Perfecting Broadband

Practical Experience with WiFi6 OFDMA

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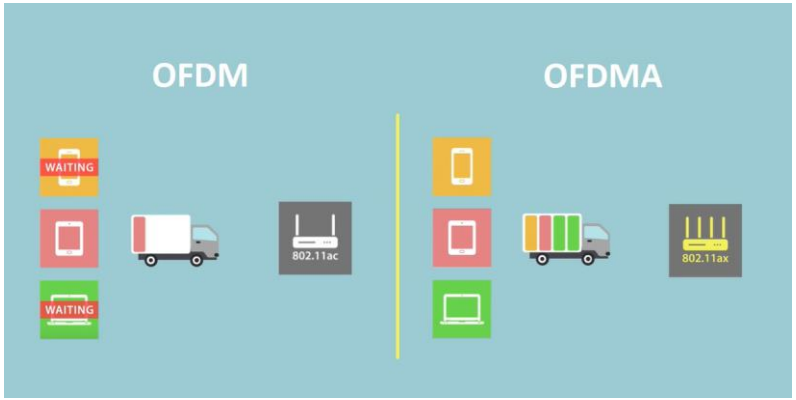
Motivation for OFDMA

- WiFi needs to be deployed in high density environment
- There is a kind of consensus that CSMA/CA would lead to lesser efficiency of airtime
- This leads to higher latencies and lower aggregate throughput overall.

=> Goal was to achieve lower latency and higher throughput

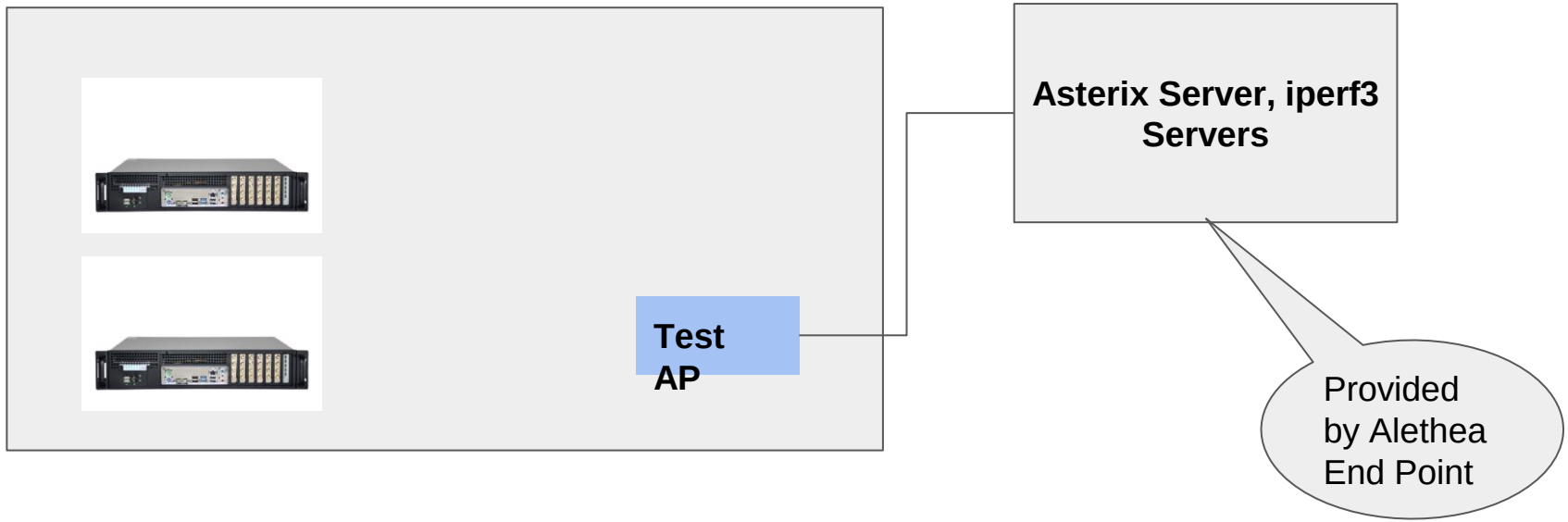
What has Changed ?

