

TCP Experiments

1st April 2017.

PART 1

File Sizes (in KBs)	Average Throughput (in Mbps)	Average Latency (in Seconds)
512	4.05	1.089
1000	5.20116	1.618
2000	7.57	2.283
5000	8.75	4.863
10000	12.94	6.911

PART 2

Experiments were performed for 32 different combinations of values of the following parameters:

SACK = ON/OFF

WINDOW SIZE = 16 KB / 256 KB

CONGESTION WINDOW SCHEME = “reno” / “cubic”

LINK DELAY = 2 ms / 50 ms

LINK DROP PERCENTAGE = 0.5% / 5 %

The obtained values are tabulated as follows:

For FILE SIZE = 512 KB

Sr.No	SACK	WINDO W_SIZE	CONG SCHEME	LINK DELAY	LINK DROP RATE	THROUGHPUT (MB/s)	TIME(s)
1	0	16	reno	2	0.5	2.136	0.24
2	0	16	reno	2	5	1.874	0.32
3	0	16	reno	50	0.5	0.776	0.62
4	0	16	reno	50	5	0.717	0.68
5	0	16	cubic	2	0.5	1.682	0.3
6	0	16	cubic	2	5	1.316	0.4
7	0	16	cubic	50	0.5	0.654	0.78
8	0	16	cubic	50	5	0.759	0.64
9	0	256	reno	2	0.5	2.084	0.22
10	0	256	reno	2	5	1.333	0.54
11	0	256	reno	50	0.5	0.716	0.68
12	0	256	reno	50	5	0.727	0.7
13	0	256	cubic	2	0.5	2.724	0.2
14	0	256	cubic	2	5	2.516	0.2
15	0	256	cubic	50	0.5	0.766	0.64
16	0	256	cubic	50	5	0.792	0.62
17	1	16	reno	2	0.5	2.862	0.18
18	1	16	reno	2	5	2.642	0.2
19	1	16	reno	50	0.5	0.775	0.62
20	1	16	reno	50	5	0.747	0.64
21	1	16	cubic	2	0.5	2.546	0.2
22	1	16	cubic	2	5	2.528	0.2
23	1	16	cubic	50	0.5	0.742	0.66

24	1	16	cubic	50	5	0.611	0.88
25	1	256	reno	2	0.5	2.58	0.2
26	1	256	reno	2	5	2.564	0.2
27	1	256	reno	50	0.5	0.723	0.66
28	1	256	reno	50	5	0.780	0.62
29	1	256	cubic	2	0.5	2.678	0.2
30	1	256	cubic	2	5	2.354	0.2
31	1	256	cubic	50	0.5	0.837	0.6
32	1	256	cubic	50	5	0.798	0.6

For FILE SIZE = 1024 KB = 1 MB

Sr.No	SACK	WINDO W_SIZE	CONG SCHEME	LINK DELAY	LINK DROP RATE	THRPT (MB/s)	TIME(s)
1	0	16	reno	2	0.5	2.814	0.36
2	0	16	reno	2	5	2.308	0.48
3	0	16	reno	50	0.5	1.074	0.94
4	0	16	reno	50	5	1.11	0.86
5	0	16	cubic	2	0.5	1.662	0.58
6	0	16	cubic	2	5	2.45	0.46
7	0	16	cubic	50	0.5	0.824	1.54
8	0	16	cubic	50	5	1.121	0.88
9	0	256	reno	2	0.5	2.86	0.32
10	0	256	reno	2	5	1.857	0.62
11	0	256	reno	50	0.5	1.284	0.76
12	0	256	reno	50	5	1.282	0.76
13	0	256	cubic	2	0.5	3.584	0.3

