

ITS 413 Internet Technologies and Applications

Assignment: Phase 2 Report

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Date: February 17, 2012

By submitting this report all members of the group listed above agree that each member has contributed approximately equal amounts to designing and performing experiments, as well as to preparing this report. All members agree that this report accurately reflects the experiments conducted by the group members, and is their own work (not works of other groups).

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Aims

1. To measure the maximum throughput that can be achieved over a wireless LAN and Ethernet link using iperf.
2. To identify the change in throughput with the change in different parameters.

Comment [s1]: Some mention of what type of parameters would be more useful. E.g. are you going to be changing the transport protocol parameters? Data link parameters? Network topology?

Network Diagram

We have used two network topologies in our experiment. Following are the network diagrams of topologies:

Wireless Topology



Figure 1 Wireless Topology

Wired Ethernet Topology



Figure 2 Wired Ethernet Topology

Equipment Specifications

Following are the devices we used in the course of experiments:

Computer A

Model: Acer Aspire1410
Processor: Intel Celeron 723 @ 1.20 GHz
Memory: 2 GB DDR2
WLAN Interface: Acer Nplify 802.11b/g/Draft-N
Operating System: Ubuntu 11.10

Comment [s2]: What about the wired LAN interface?

Computer B

Model: Dell Studio 1435
Processor: intel Core 2 Dui CPU T6400 @ 2.00 GHz
Memory: 4 GB DDR2
WLAN Interface: DELL Wireless 1397 802.11b/g
Operating System: Ubuntu 11.10

Router

Model: Linksys WRT54GL
Firmware: penWrt Backfire 10.03.1 / LuCI 0.10.0 Release (0.10.0)
Kernel Version: 2.4.37.9

Parameters

Following are the parameters that are to be considered in the experiments mentioned in the experiments:

Parameters	Default Value
Sending Rate	30 Mb/s
RTS/CTS Threshold	250 Bytes
Protocol Used	UDP

Comment [s3]: What about other parameters? Wireless LAN data rate? WEP on or off? Ethernet data rate? ...

Experiments and Results

We have broken our experiment into various parts analysing various parameters.

Comment [s4]: What iperf commands did you use for the tests?

Experiment 1 – Wireless Link (Parameter - sending rate)

Scenario 1

Protocol used: UDP

Client: Computer A

Server: Computer B

RTS/CTS Threshold: Default

Sending Rate: From 1 to 54 Mb/s (step of 1)

In this experiment we, measured the average throughput of the wireless link by increasing the sending rate by the step of 1Mb/s. The average was from 5 different tests. Following was our result:

Comment [s5]: Ok, good. But unless there is something special to show from the results, there is no need to show the results for the 5 individual tests. Just show the average results. To be more scientifically accurate, you could also show confidence intervals (which is related to the standard deviation – gives an indicator of how accurate the average result is).

Throughput (Mb/s)