- Introduction of RUs with variable subcarriers
- Centrally controlled medium access with dynamic assignment



- MU PPDUs along with other supporting types (Trigger, BSR, BSRP, MU BARs, Trigger Block ACKs)
- It is mandatory to support reception of MU PPDUs by all WiFi Clients

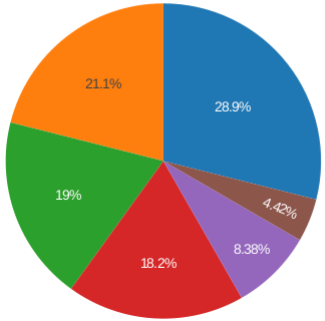
Test Equipment & Setup



Test Equipment and Setup

- “LinA” contains 12 AX200/AX210 cards
- 6 cards can be in STA mode and 6 in monitor mode
- All 12 cards can be in STA+monitor mode.
- Analysis of the captured frames

DL Allocation from OFDMA Frames



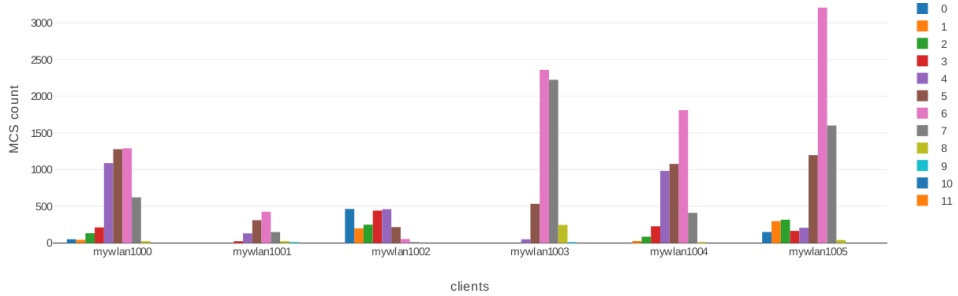
UL OFDMA Stats

No. of SU PPDUs in UL	43064
No. of HE Trigger Data PPDUs	1
No. of Trigger Null Frames	37725
No. of Trigger Block ACKs	10515

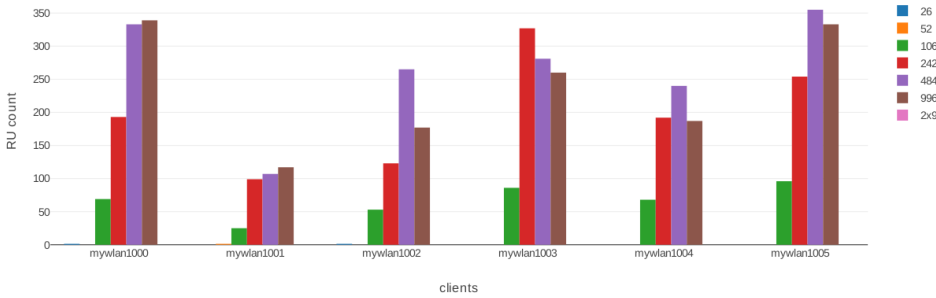
DL OFDMA Stats

No. of SU PPDUs in DL	6454
No. of Basic Trigger Frames	2379
No. of Trigger BSRPs	53916
No. of Trigger MU BARs	111613
No. of HE MU PPDUs	25119

MCS data DL



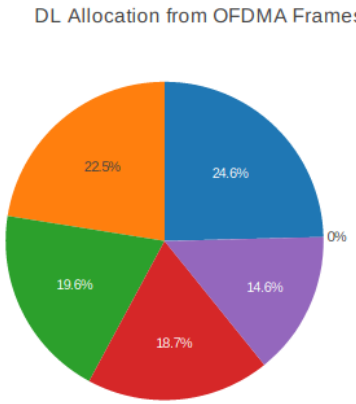
RU Allocation DL



SIP Call Results

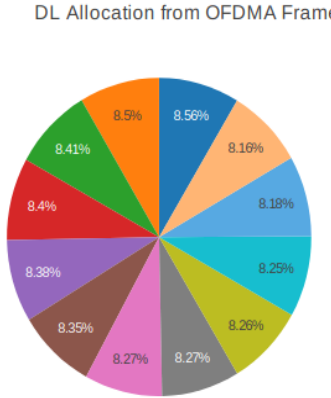
- Test
  - 6+6 SIP calls
  - 12+12 SIP calls

	Latency (ms)	Jitter (ms)	Loss (%)
OFDMA OFF	22.98	17.49	0.04
OFDMA ON	12.62	7.99	0



MU Frames 83%

	Latency (ms)	Jitter (ms)	Loss (%)
OFDMA OFF	85.93	33.64	1.48
OFDMA ON	29.28	19.68	0