14	0	256	cubic	2	5	3.616	0.28
15	0	256	cubic	50	0.5	1.188	0.8
16	0	256	cubic	50	5	1.278	0.76
17	1	16	reno	2	0.5	3.598	0.3
18	1	16	reno	2	5	3.512	0.3
19	1	16	reno	50	0.5	1.184	0.84
20	1	16	reno	50	5	1.232	0.82
21	1	16	cubic	2	0.5	3.552	0.3
22	1	16	cubic	2	5	3.692	0.28
23	1	16	cubic	50	0.5	1.042	0.96
24	1	16	cubic	50	5	1.031	0.98
25	1	256	reno	2	0.5	3.352	0.3
26	1	256	reno	2	5	2.866	0.36
27	1	256	reno	50	0.5	1.060	0.94
28	1	256	reno	50	5	1.142	0.86
29	1	256	cubic	2	0.5	3.43	0.32
30	1	256	cubic	2	5	3.452	0.3
31	1	256	cubic	50	0.5	1.258	0.78
32	1	256	cubic	50	5	1.167	0.82

For FILE SIZE = 2048 KB = 2 MB

Sr.No	SACK	WINDO W_SIZE	CONG SCHEME	LINK DELAY	LINK DROP RATE	THRPT (MB/s)	TIME(s)
1	0	16	reno	2	0.5	3.062	0.74
2	0	16	reno	2	5	3.384	0.58
3	0	16	reno	50	0.5	1.379	1.78

4	0	16	reno	50	5	1.5	1.38
5	0	16	cubic	2	0.5	2.83	0.76
6	0	16	cubic	2	5	2.194	1.06
7	0	16	cubic	50	0.5	0.981	2.64
8	0	16	cubic	50	5	1.702	1.24
9	0	256	reno	2	0.5	2.15	1.06
10	0	256	reno	2	5	2.155	1.12
11	0	256	reno	50	0.5	1.838	1.08
12	0	256	reno	50	5	2.026	0.96
13	0	256	cubic	2	0.5	4.176	0.46
14	0	256	cubic	2	5	4.008	0.5
15	0	256	cubic	50	0.5	1.936	1.02
16	0	256	cubic	50	5	1.818	1.08
17	1	16	reno	2	0.5	4.526	0.42
18	1	16	reno	2	5	4.216	0.48
19	1	16	reno	50	0.5	1.918	1
20	1	16	reno	50	5	1.896	1.04
21	1	16	cubic	2	0.5	4.32	0.46
22	1	16	cubic	2	5	3.658	0.54
23	1	16	cubic	50	0.5	1.766	1.12
24	1	16	cubic	50	5	1.84	1.06
25	1	256	reno	2	0.5	3.692	0.52
26	1	256	reno	2	5	4.124	0.48
27	1	256	reno	50	0.5	1.87	1.04
28	1	256	reno	50	5	1.778	1.12
29	1	256	cubic	2	0.5	4.294	0.48
30	1	256	cubic	2	5	3.85	0.5

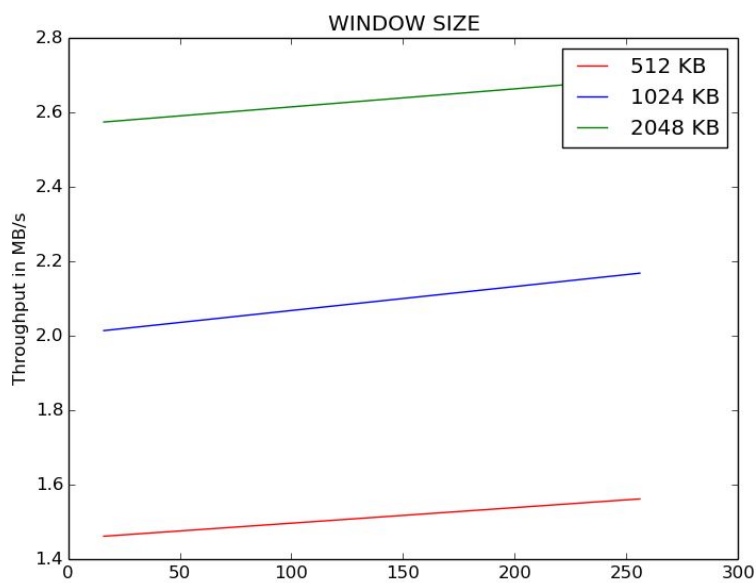
31	1	256	cubic	50	0.5	1.550	1.52
32	1	256	cubic	50	5	1.766	1.1

