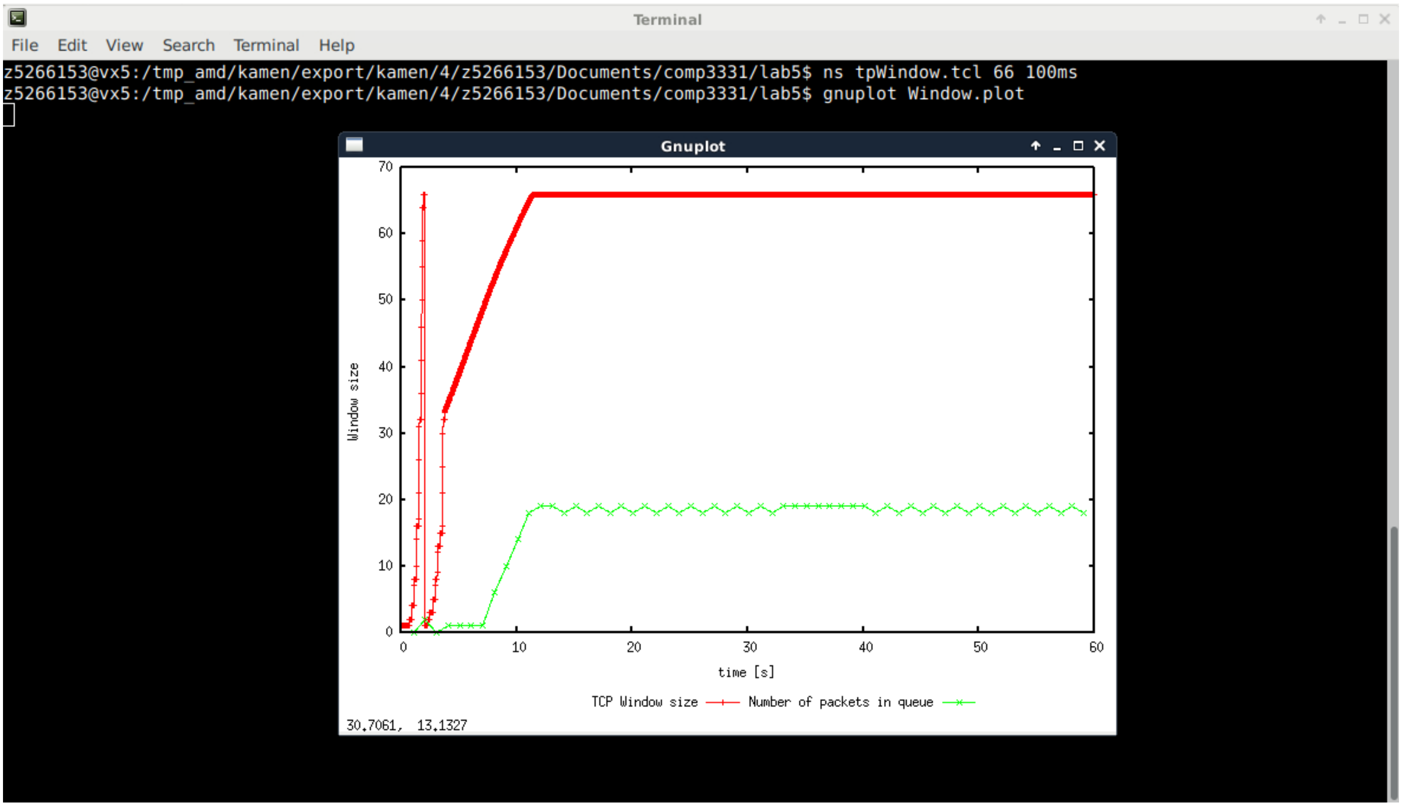
Q2:

