Programming Assignment 2

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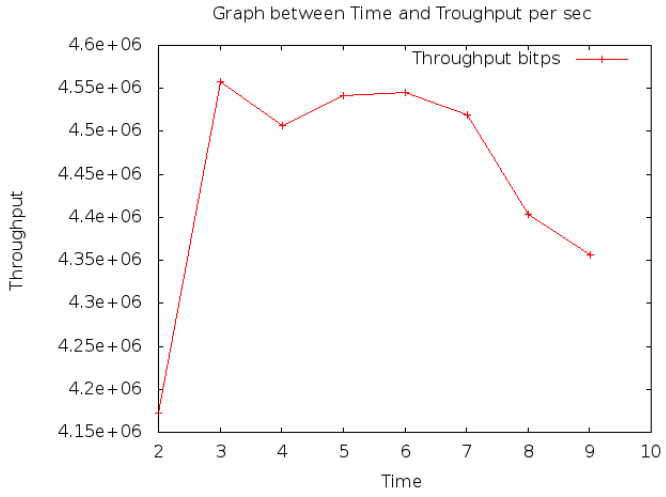
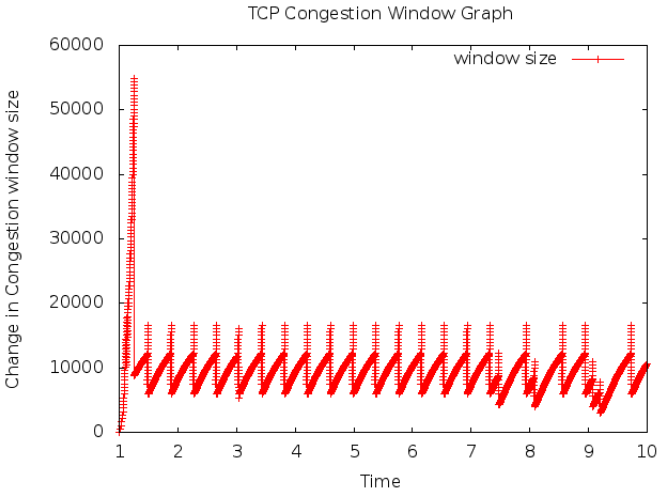
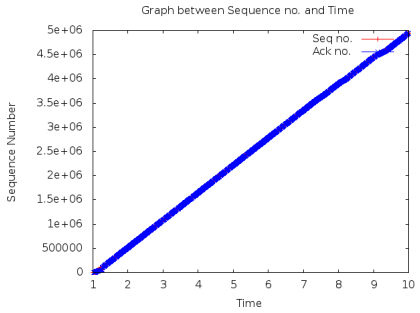
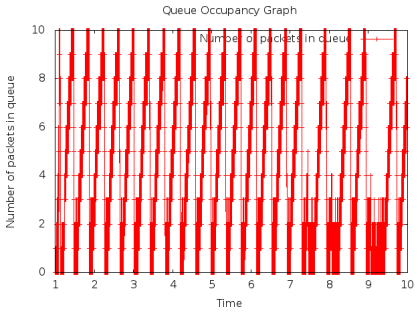
0.1 Part 1

