

TDMA WiFi implementation comparison

To test throughput, iperf utility under Ubuntu 12.04 is used.

Iperf is launched with settings to report throughput every 5 seconds.

To check throughput in UDP mode, bidirectional test is used with maximal bandwidth to have less than 0,1% drops and reordering

To check throughput in TCP mode, unidirectional test is used.

To align TCP throughput in CSMA/CA mode to TDMA mode, the maximal unidirectional throughput divided per 2.

The command samples

```
iperf -c SERVER_IP_ADDRESS -i5 -t50 -r
```

```
iperf -c SERVER_IP_ADDRESS -i5 -t50 -u -d -bBANDWIDTH_IN_MB
```

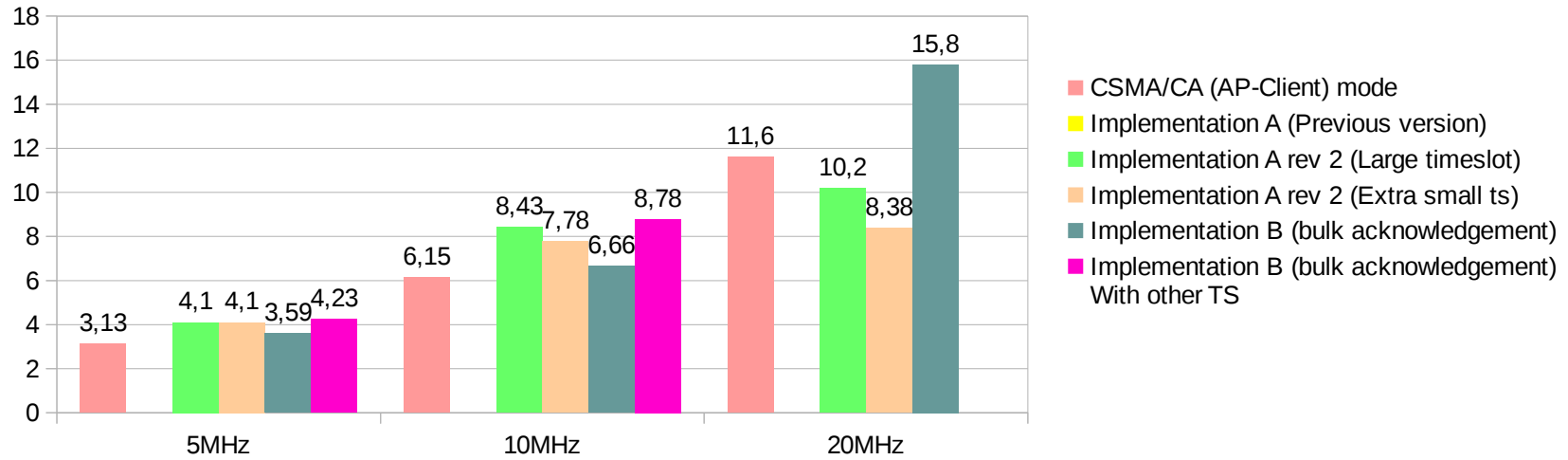
Testbed is configured for 2 nodes in the network.

AR7240 CPU based board with 32Mb of RAM. Frequency 5180MHz. Automatic power settings.