GRAPHS

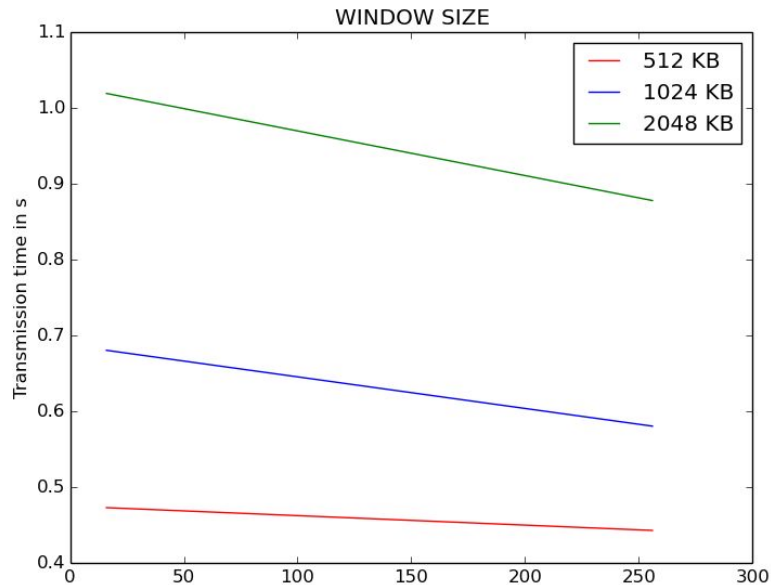
In order to observe the effect of each of these parameters individually, the average speed and time taken was plotted over all combinations of the other parameter values. The results have been tabulated as follows:

RECEIVER WINDOW SIZE = 16KB/256KB

FILE SIZE (KB)	Throughput with ws = 16 KB(MB/s)	Throughput ws = 256 KB(MB/s)	Time with ws = 16 KB (s)	Time with ws = 256KB (s)
512	1.461	1.561	0.472	0.442
1024	2.013	2.167	0.68	0.58
2048	2.573	2.689	1.019	0.877



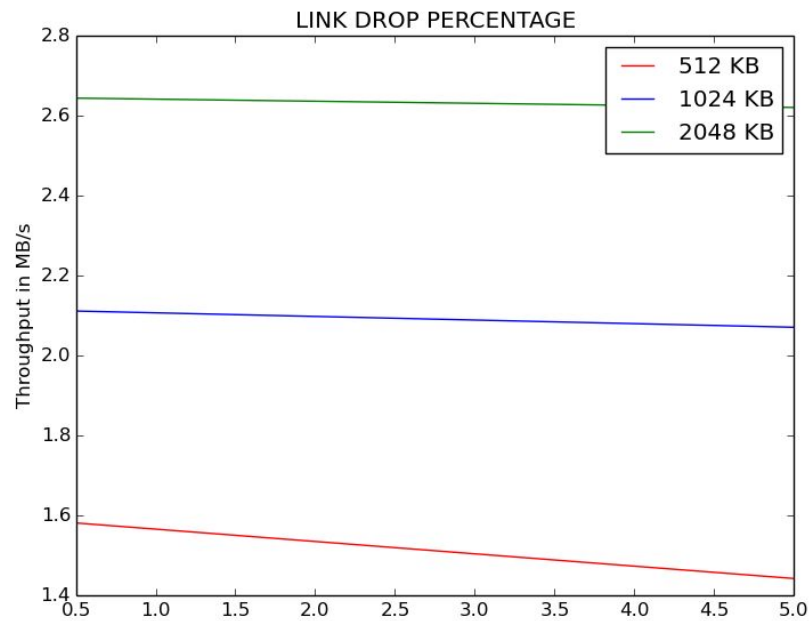
The throughput increases with increase in window size. When the receiver window size is small, the receiver acts as a bottleneck since it prevents the server from sending more packets. If the window size is increased, the sender is allowed to send more packets without having to wait in between and hence the throughput increases.