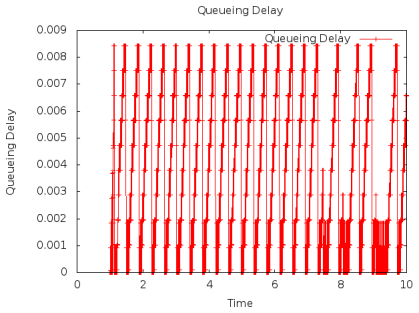
0.1.1 Exercise 1.1





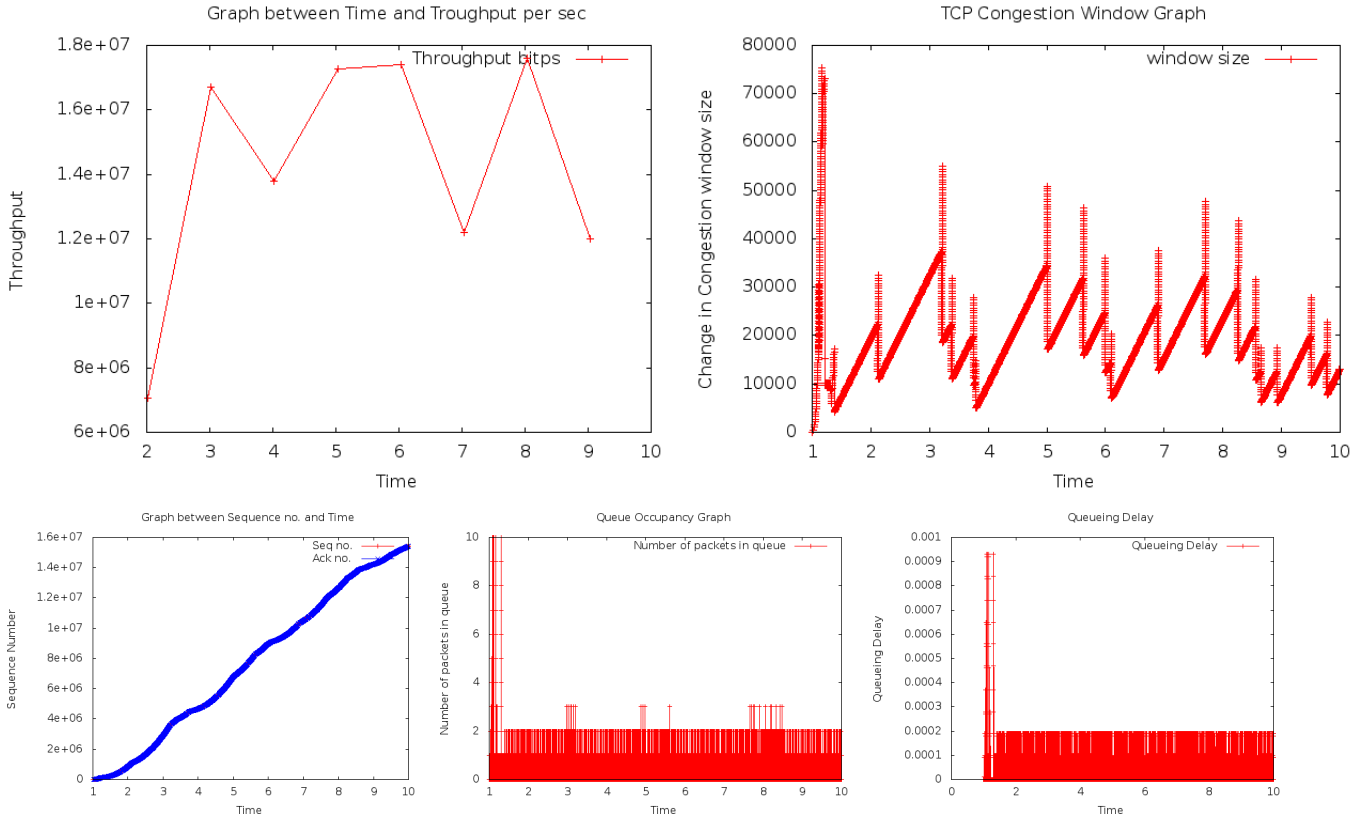






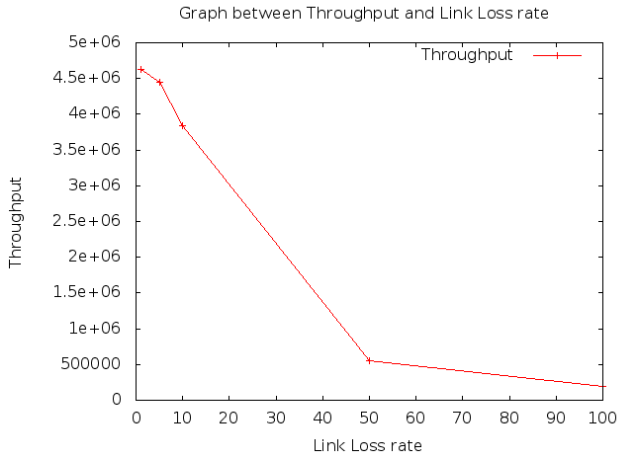
- Avg Throughput is 4.45 Mbps which is close to 5 Mbps but in last seconds graph goes down which indicate momentarily fall in throughput.
- 25 times CWND reduced size , This happend because TCP using AIMD algorithm in which when loss of packets or congestion happen CWND reduce to half of previous size which is stored in ssthreshold .