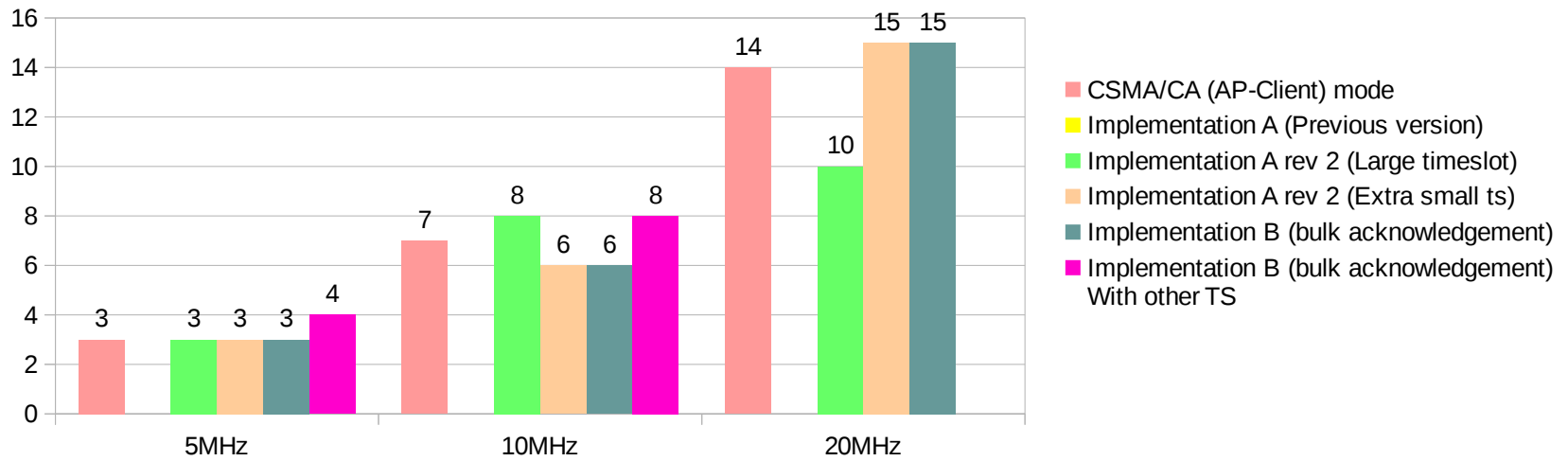
Channel width	RSSI	Timeslot size	TCP						UDP	
			BS->CPE			CPE-BS				
			max	min	avg	max	min	avg		
5	40-46		3,46	2,94	3,13	3,15	3,08	3,1	3	
10	44-51		6,6	6	6,15	6,15	6,05	6,1	7	
20	48-56		12,05	11,45	11,6	11,65	11,55	11,6	14	
5										
10	No data for tests with previous version									
20										
5	42-46	30	4,4	3,77	4,1	4,04	3,95	4	3	
10	42-46	30	8,81	7,97	8,43	8,47	8,23	8,38	8	
20	45-50	30	11,3	9,93	10,2	11	9,93	10,2	10	
5		29	It's similar to the TS 30ms							
10	42-46	15	8,18	7,34	7,78	7,74	7,68	7,72	7	
20	44-50	9	8,6	7,97	8,38	8,37	8,26	8,32	8	
5	38-44	24	4,82	3,98	4,23	4,19	4,11	4,15	4	
10	41-46	16	9,44	8,6	8,78	8,73	8,59	8,7	8	
5	39-44	12	3,77	3,34	3,59	3,52	3,49	3,5	3	
10	42-46	8	7,13	6,5	6,66	6,71	6,31	6,51	6	
20	45-51	8	16,8	15,7	15,8	15,9	15,5	15,8	15	

- CSMA/CA (AP-Client) mode
- Implementation A (Previous version)
- Implementation A rev 2 (Large timeslot)
- Implementation A rev 2 (Extra small ts)
- Implementation B (bulk acknowledgement)