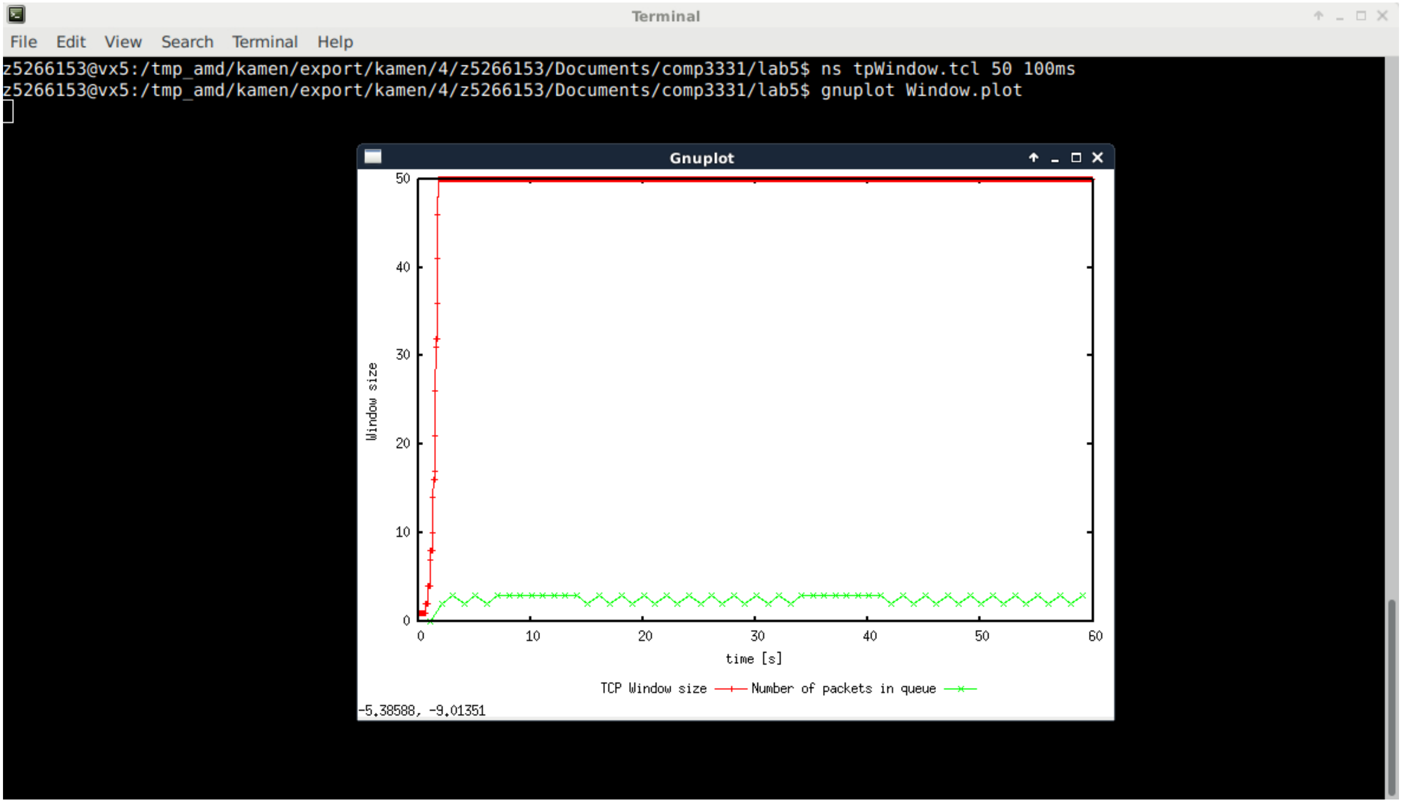


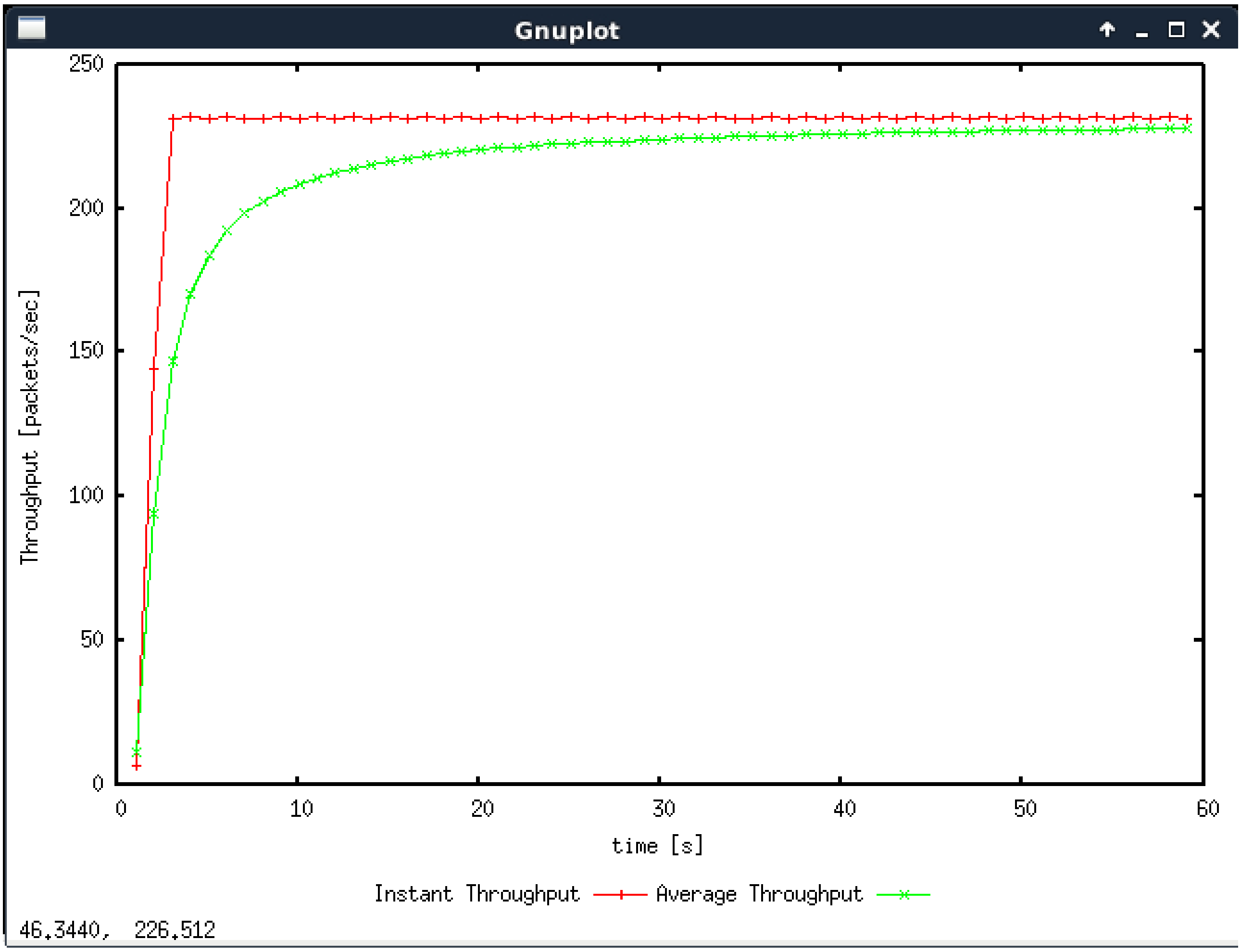
From the graph, we could see that the average throughput is 190 packets/second. Each packet contain 500-20 = 480 bytes of payload which is 3840 bits. Therefore the average throughput is 729600 bits/second.

Q3:



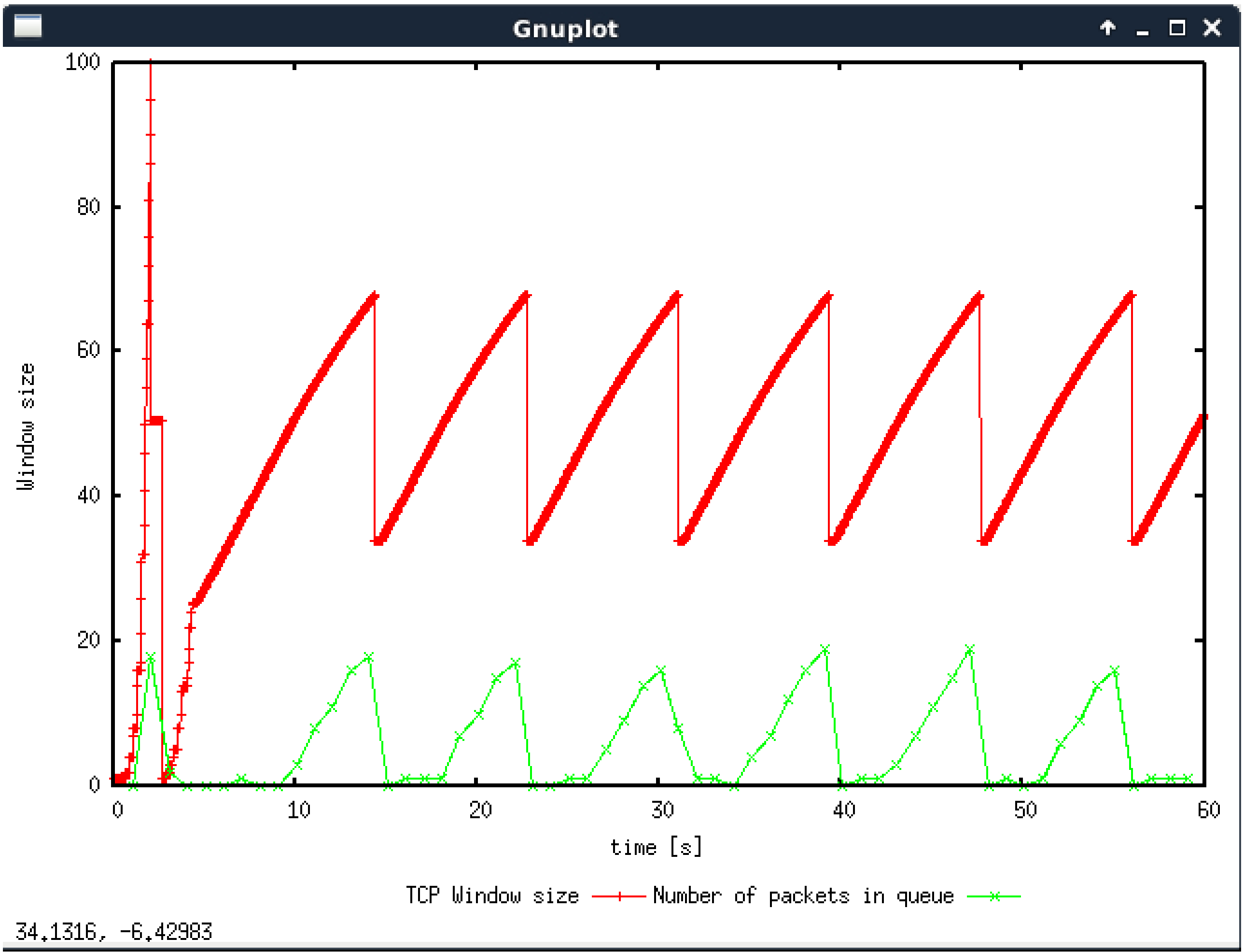




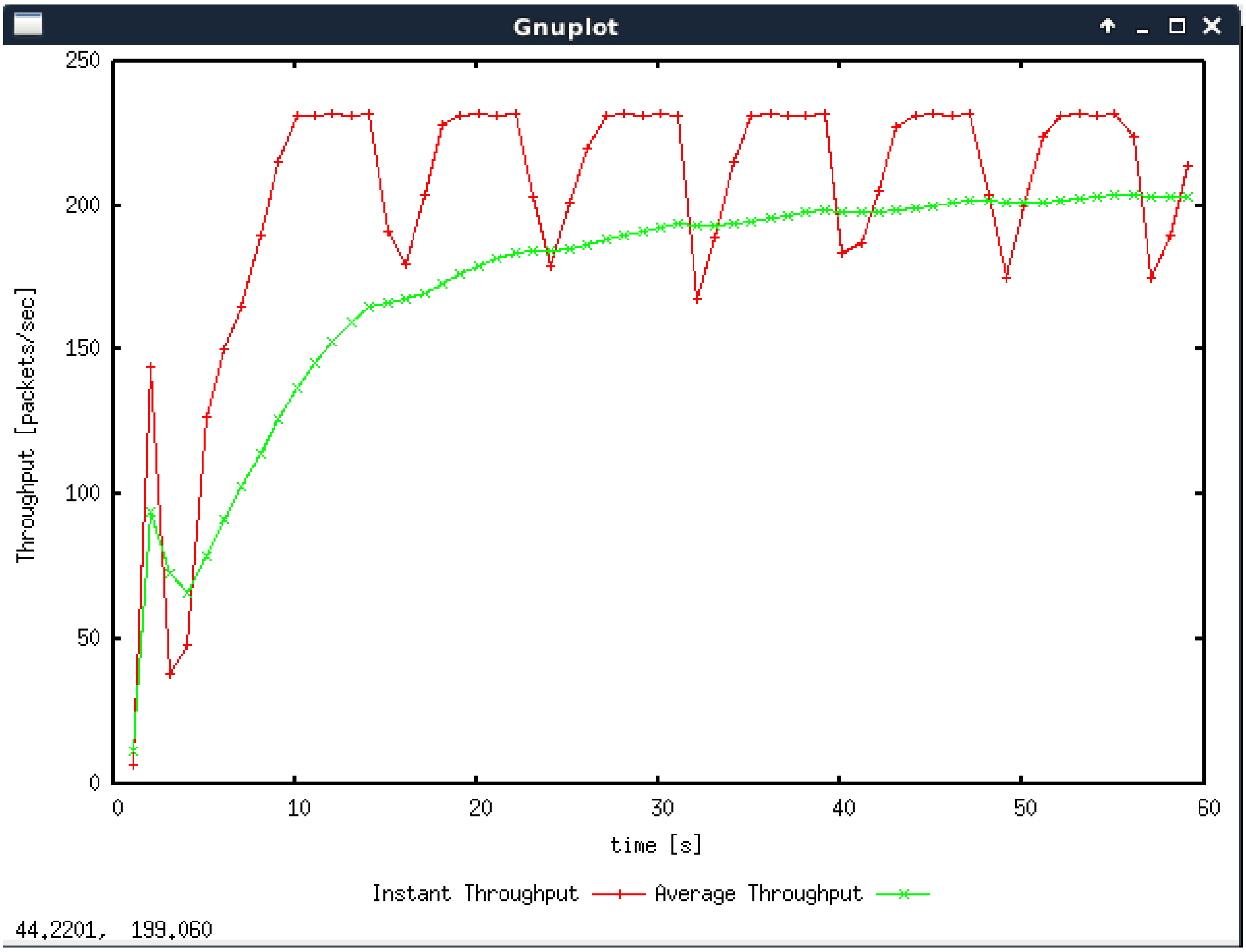


From the above graph, TCP stop oscillating when the max congestion window size is lower than 66 and start oscillating when max congestion window size higher than 66. Therefore, the maximum congestion window is 66 at which TCP stops oscillating to reach a stable behaviour. The average throughput is approximate 225 packets/second which is 864000 bits/second. The actual link capacity is 8000000 bits/second which is about 10 times greater than average throughput.

Q4



Gnuplot
Window size
100
80
60
40
20
0
0
10
20
30
40
50
60
time [s]
TCP Window size
Number of packets in queue
34.1316, -6.42983