0.1.2 Exercise 1.2

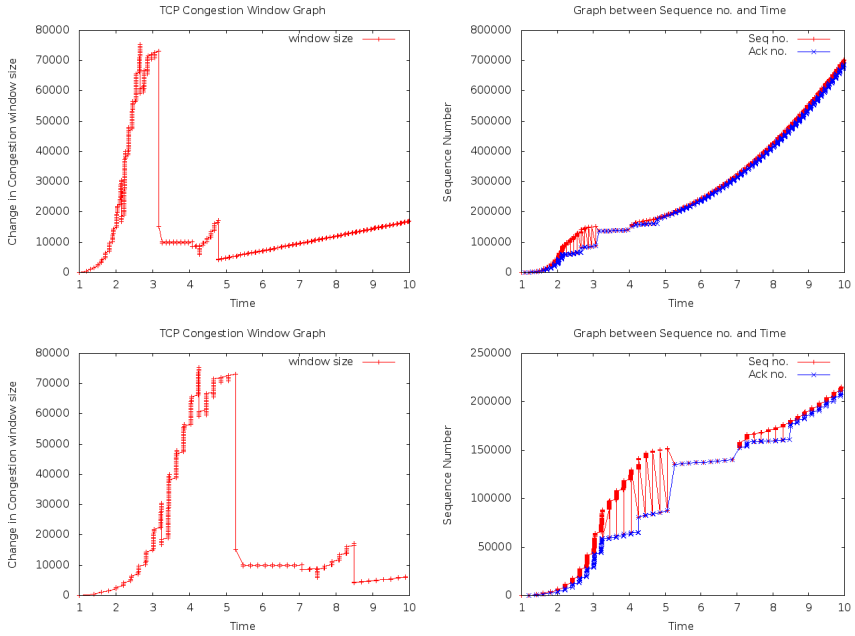


- Avg Avg Throughput = 14.21 Mbps In this case Link rate increased so BDP increased accordingly , TCP try to estimate ideal window size by increasing window size with slow start Algorithm . So this Window will allow to go many packets in 1 RTT that will lead to congestion because there is very short QUEUE size 10 which will start to drop packets after overflow.
- Main reason for this low throghput is mismatch between Linkrate and Queue size if we increase Queue size then it will improve throghput.

0.1.3 Exercise 1.3

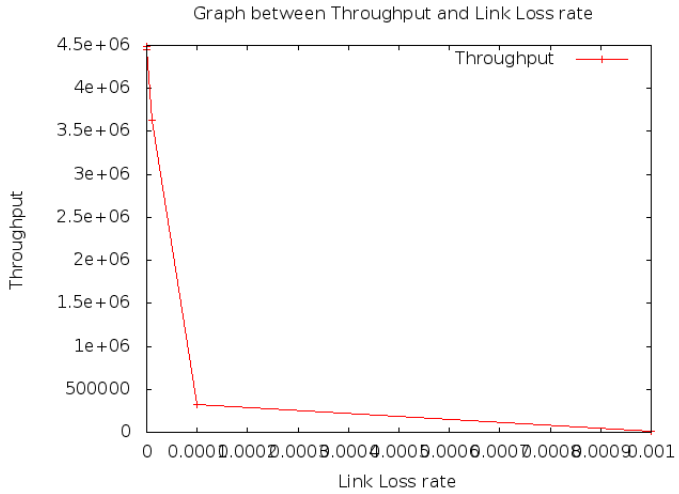


Graphs with 50ms 100ms delay.