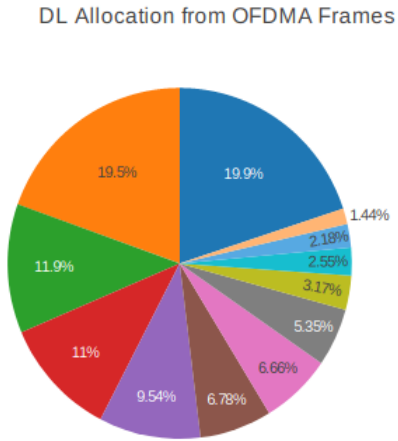
MU Frames 93%

DL Throughput Results

- Test done with iperf3 and a ping running in parallel for 12 clients

	Aggregate Throughput (Mbps)	Latency (ms)	Loss (%)
OFDMA OFF	507	104.87	2.69
OFDMA ON	423	79.53	3.1

MU Frames 11%

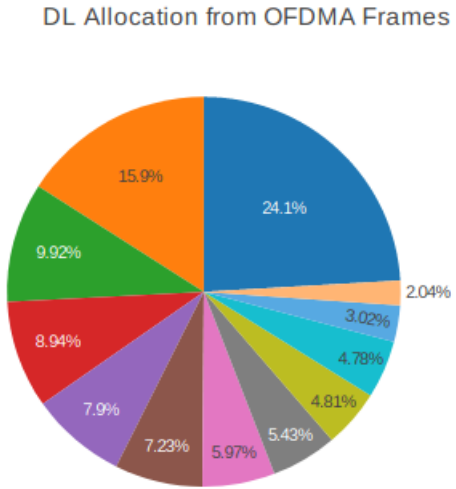


UL Throughput Results

- Test done with iperf3 and a ping running in parallel for 12 clients

	Aggregate Throughput (Mbps)	Latency (ms)	Loss (%)
AP1 OFDMA OFF	635	200	4.35
AP1 OFDMA ON	539	220	4

MU Frames 68%



DL+UL Throughput results

- Test done with iperf3 and a ping running in parallel for 6 clients clients

UL	Aggregate Throughput (Mbps)	Latency (ms)	Loss (%)
OFDMA OFF	469	302	4.4
OFDMA ON	413	266	7.9

MU Frames 64%

DL	Aggregate Throughput (Mbps)	Latency (ms)	Loss (%)
OFDMA OFF	47	375	0.7
OFDMA ON	39	214	1.5

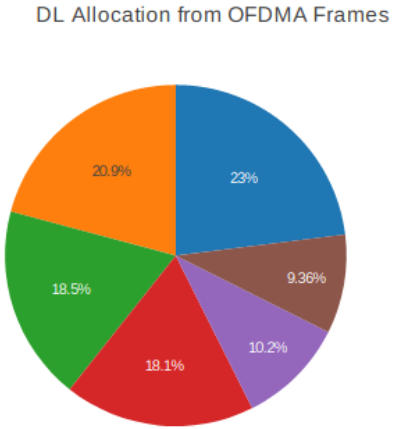
MU Frames 11.6 %

Mixed Traffic Results

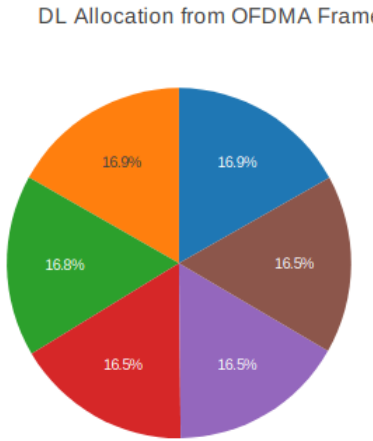
- Test done with iperf3 and a ping running in parallel for 6 clients and SIP Call on other 6 clients

	Aggregate Throughput (Mbps)
OFDMA OFF	395
OFDMA ON	101

MU Frames
3.2%



	Latency (ms)
OFDMA OFF	124
OFDMA ON	30.63



MU Frames
92%

AP Comparision VOIP

- Test done with Simulated VoIP Traffic

	Latency (ms)	Jitter (ms)	Loss (%)
AP1 OFDMA OFF	22.24	10.26	0.08
AP1	10.45	7.28	0
AP2	8.1	9.8	0
AP3	16.9	8.9	0
AP4	1.34	0.34	0

AP Comparision DL TCP Throughput

- Test done with iperf3 and a ping running in parallel for 12 clients

	Aggregate Throughput (Mbps)	Latency (ms)	Loss (%)
AP1 OFDMA OFF	507	104.87	2.69
AP1	423	79.53	3.1
AP2	137	1000	0.463
AP3	688	110	3
AP4	364	62.24	0.32

Summary Thoughts

- UL OFDMA is broken if BSR is not supported by clients.
- DL OFDMA works for small number of clients and less amount of data
- Latency decreases in mixed traffic sometimes at the cost of aggregate throughput
- Better efficiency is with AMPDU/AMSDU at full buffer
- Open question: 500 client tests would they give low latency ?

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Questions ?

Thankyou