TCP throughput per node



UDP throughput per node

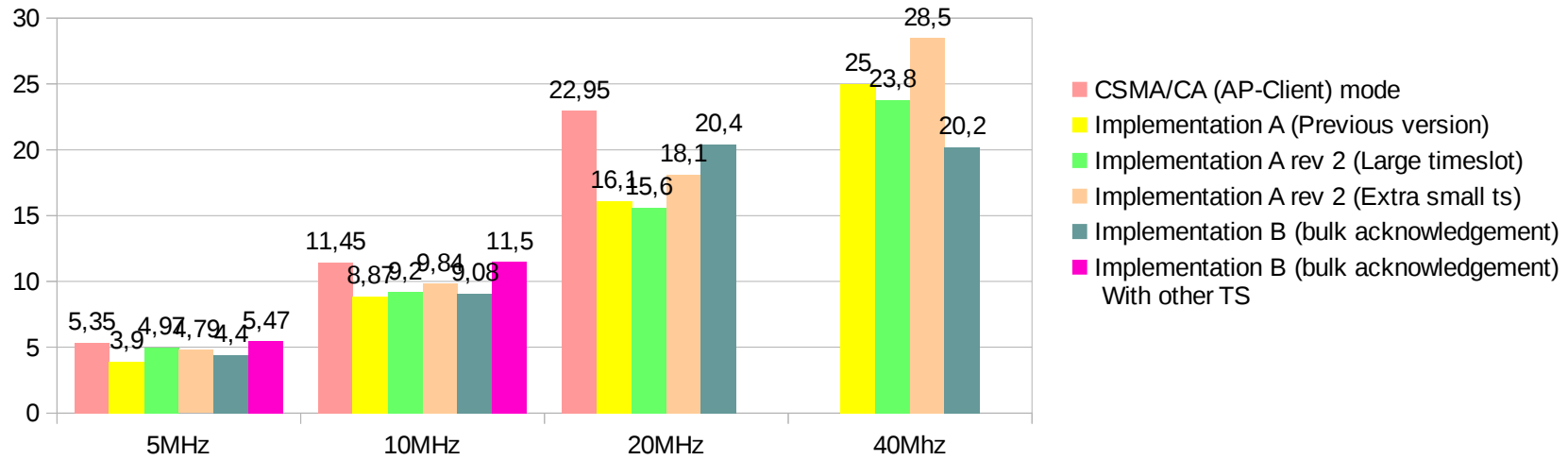


Engenius 5XXX board with AR7240 CPU and 32Mb of RAM. MIMO-1. Frequency 5180MHz. Automatic power settings.

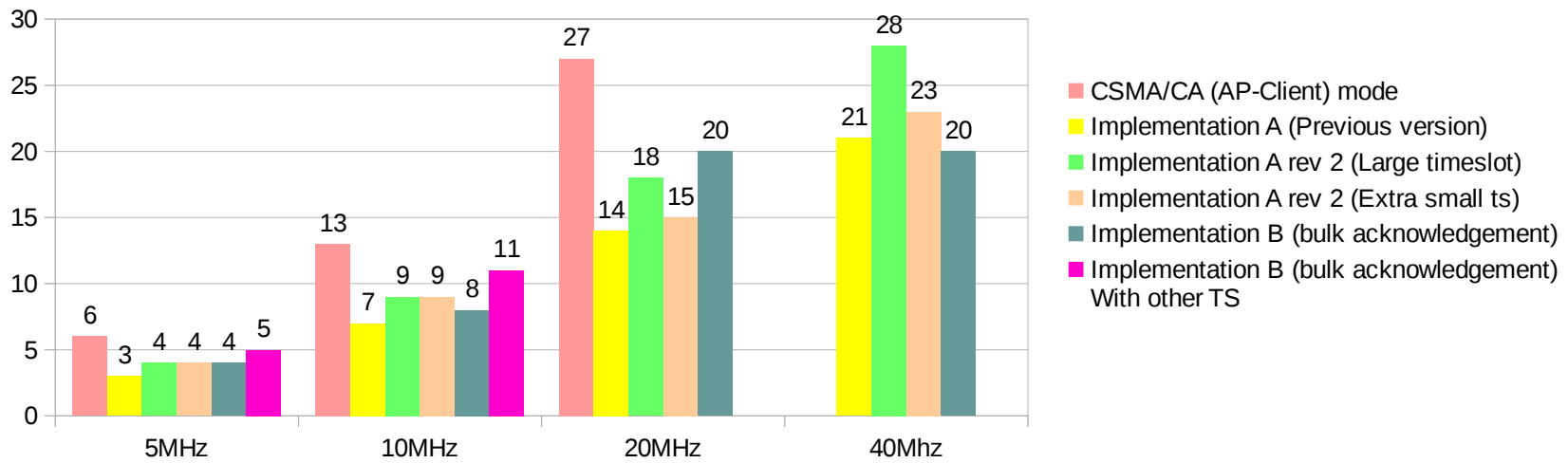
Channel width	RSSI	Timeslot size	TCP						UDP
			BS->CPE			CPE-BS			
			max	min	avg	max	min	avg	
5 43-49			5,85	5,05	5,35	5,5	5,1	5,35	6
10 43-56			11,75	11,1	11,3	11,8	11,2	11,45	13
20 48-56			23,15	22,45	22,8	23,35	22,6	22,95	27
5 35-38		28	4,14	3,15	3,7	4,4	3,15	3,9	3
10 40-50		18	9,23	7,55	8,87	8,81	7,55	7,97	7
20 42-44		14	16,8	15,7	16,1	16,4	14,5	15,1	14
40 37-53		14	26,2	24,5	25	23,9	22,2	22,7	21
5 41-45		30	5,45	4,4	4,79	4,69	4,57	4,67	4
10 58-61		30	10,7	9,02	9,84	9,84	9,55	9,8	9
20 39-44		30	18,9	17,4	18,1	18,6	17,8	18,4	18
40 44-52		30	26	23,3	25,3	29,5	26,1	28,5	28
5 41-44		29	5,45	4,82	4,97	4,94	4,81	4,87	4
10 55-62		15	9,86	8,39	9,2	9,22	8,92	9,13	9
20 41-44		9	16,6	15,1	15,5	15,6	15,5	15,6	15
40 44-51		9	24,7	23,1	23,6	24	23,3	23,8	23
5 37-40		24	6,08	5,03	5,47	5,39	5,33	5,35	5
10 57-63		16	12,4	10,7	11,5	11,4	11,2	11,4	11
5 36-39		12	5,03	4,19	4,4	4,34	4,26	4,32	4
10 53-63		8	9,44	8,81	9,08	9	8,89	8,95	8
20 40-50		8	21,4	20,1	20,4	20,3	20	20,2	20
40 40-49		8	21,2	19,9	20,2	20,2	19,4	20	20