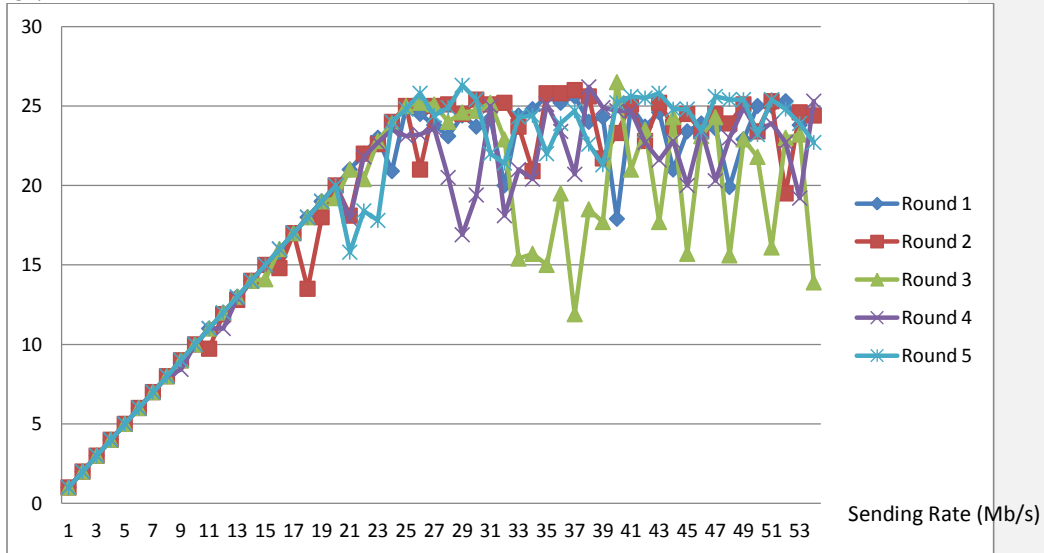


Figure 3 the comparison of the throughput of different round of tests

Throughput (Mb/s)

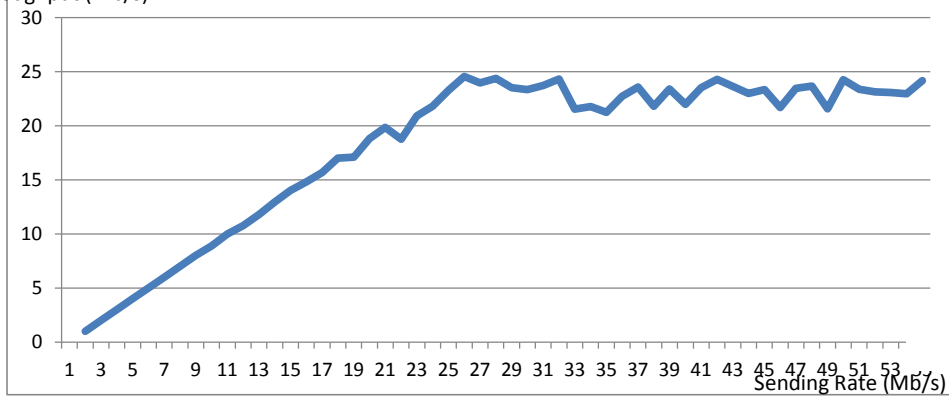


Figure 4 the average value of the throughput

Conclusion

With increase in sending rate, the throughput increase to about 25-26 Mb/s and after that it tends to stabilize.

Comment [s6]: Good. Any reasons why the throughput stabilizes at this value? Why is the maximum throughput 26Mb/s and not 42Mb/s or 54Mb/s?

Scenario 2 (swap the client computer and server computer)

Protocol used: UDP

Client: Computer B

Server: Computer A

RTS/CTS Threshold: Default

Sending Rate: From 1 to 54 Mb/s (step of 1)

In this experiment we, measured the average throughput of the wireless link by increasing the sending rate by the step of 1Mb/s. The average was from 5 different tests. Following was our result:

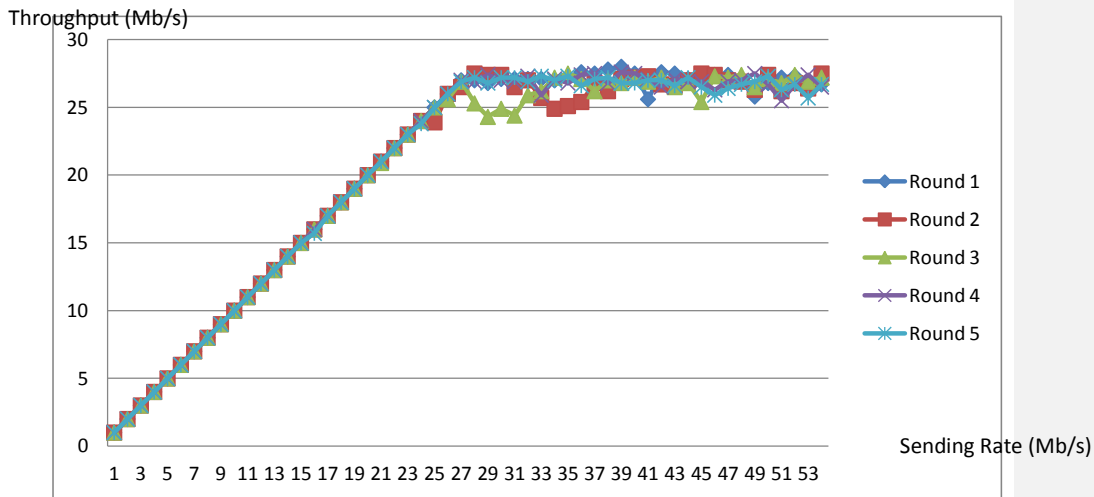


Figure 5 the comparison of the throughput of different round of tests

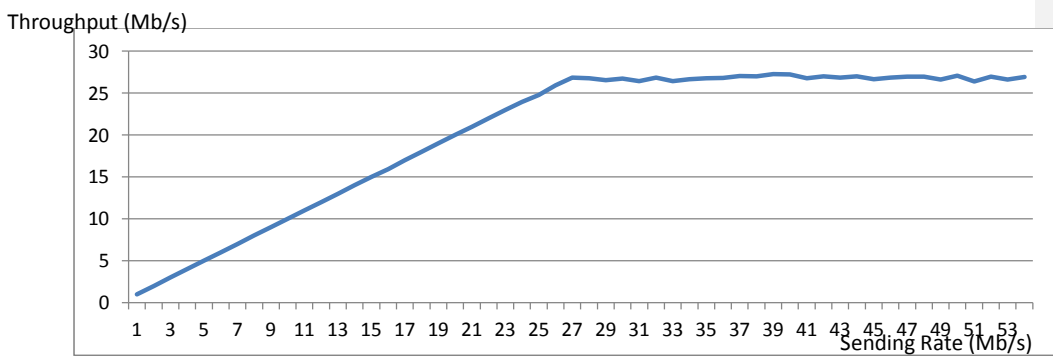


Figure 6 the average value of the throughput

Conclusion

With increase in sending rate, the throughput increase to about 27-28 Mb/s and after that it tends to stabilize. Moreover, when we changed the client to a better computer there is less fluctuation in the throughput, as you can see from figure 6.

Comment [s7]: Ok, this is an interesting and useful test. Why do you think a different computer gives different results? Isn't wireless LAN protocol the same on all computers?

Experiment 2 – Wired Ethernet Link (Parameter - sending rate)

Protocol used: UDP

Client: Computer A

Server: Computer B

RTS/CTS Threshold: Default

Sending Rate: From 1 to 100 Mb/s (step of 1)

In this experiment we, measured the average throughput of the wired link by increasing the sending rate by the step of 1Mb/s. The average was from 5 different tests. Following was our result:

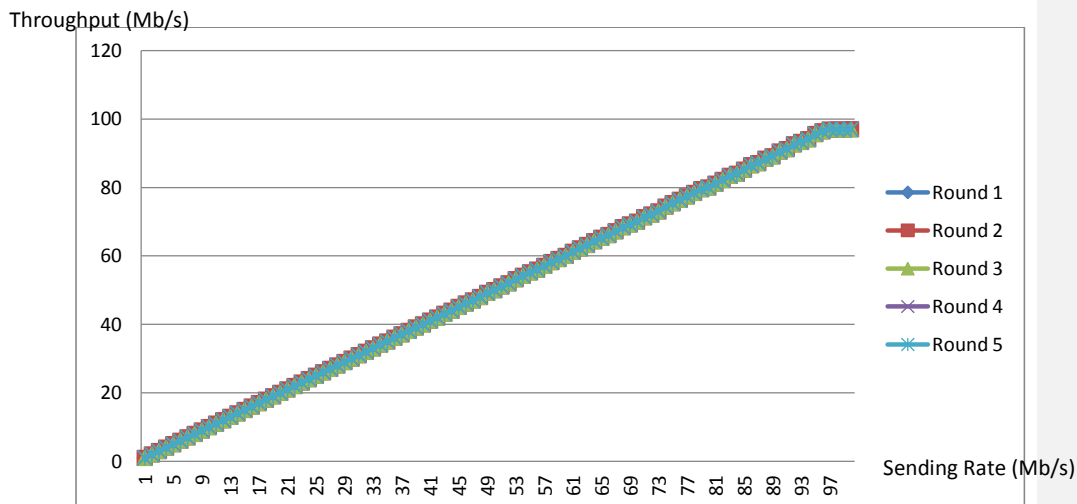


Figure 7 the comparison of the throughput of different round of tests

Conclusion

With increase in sending rate, the throughput increase to about 97 Mb/s and after that it tends to stabilize. We did not plot the average value of throughput because it is much the of same to figure 7.