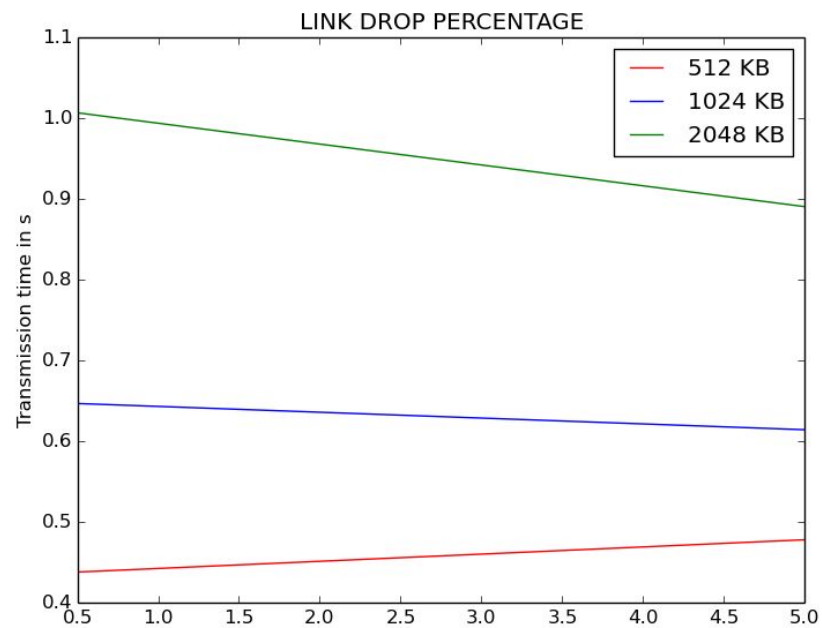
The total transmission time decreases on increasing window size. On increasing receiver window size, the sender can now send more packets without waiting than before; hence the total time taken to transmit all packets reduces.

LINK DROP PERCENTAGE (LDP) = 0.5% / 5%

FILE SIZE (KB)	Throughput with ldp=0.5 (MB/s)	Throughput ldp=5.0 (MB/s)	Time with ldp=0.5 (s)	Time with ldp=5.0 (s)
512	1.580	1.441	0.437	0.477
1024	2.110	2.069	0.646	0.613
2048	2.643	2.619	1.006	0.89



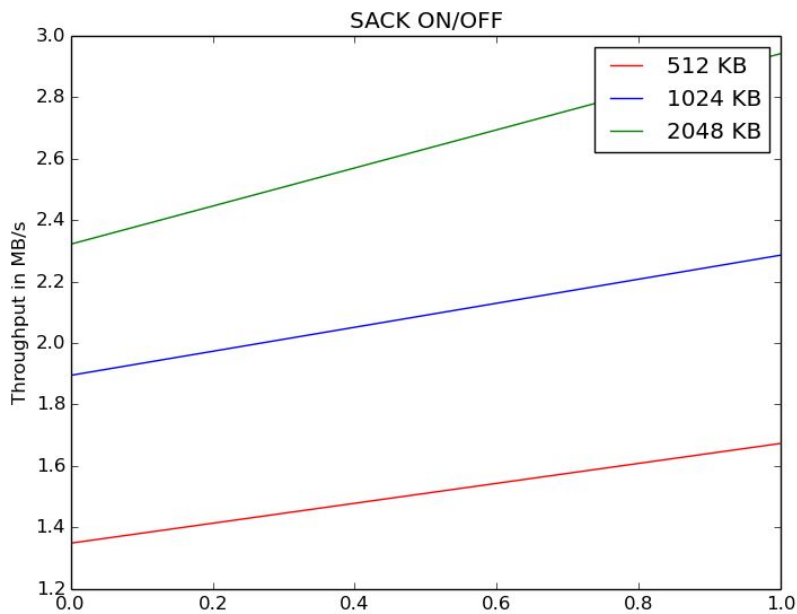
The throughput drops on increasing the link drop percentage. On increasing link drop percentage, a packet may have to be retransmitted several times for successful transmission and hence the bandwidth spent sending useful data is reduced. Hence the throughput drops.