- CSMA/CA (AP-Client) mode
- Implementation A (Previous version)
- Implementation A rev 2 (Large timeslot)
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- Implementation B (bulk acknowledgement)

TCP throughput per node



UDP throughput per node

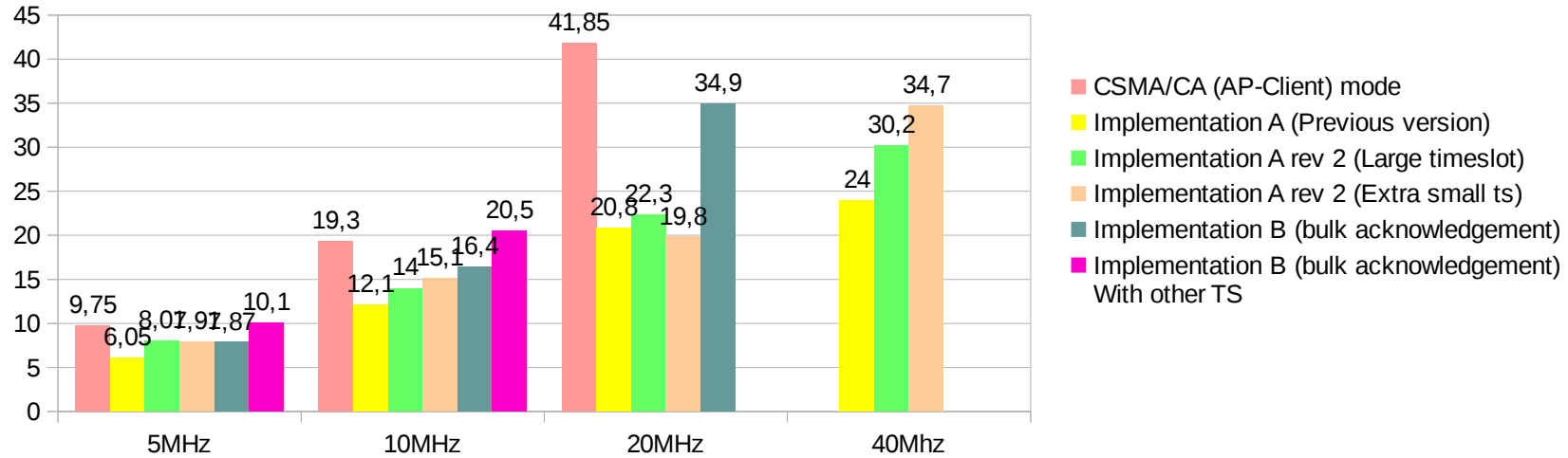


ALFA N5 board with AR7240 CPU and 32Mb of RAM. MIMO-2. Frequency 5180MHz. Automatic power settings.