Comment [s8]: Why is it much higher than wireless LAN? Not just as an absolute value, but also as a percentage of data rate.

Comment [s9]: I'd prefer to see the average, not the individual values, if only because on the individual values the markers you use (squares, crosses, diamonds etc) it is hard to distinguish between 95Mb/s and 99Mb/s. But with the average, when a thinner line is used, you can see more precisely the value.

Experiment 3 – Wired Ethernet Link (Parameter – RTS/CTS Threshold)

Protocol used: UDP

Client: Computer B

Server: Computer A

Sending Rate: From 30 Mb/s

RTS/CTS Threshold: [1, 250, 500, 750, 1000, 1250, 1500, 1750, 2000, 2250] Byte

Comment [s10]: Why did you choose these values? Especially why start at 1 and stop at 2250? Think about how big the wireless LAN frames sent by iperf are?

In this experiment we, measured the average throughput of the wireless link by increasing the RTS/CTS threshold by the step of 250 Bytes. The average was from 5 different tests. Following was our result:

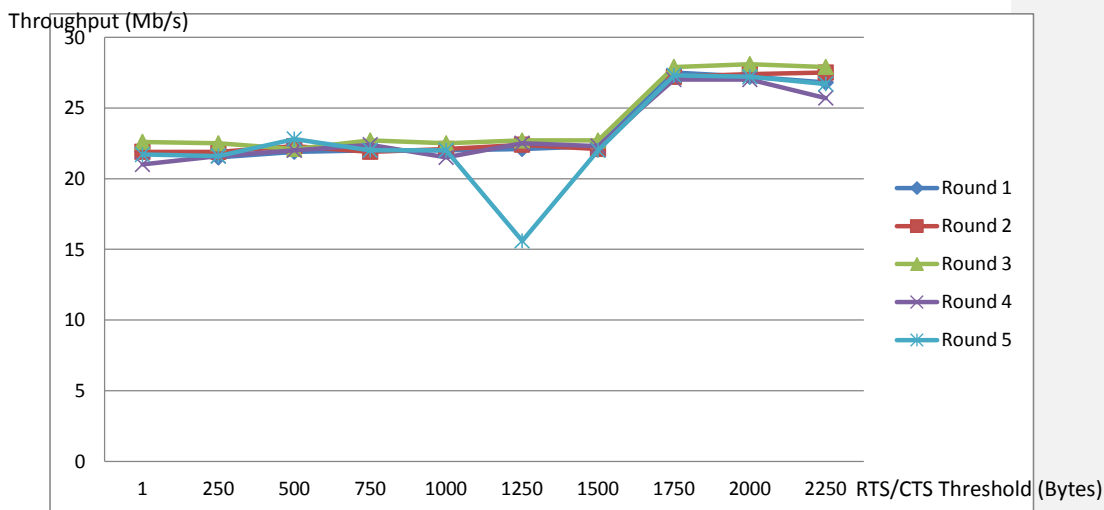


Figure 8 the comparison of the throughput of different round of tests

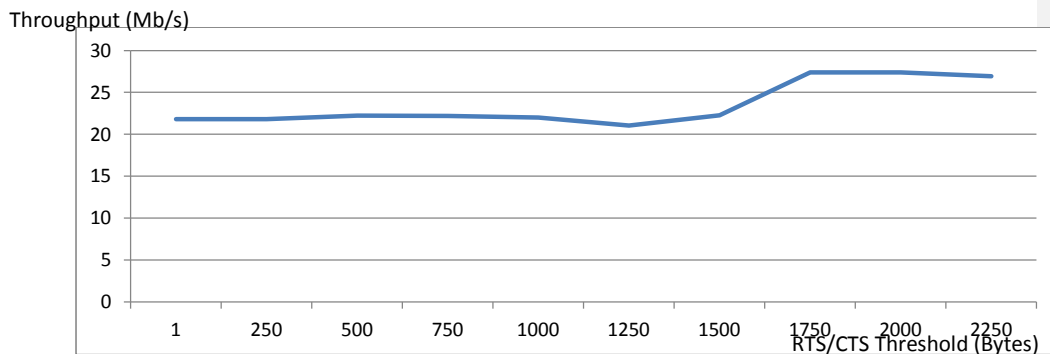


Figure 9 the average value of the throughput

Conclusion

Upto the RTS/CTS threshold of 1500 Bytes, the throughput steadies around 22 Mb/s and after that it rises to about 27 Mb/s.

Comment [s11]: Why? Why does it rise from 22 to 27 at 1500B? Why is it 22 for lower values (when your results in previous sections achieved >24Mb/s)?

Appendix

The readings of Experiments:

Comment [s12]: Ok to include this data in appendix.

Experiment 1 (Scenario 1)

Sending Rate (Mb/s)	Throughput (Mb/s)					Average (Mb/s)