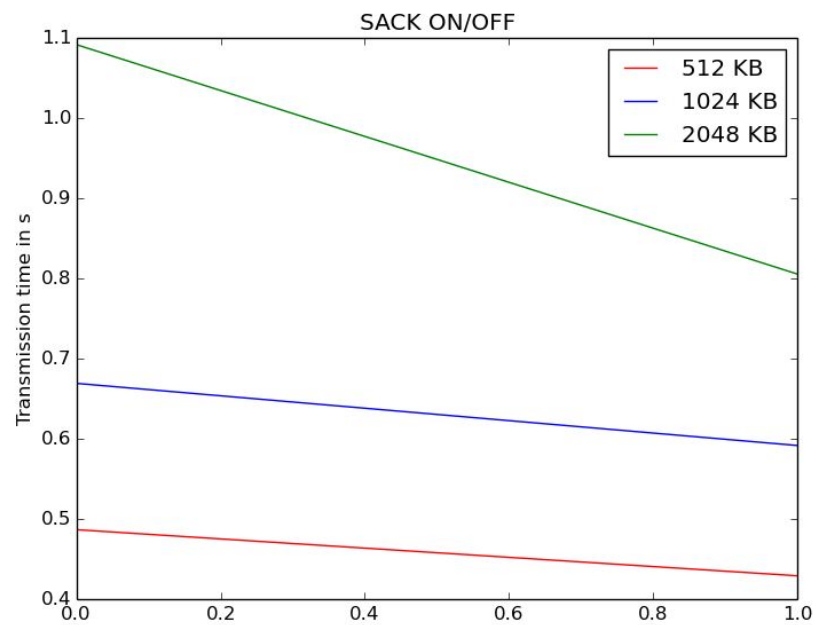
The transmission time should increase because the sender may have to retransmit each packet several times.

SELECTIVE ACKNOWLEDGEMENT = ON/OFF

FILE SIZE (KB)	Throughput with SACK = 0 (MB/s)	Throughput with SACK = 1 (MB/s)	Time with SACK = 0 (s)	Time with SACK = 1 (s)
512	1.348	1.673	0.486	0.429
1024	1.894	2.286	0.668	0.591
2048	2.321	2.941	1.091	0.805