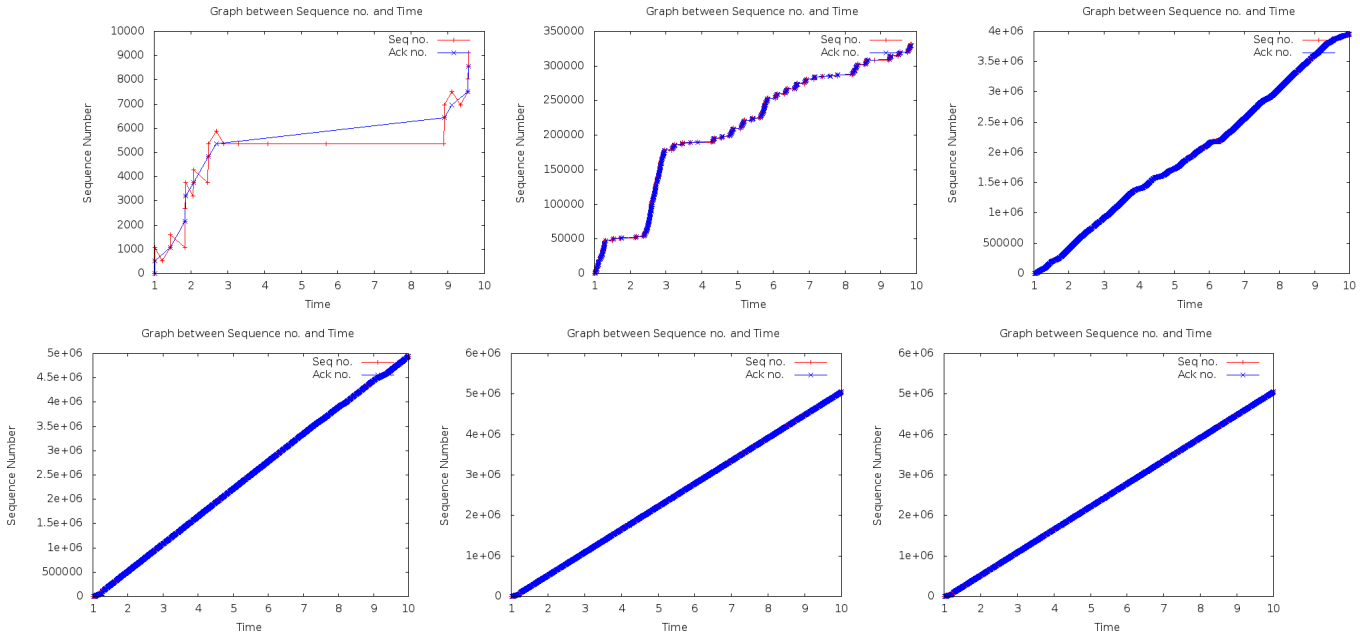


- Avg Throughput goes down with link delay.
- In this case link Delay increases which leads to increase in BDP so TCP will allow large size of window , now this large window will allow many packets to go in RTT it will lead to Queue overflow and congestion in link that will lead to Reduction of CWND size
- According to avobe CWND graphs it is clear that first CWND size goes very high then it reduces drastically , upto that time queue and receiver window has overflowed . after that receiver sends advertised window to prevent overflow so cwnd becoms constant for some time after that it again goes to slow start phase then due to again congestion finally Due to timeouts it goes to CONGESTION Avoidence phase
- Using Time Sequence graphs we can infer that in middle of transmission many packet lost and no new Sequence no. is used.

0.1.4 Exercise 1.4



Time Sequence Graphs with loss rate of link $10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8}$



- In this case as Loss rate of link increases packet loss increases too, due to this packet losses CWND size reduced to half every time so it leads to very few packets in link than its capacity to hold . Thats Why Throughput goes down drastically .
- See Time Sequence graphs with high loss rate , in these it is clearly visible that packets are lost many retransmission happend which leads to smaller cwnd size and low througput.