	Round 1	Round 2	Round 3	Round 4	Round 5	
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	8.43	9	8.886
10	10	10	10	10	10	10
11	11	9.73	11	11	11	10.746
12	12	11.9	12	11	12	11.78
13	13	12.8	13	12.9	13	12.94
14	14	14	14	14	14	14
15	15	15	14.1	15	15	14.82
16	15.5	14.8	16	16	16	15.66
17	17	17	17	17	17	17

18	18	13.5	18	18	18	17.1
19	19	18	19	19	19	18.8
20	20	20	19.2	20	20	19.84
21	21	18.1	21	17.9	15.8	18.76
22	22	22	20.4	21.8	18.4	20.92
23	23	22.6	22.8	22.7	17.8	21.78
24	20.9	24	23.9	23.5	24	23.26
25	24.9	25	25	23.1	24.8	24.56
26	24.5	21	25.2	23.2	25.8	23.94
27	23.8	25	25.1	23.6	24.4	24.38
28	23.1	25.1	24	20.5	24.9	23.52
29	24.4	24.5	24.6	16.9	26.3	23.34
30	23.7	25.4	24.7	19.4	25.4	23.72
31	24.2	25.1	25.2	25	22	24.3
32	20	25.2	22.9	18.1	21.4	21.52
33	24.4	23.7	15.4	21	24.3	21.76
34	24.8	20.9	15.7	20.4	24.4	21.24
35	25.6	25.8	15	25.1	22	22.7
36	25.2	25.8	19.5	23.4	23.9	23.56
37	25.6	26	11.9	20.7	24.7	21.78
38	24	25.6	18.5	26.2	22.6	23.38
39	24.3	21.7	17.7	24.9	21.3	21.98
40	17.9	23.3	26.5	24.7	25.2	23.52
41	25	25.1	21	24.7	25.6	24.28
42	23.7	22.8	23.5	22.7	25.5	23.64
43	24.6	25.2	17.7	21.6	25.8	22.98
44	21	23.7	24.3	22.8	24.8	23.32
45	23.4	24.5	15.7	20	24.8	21.68
46	23.9	23.4	23.1	23.5	23.4	23.46
47	23.6	24.5	24.3	20.3	25.6	23.66
48	19.9	23.9	15.6	23	25.4	21.56
49	22.9	25.1	22.9	24.9	25.4	24.24
50	25	23.4	21.8	23.4	23.2	23.36
51	25	25.3	16.1	23.9	25.4	23.14
52	25.3	19.5	23	22.7	24.8	23.06
53	23.8	24.6	23.2	19.2	23.9	22.94
54	24.5	24.4	13.9	25.3	22.7	22.16

Experiment 1 (Scenario 2)

Sending Rate (Mb/s)	Throughput (Mb/s)					Average (Mb/s)
	Round 1	Round 2	Round 3	Round 4	Round 5	
1	1	1	1	0.999	1	0.9998
2	2	2	2	2	2	2