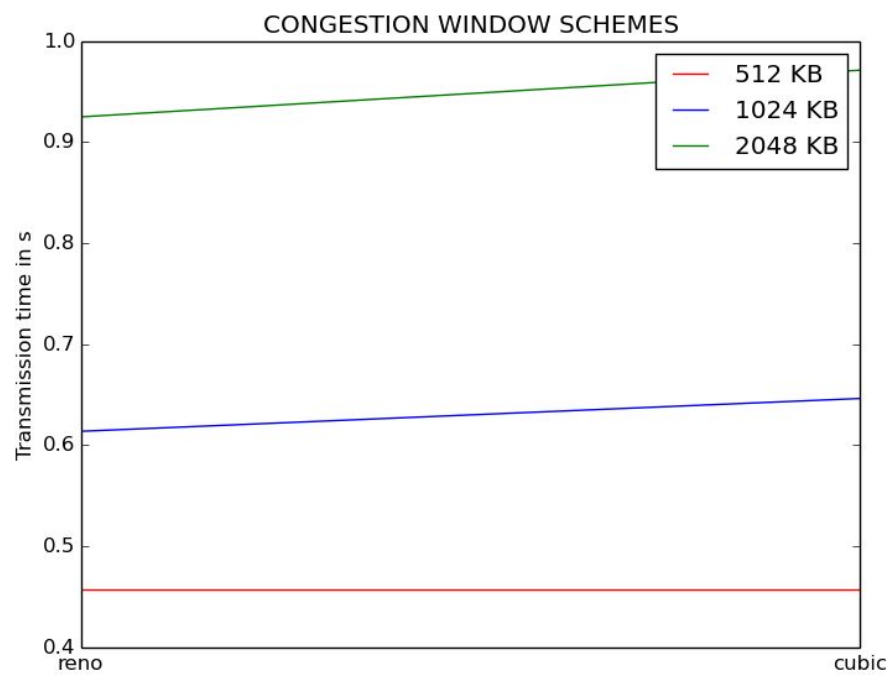
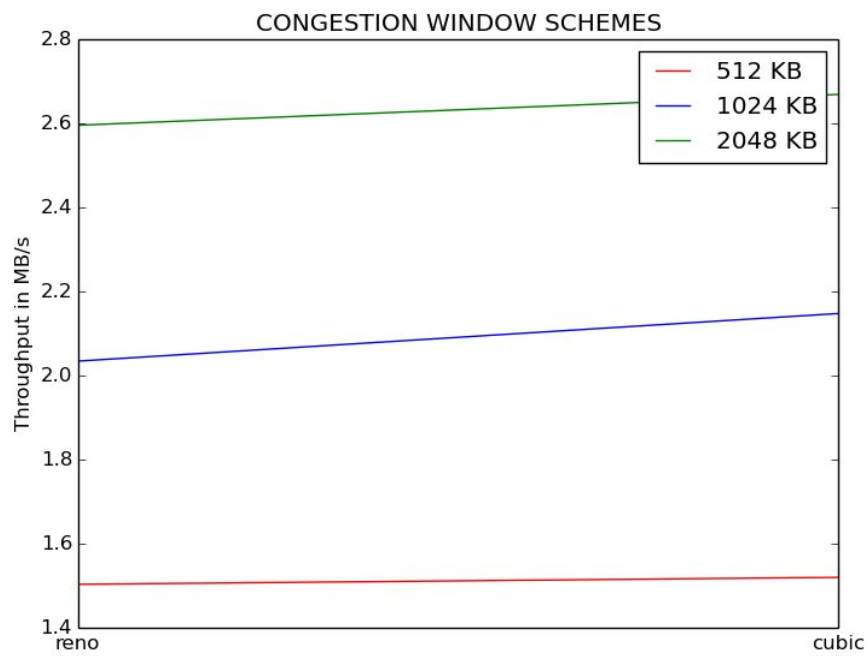


On switching SELECTIVE ACKNOWLEDGEMENTs, the throughput increases greatly. The default scheme when SACK is OFF is Go-Back-N in which all packets since last successful packet are retransmitted again, which causes a huge performance hit since already received packets are discarded by the receiver. When SACK is ON, the receiver only requests for individual packets that it did not receive thereby greatly improving utilization of the network. So throughput increases. Similarly, the transmission time decreases since each packet needs to be successfully transmitted exactly once.