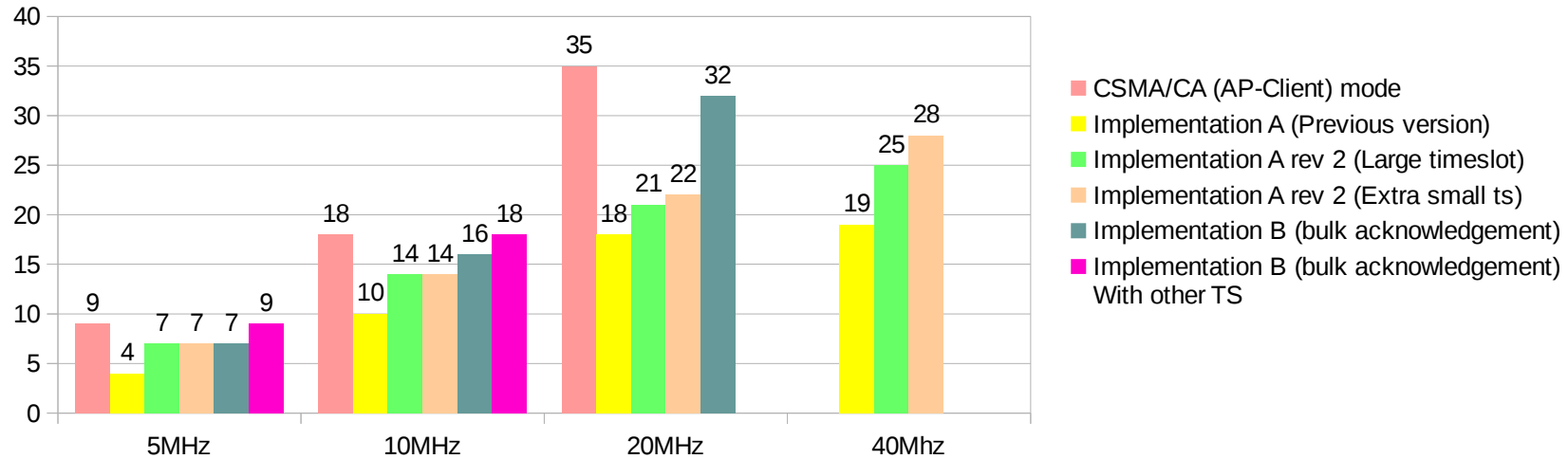
Channel width	RSSI	Timeslot size	TCP						UDP
			BS->CPE			CPE-BS			
			max	min	avg	max	min	avg	
5 20-29			10,4	9,4	9,75	10,4	9,4	9,75	9
10 24-31			20	18,95	19,3	20	18,95	19,3	18
20 28-35			42,3	40,75	41,85	42,3	40,75	41,85	35
5 34-40		28	7,13	5,03	5,79	7,13	5,45	6,05	4
10 37-44		18	13,6	10,1	11,5	13,4	10,1	12,1	10
20 35-45		14	22,6	19,5	20	22	20,1	20,8	18
40 36-42		14	25,8	21,8	24	24,7	21,8	23,1	19
5 18-27		30	9,02	7,55	7,91	8	7,55	7,9	7
10 21-30		30	15,7	14,3	15,1	15,5	14,7	15,3	14
20 24-34		30	20,8	19,1	19,8	21,3	19,5	19,8	22
40 24-35		30	36,9	30,4	35,1	35,5	29,8	34,7	28
5 18-27		29	8,81	7,55	8,01	7,96	7,68	7,9	7
10 21-31		15	15,1	13	14	14,1	13,9	14	14
20 24-34		8	23,9	21,6	22,3	22,9	22,7	22,8	21
40 25-37		8	30,6	27,3	29,2	30,4	30	30,2	25
5 19-26		24	10,9	9,23	10,1	10,2	9,91	10,1	9
10 21-32		16	21,6	17,8	20,1	20,7	19,8	20,5	18
5 20-27		12	8,39	7,13	7,78	7,95	7,59	7,87	7
10 23-31		8	17,2	15,5	16,4	16,5	16,1	16,4	16
20 31-33		8	35,9	33,1	34,9	35,7	31,2	34,9	32
40 24-36		8			14,2			33,3	

- CSMA/CA (AP-Client) mode
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- Implementation B (bulk acknowledgement)