3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	4.99	5	4.998
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9
10	10	10	10	10	10	10
11	11	11	11	11	11	11
12	12	12	12	12	12	12
13	13	13	13	13	13	13
14	14	14	14	14	14	14
15	15	15	15	15	15	15
16	16	16	16	16	15.7	15.94
17	17	17	17	17	17	17
18	18	18	18	18	18	18
19	19	19	19	19	19	19
20	20	20	20	20	20	20
21	21	21	20.9	21	21	20.98
22	22	22	22	22	22	22
23	23	23	23	23	23	23
24	24	24	24	24	23.8	23.96
25	25	23.9	25	25	25	24.78
26	26	26	25.6	26	26	25.92
27	27	26.5	26.9	27	26.9	26.86
28	27	27.5	25.3	26.9	27.2	26.78
29	26.8	27.4	24.3	27.4	26.8	26.54
30	27.1	27.4	24.9	27	27.2	26.72
31	27.1	26.5	24.4	26.9	27.2	26.42
32	27.1	27	25.9	27.3	26.9	26.84
33	27.1	25.7	26.2	25.9	27.3	26.44
34	27	24.9	27.2	27.1	27	26.64
35	27.2	25.1	27.5	26.8	27.3	26.78
36	27.6	25.4	27.1	27.4	26.6	26.82
37	27.5	26.8	26.2	27.5	27.1	27.02
38	27.8	26.2	27	26.8	27.2	27
39	28	27.1	26.8	27.6	26.8	27.26
40	27.5	27.2	27.2	27.5	26.8	27.24
41	25.6	27.3	26.9	27.1	27	26.78
42	27.6	26.7	27.2	26.5	27	27
43	27.5	26.6	26.5	27.1	26.6	26.86
44	27.1	27	26.8	26.9	27.2	27
45	26.9	27.5	25.4	26.9	26.5	26.64
46	27.4	27.4	27.3	26.3	25.9	26.86

47	27.4	27	27.2	26.9	26.4	26.98
48	26.9	26.9	27.4	27	26.7	26.98
49	25.8	26.3	26.5	27.5	26.9	26.6
50	26.8	27.4	27.1	26.7	27.3	27.06
51	27.2	26.2	26.8	25.5	26.3	26.4
52	27.3	26.8	27.4	26.7	26.7	26.98
53	26.6	26.4	26.9	27.4	25.7	26.6
54	26.7	27.5	27.2	26.5	26.7	26.92

Experiment 2

Sending Rate (Mb/s)	Throughput (Mb/s)					Average (Mb/s)
	Round 1	Round 2	Round 3	Round 4	Round 5	
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9
10	10	10	10	10	10	10
11	11	11	11	11	11	11
12	12	12	12	12	12	12
13	13	13	13	13	13	13
14	14	14	14	14	14	14
15	15	15	15	15	15	15
16	16	16	16	16	16	16
17	17	17	17	17	17	17
18	18	18	18	18	18	18
19	19	19	19	19	19	19
20	20	20	20	20	20	20
21	21	21	21	21	21	21
22	22	22	22	22	22	22
23	23	23	23	23	23	23
24	24	24	24	24	24	24
25	25	25	25	25	25	25
26	26	26	26	26	26	26
27	27	27	27	27	27	27
28	28	28	28	28	28	28
29	29	29	29	29	29	29
30	30	30	30	30	30	30
31	31	31	31	31	31	31