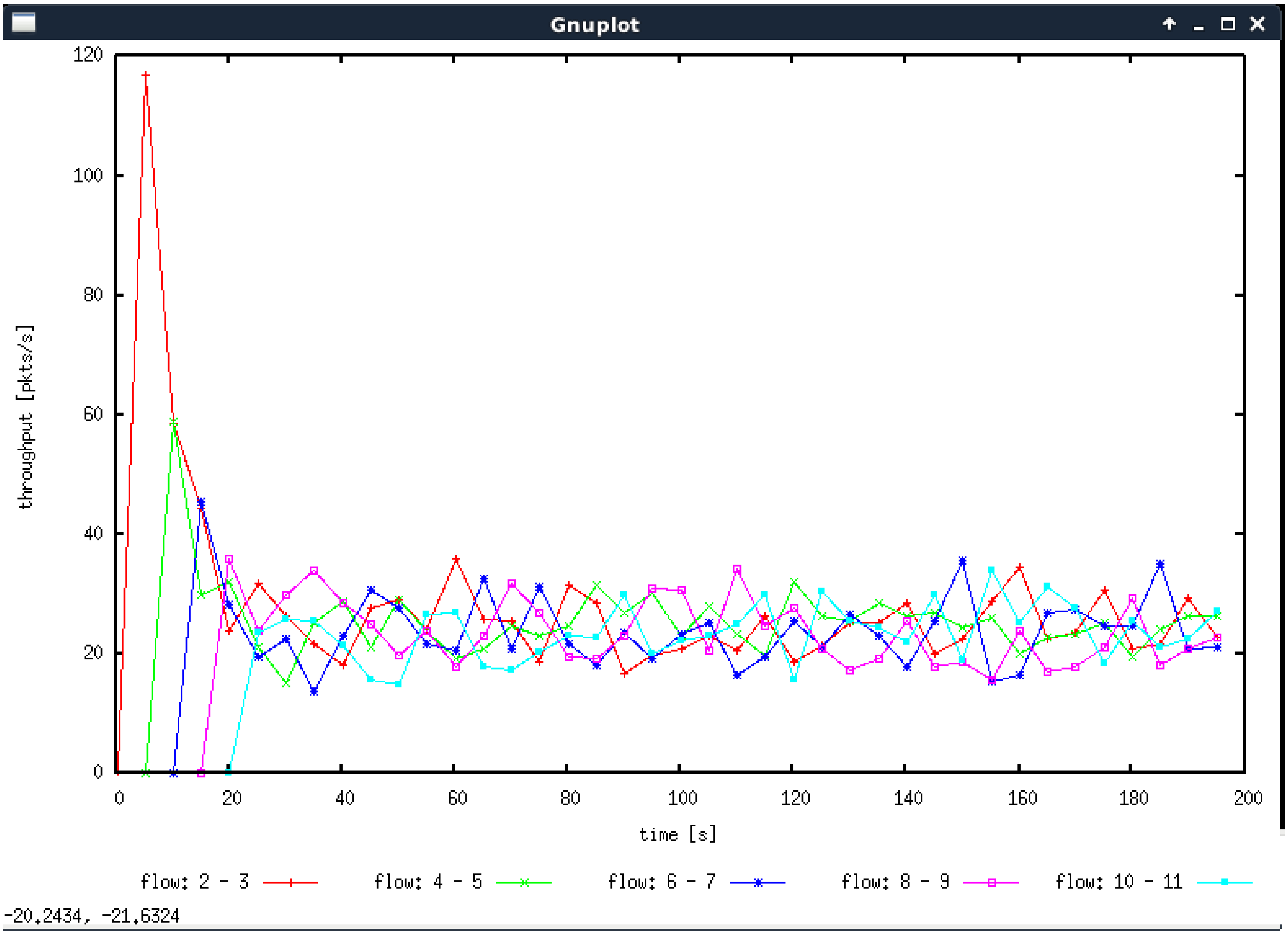


Gnuplot
Throughput [packets/sec]
250
200
150
100
50
0
0
10
20
30
40
50
60
time [s]
Instant Throughput
Average Throughput
44.2201, 199.060

TCP Reno experienced 7 lost events but the congestion window only go back to zero once, while TCP Tahoe experienced 7 lost events and the congestion window go back to zero 7 times. For the average throughput, TCP Reno has average throughput approximate 200 packets/second while TCP Tahoe has average throughput approximate 190 packets/second. Therefore TCP Reno perform better in this case .

Exercise 2:

Q1:

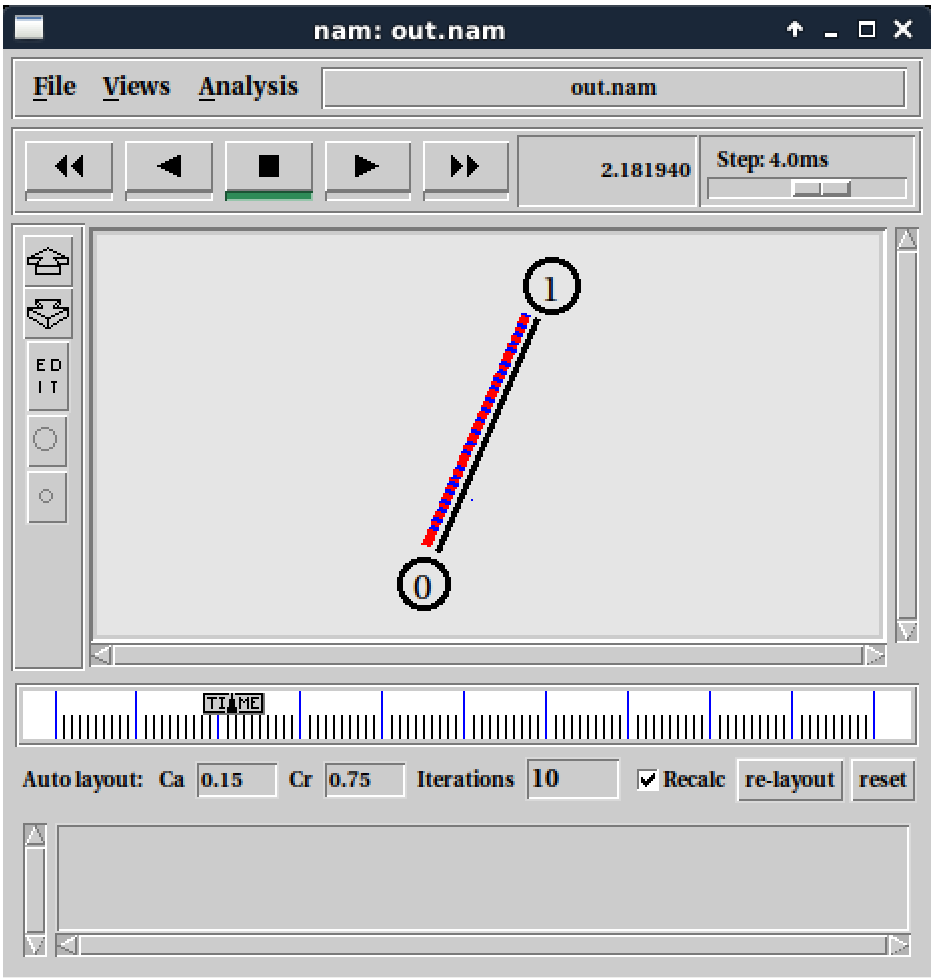


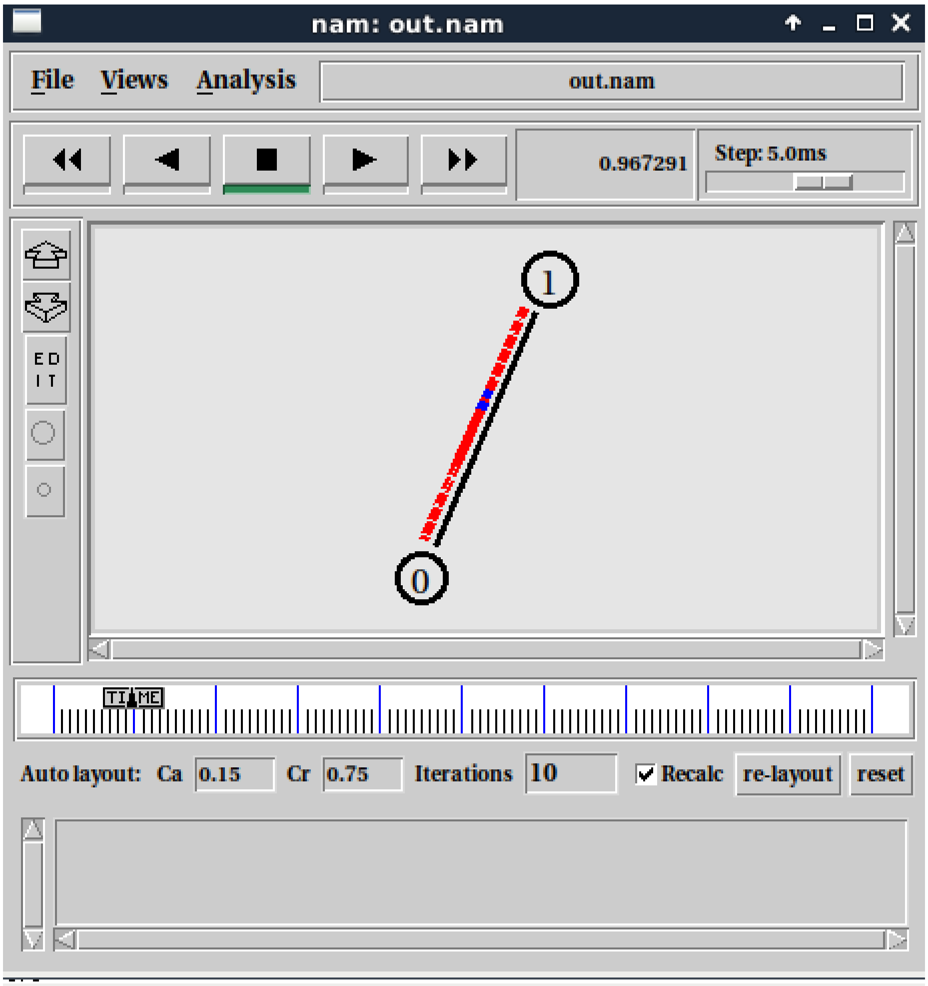
Roughly speaking each flow get an equal share of the capacity of the common link, this can be observed after the last flows joined which is from 20s to the end. And each of these flow have about 25 packets/second average throughput.

Q2:

When a new flow is created, the pre-existing TCP flows experience a considerable decrease in its throughput which make its throughput approximately half of before. The mechanisms of TCP which contribute to this behaviour is AIMD additive increase multiplicative increase and this behaviour should be fair.