TCP throughput per node

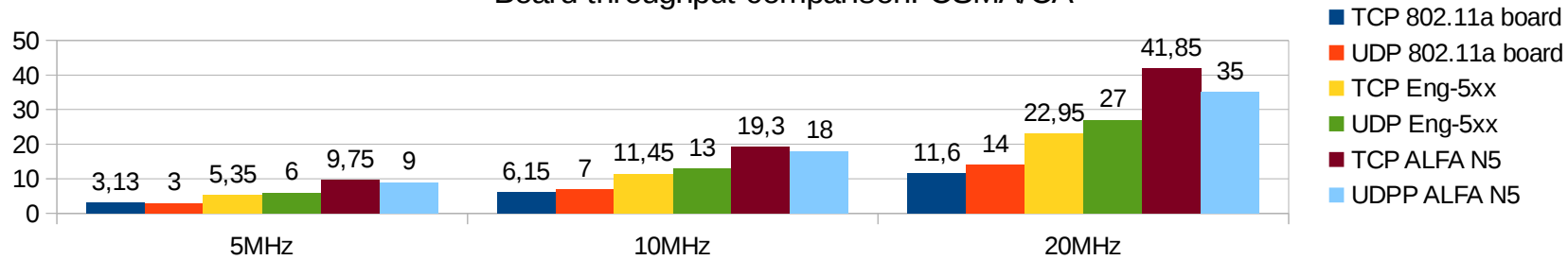


UDP throughput per node

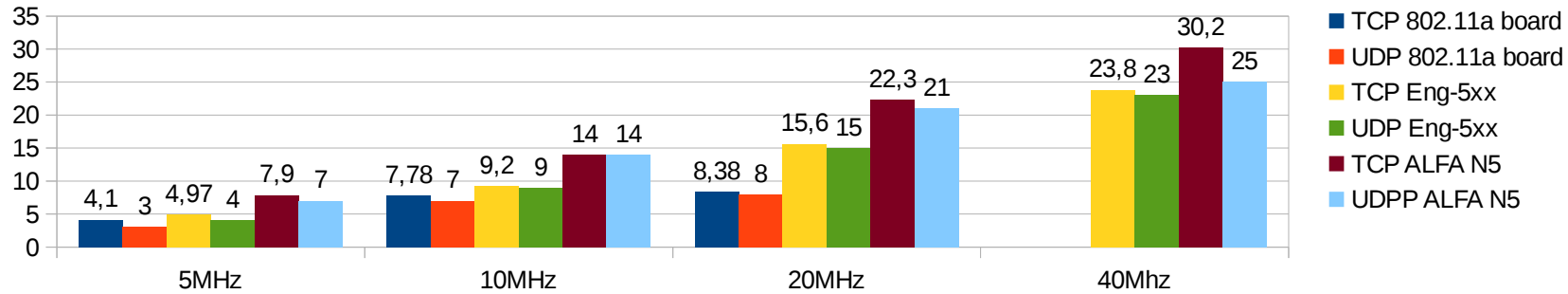


Board's comparison

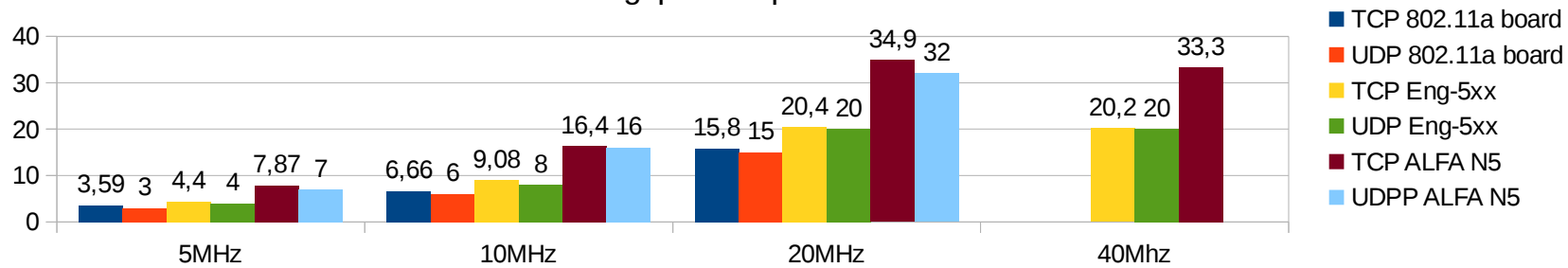
Board throughput comparison. CSMA/CA



Board throughput comparison. TDMA extra small timeslot



Board throughput comparison. TDMA bulk ack



Conclusion

The tests show throughput enhancement in 15-50 percents between implementations without latency increase for the similar hardware platforms.

Throughput for the TDMA mode with bulk acknowledgements is close to the maximal throughput in CSMA/CA mode.

TDMA enabled wireless stack is useful to improve throughput for old systems (ath5k based).

The tests show that the combination of AR7240 class CPU with 32Mb of RAM could not utilize all possible throughput for MIMO-2 modes with 20 and 40MHz channel widths.

The throughput in TDMA modes can be improved during time slot and overhead optimization (especially with bulk acknowledgement).