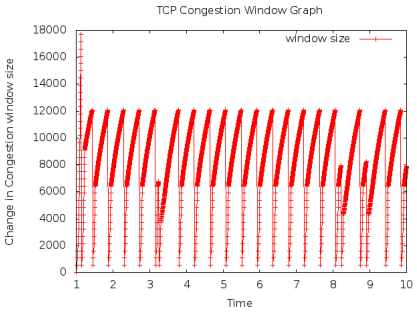
0.1.5 Q1.5

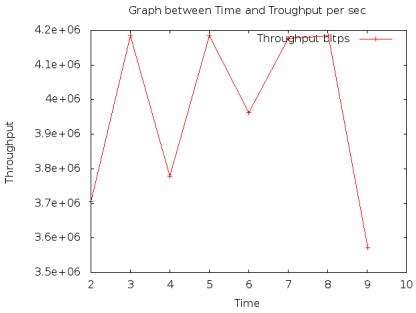
1. Queue Size 1
    - Average Throughput = 0.18 Mbps
    - Average Queue Occupancy = 0.5
    - Average Queueing Delay = 0.0004179 sec
    - Average cwnd = 1347.68
2. Queue Size 2
    - Average Throughput = 3.445 Mbps
    - Average Queue Occupancy =0.8588
    - Average Queueing Delay = 0.0006307 sec
    - Average cwnd = 6139.80
3. Queue Size 5
    - Average Throughput = 4.043 Mbps
    - Average Queue Occupancy =1.9299
    - Average Queueing Delay = 0.0014567 sec
    - Average cwnd = 7671.27
4. Queue Size 10
    - Average Throughput = 4.4472 Mbps
    - Average Queue Occupancy = 4.6922
    - Average Queueing Delay = 0.0039260 sec
    - Average cwnd = 9882.61
5. Queue Size 100
    - Average Throughput = 4.5478 Mbps
    - Average Queue Occupancy = 38.8894
    - Average Queueing Delay = 0.035567 sec
    - Average cwnd = 29370.49
6. Queue Size 500
    - Average Throughput = 4.588846 Mbps
    - Average Queue Occupancy = 58.4932
    - Average Queueing Delay = 0.05379 sec
    - Average cwnd = 39336.18
7. Queue Size 1000
    - Average Throughput = 4.588846 Mbps
    - Average Queue Occupancy = 58.4932
    - Average Queueing Delay = 0.05379 sec
    - Average cwnd = 39336

With increase in queue size Avg Throughput increases significantly upto Queue size 100 after that there is no significant improvement in Avg Througput but Queueing Delay increased from 0.035567sec to 0.05379sec So IDEAL QUEUE SIZE FOR this SIMULATION is 100

0.1.6 Q1.6

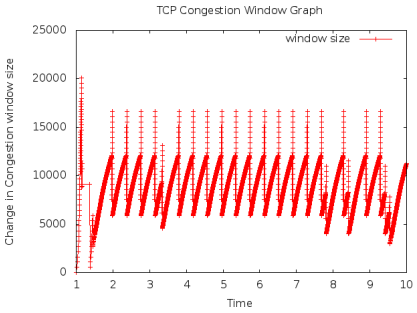
Tahoe :

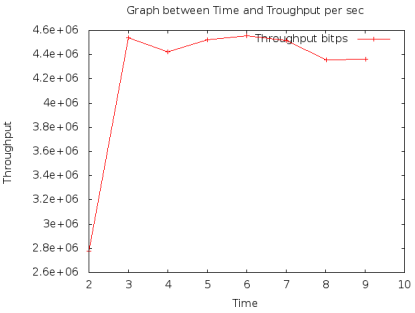




In Tahoe version of TCP when packet lost it waits for a timeout and so pipeling goes disturbed and leads to empty holes in pipeline. so it leads to low throughput.

Reno :





* According to throughput graphs Reno has better Througput. because Reno implements Fast Recovery after 3 dup acks so it maintains pipelinig .

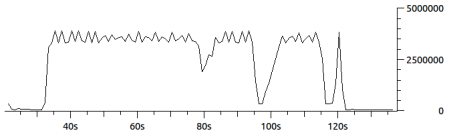
Fast Recovery : In fast recovery for every dupacks window size icreases by 1 mss so until it recieve an fresh acks.