Exercise 3:

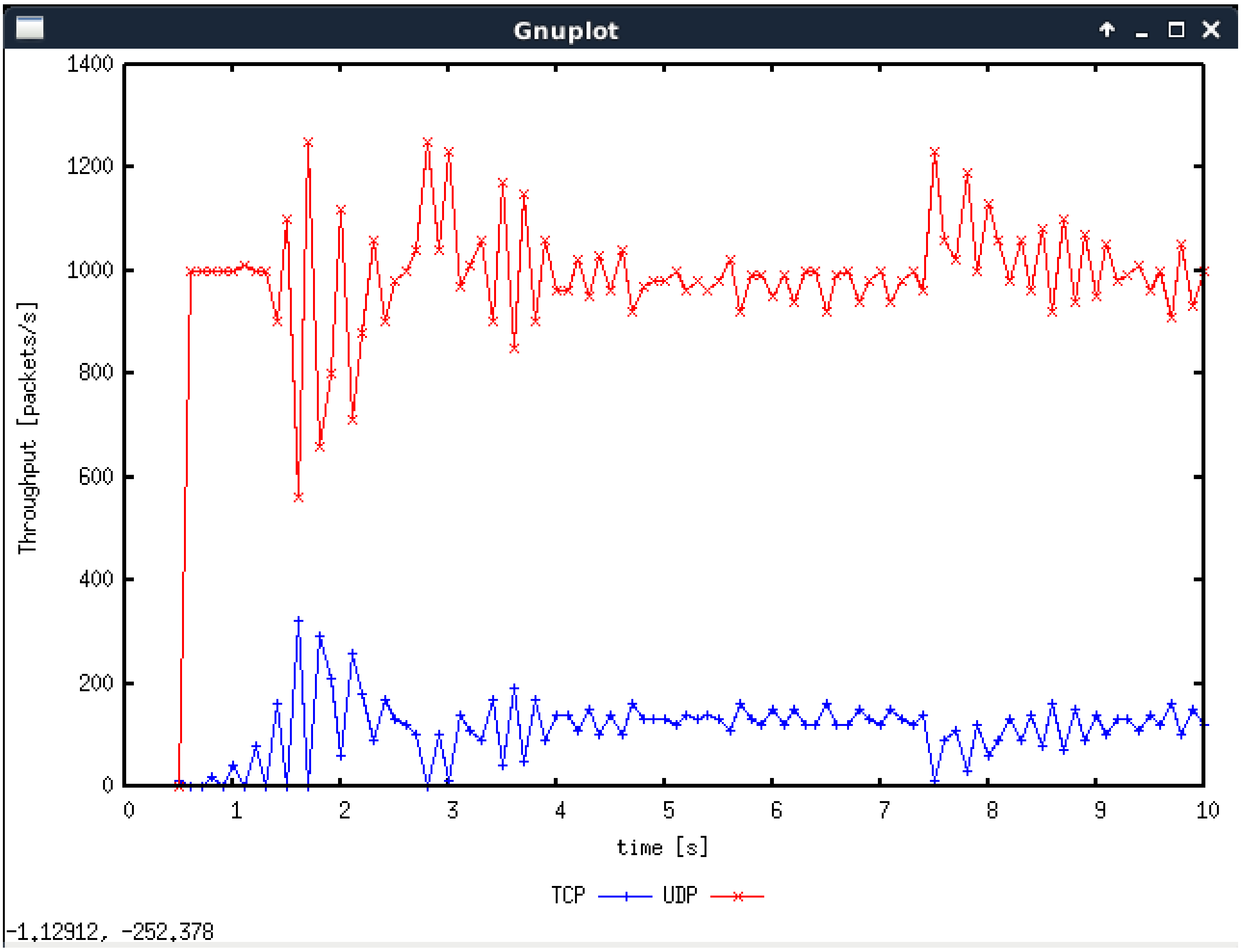

nam: out.nam
File
Views
Analysis
out.nam
2.181940
Step: 4.0ms
EDIT
1
0
TIME
Auto layout:
Ca
0.15
Cr
0.75
Iterations
10
Recalc
re-layout
reset


nam: out.nam
File
Views
Analysis
out.nam
0.967291
Step: 5.0ms
EDIT
1
0
TIME
Auto layout:
Ca
0.15
Cr
0.75
Iterations
10
Recalc
re-layout
reset

Q1:

From the graph, the red flow sending packet in a higher rate. So the red one should be UDP flow since UDP doesn't have congestion control and it will send packets in its best effort. While the blue should be TCP flow, since TCP have congestion control and it decrease its sending rate when meet lost event.

Q2:



UDP send as many packet as possible and it will use all the bandwidth in this network then reach a stable level. TCP has congestion control mechanisms, when TCP meet lost events, it will decrease its sending rate and force TCP to stabilise to the observed throughput.

Q3:

UDP is much faster than TCP because there is no congestion control and connection but UDP may experience many lost events and can't guarantee data all arrive safely. If everyone start using UDP then the congestion collapse may happen to our network.