32	32	32	32	32	32	32
33	33	33	33	33	33	33
34	34.1	34.1	34.1	34.1	34.1	34.1
35	35	35	35	35	35	35
36	36.1	36.1	36.1	36.1	36.1	36.1
37	37.1	37.1	37.1	37.1	37.1	37.1
38	38.1	38.1	38.1	38.1	38.1	38.1
39	39.1	39.1	39.1	39.1	39.1	39.1
40	40	40	40	40	40	40
41	41.1	41.1	41.1	41.1	41.1	41.1
42	42	42	42	42	42	42
43	43.1	43.1	43.1	43.1	43.1	43.1
44	44	44	44	44	44	44
45	45.1	45.1	45.1	45.1	45.1	45.1
46	46.1	46.1	46.1	46.1	46.1	46.1
47	47	47	47	47	47	47
48	48	48	48	48	48	48
49	49.2	49.2	49.2	49.2	49.2	49.2
50	50	50	50	50	50	50
51	51.1	51.1	51.1	51.1	51.1	51.1
52	52	52	52	52	52	52
53	53.2	53.2	53.2	53.2	53.2	53.2
54	54.2	54.2	54.2	54.2	54.2	54.2
55	55.2	55.2	55.2	55.2	55.2	55.2
56	56	56	56	56	56	56
57	57.1	57.1	57.1	57.1	57.1	57.1
58	58.2	58.2	58.2	58.2	58.2	58.2
59	59.1	59.1	59.1	59.1	59.1	59.1
60	60	60	60	60	60	60
61	61.2	61.2	61.2	61.2	61.2	61.2
62	62.2	62.2	62.2	62.2	62.2	62.2
63	63.2	63.2	63.2	63.2	63.2	63.2
64	64.3	64.3	64.3	64.3	64.3	64.3
65	65.3	65.3	65.3	65.3	65.3	65.3
66	66.1	66.1	66.1	66.1	66.1	66.1
67	67.2	67.2	67.2	67.2	67.2	67.2
68	68.4	68.4	68.4	68.4	68.4	68.4
69	69.1	69.2	69.2	69.2	69.2	69.18
70	70	70	70	70	70	70
71	71.3	71.3	71.3	71.3	71.3	71.3
72	72.1	72.1	72.1	72.1	72.1	72.1
73	73	73	73	73	73	73
74	74.4	74.4	74.4	74.4	74.4	74.4
75	75.4	75.4	75.4	75.4	75.4	75.4

76	76.4	76.4	76.4	76.4	76.4	76.4
77	77.4	77.4	77.4	77.4	77.4	77.4
78	78.4	78.4	78.4	78.4	78.4	78.4
79	79.5	79.5	79.5	79.5	79.5	79.5
80	80	80	80	80	80	80
81	81.1	81.1	81.1	81.1	81.1	81.1
82	82.2	82.2	82.2	82.2	82.2	82.2
83	83.4	83.4	83.4	83.4	83.4	83.4
84	84	84	84	84	84	84
85	85.2	85.2	85.2	85.2	85.2	85.2
86	86.5	86.5	86.5	86.5	86.5	86.5
87	87.1	87.1	87.1	87.1	87.1	87.1
88	88.4	88.4	88.4	88.4	88.4	88.4
89	89.1	89.1	89.1	89.1	89.1	89.1
90	90.5	90.5	90.5	90.5	90.5	90.5
91	91.2	91.2	91.2	91.2	91.2	91.2
92	92.6	92.6	92.6	92.6	92.6	92.6
93	93.3	93.3	93.3	93.3	93.3	93.3
94	94.1	94.1	94.1	94.1	94.1	94.1
95	95.6	95.6	95.6	95.6	95.6	95.6
96	96.4	96.4	96.4	96.4	96.4	96.4
97	97	96.9	97	97	97	96.98
98	97	96.9	97	96.9	96.9	96.94
99	96.9	96.9	96.9	97	96.9	96.92
100	96.9	97	97	97	97	96.98

Experiment 3

RTS/CTS Threshold (Byte)	Throughput (Mb/s)					Average (Mb/s)
	Round 1	Round 2	Round 3	Round 4	Round 5	
1	21.9	21.9	22.6	21	21.7	21.82
250	21.5	21.9	22.5	21.6	21.6	21.82
500	21.9	22.3	22.1	22	22.8	22.22
750	22	21.9	22.7	22.4	22	22.2
1000	22	22.1	22.5	21.5	22	22.02
1250	22.1	22.4	22.7	22.5	15.6	21.06
1500	22.3	22.1	22.7	22.3	22	22.28
1750	27.5	27.2	27.9	27	27.3	27.38
2000	27.2	27.4	28.1	27	27.2	27.38
2250	26.8	27.5	27.9	25.7	26.7	26.92