- Slow Start Phase : slow start phase for both variants looks same .
- Fast Recovery : In Reno Fastrecovery is implemented but in Tahoe no Fast Recovery. You can observe this by seeing CWND graphs ,IN CWND graph for Reno spikes (peaks) before Reducing cwnd size to half.
- Congestion Avoidance : In tahoe after reaching to ssthreshold it sets cwnd size to 1 MSS but in Reno it sets cwnd size to half. it clearly visible in CWND graphs

0.2 Part 2

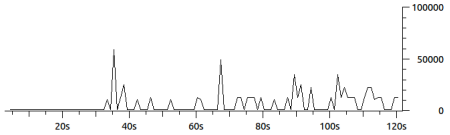
0.2.1 Exercise 2.1

(i) Througput graph



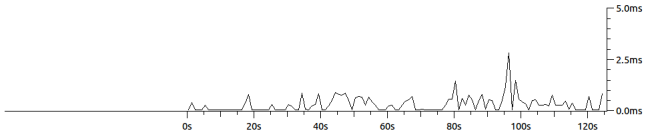
Avg Throughput = 2.033 Mbps, I have downloaded 30 MB zip file of songs.

(ii) Retransmission graph



372 retransmission due to Dupacks .

(iii) Avg RTT graph



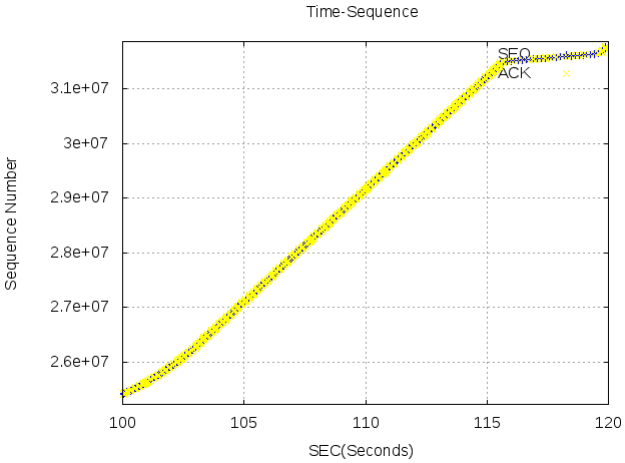
Max RTT = 40ms

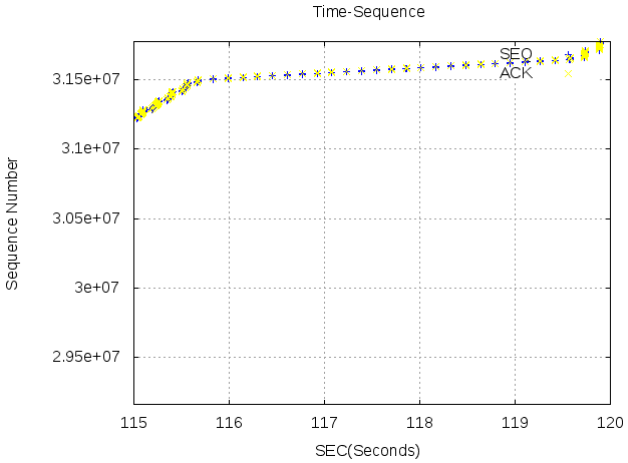
Min RTT = 10ms

* RTT depends on many factors but Queueing delay is most significant because usually Propagation delay is less for links.

* But for some long distance link propagation delay also plays a significant role to decide RTT.

0.2.2 Exercise 2.2





In this graph after **115 -120** there is lot of transmissions took place but i am not seeing any fast recovery so i can assume that sender is using Tahoe style version of TCP . In that period no New sequence no. sent.

After that period of time slow start again with half window because the slope looks similar to previous flow of sequence no.

It is clearly visible that in 115 - 120 Absence of Fast Recovery in the transmission because if it were fast recovery there will be increase in sequence no instead of line to parallel to x axis if it were Fast recovery then it would with positive slope. Due to tahoe style i think there is no SACK based recovery.