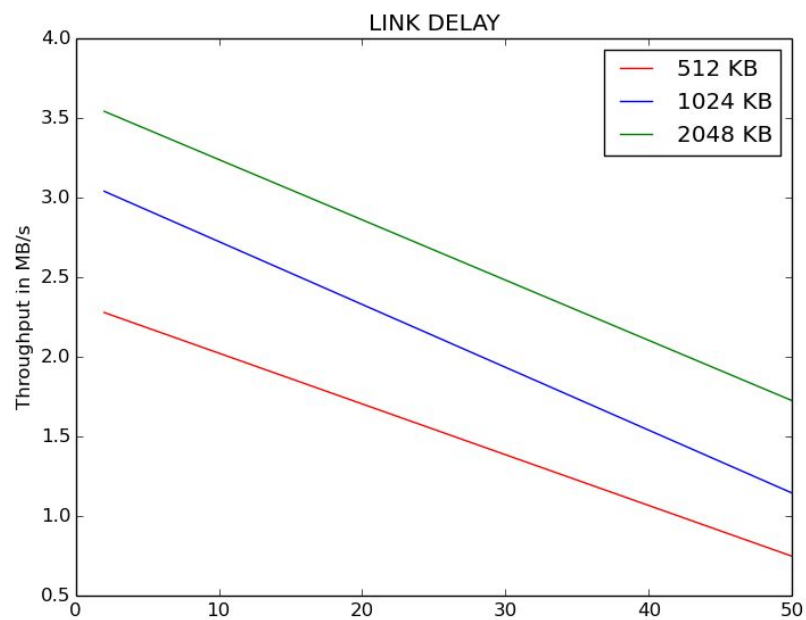
CONGESTION WINDOW SCHEME = RENO/CUBIC

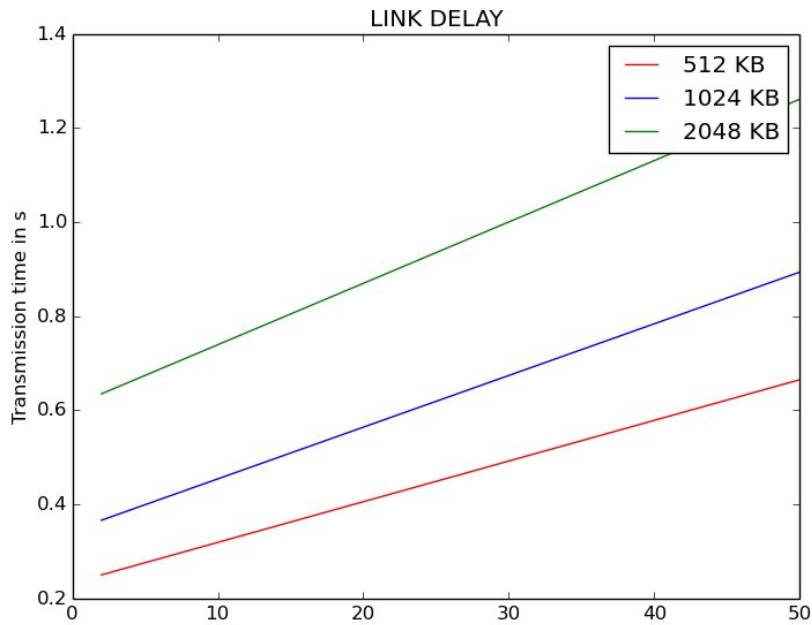
FILE SIZE (KB)	Throughput with RENO (MB/s)	Throughput with CUBIC (MB/s)	Time with RENO (s)	Time with CUBIC (s)
512	1.502	1.519	0.458	0.458
1024	2.033	2.147	0.614	0.647
2048	2.594	2.668	0.925	0.971



LINK DELAY = 2 ms/ 50 ms

FILE SIZE (KB)	Throughput with Link Delay = 2 ms (MB/s)	Throughput with Link Delay = 50 ms (MB/s)	Time with Link Delay = 2 ms(s)	Time with Link Delay = 50 ms (s)
512	2.276	0.745	0.250	0.665
1024	3.038	1.144	0.366	0.894
2048	3.539	1.722	0.635	1.262





The throughput drastically drops and transmission time drastically increases on increasing link delay from 2 ms to 50 ms. On increasing the link delay, the propagation delay T_{prop} is increased and hence the efficiency $= \frac{T_{data}}{T_{prop}}$ is decreased. Also total transmission time is directly proportional to the propagation delay, so that too increases.

