Analysis: 802.11ax OFDMA and video stream experience

Since the dawn of WiFi over 20 years ago the only implemented media access method has been CSMA/CA which is built over contention for time slots. WiFi 6 and the IEEE standard which its build on the 802.11ax comes with a new access method OFDMA. OFDMA is no stranger to wireless communications since it has been implemented in cellular networks for many years now and it has proven to a valuable and reliable access method over the years. In the WiFi version of OFDMA the total bandwidth of 160MHz channel is divided into smaller resource units (RU). The smallest is RU26 which contains 26 tones and has an approximate bandwidth of 2MHz and the largest is RU996 which has 996 tones in it and a bandwidth of 80MHz.

OFDMA gives the AP more control over who uses resources and how much of them is allocated to each client. To accomplish this the AP use trigger frames. These trigger frames are also used to sync clients whether it was for a DL traffic so each of them would listen to exact portion of the bandwidth that has its packets or share an UL bandwidth and send traffic over a specific and dedicated portion of the bandwidth without overlapping other clients RUs.

On the UL, OFDMA can prove to be beneficial by increasing the SNR and reducing latency. Multiple clients on the UL can share BW by using smaller RUs that are subsets of the total available bandwidth. Cameras and VoIP clients would gain the most by doing OFDMA on UL. By doing UL OFDMA the AP will guarantee them a small dedicated RU so they do not have to contend for the medium every time they need to upload. Since these clients have low UL throughput (ranges from few Kbps to few Mbps) but low latency tolerance. A dedicated 26 or 52 RU should be more than enough to cover their throughput needs but it will provide vital low latency to insure the delivery of video and voice packets on time.

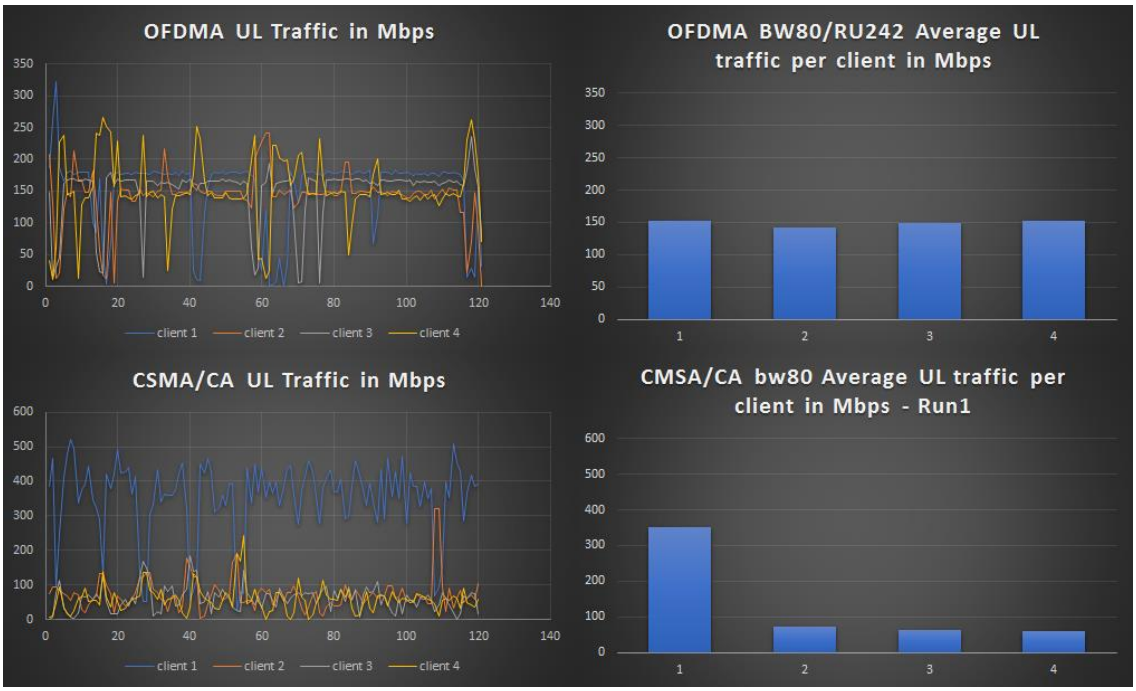
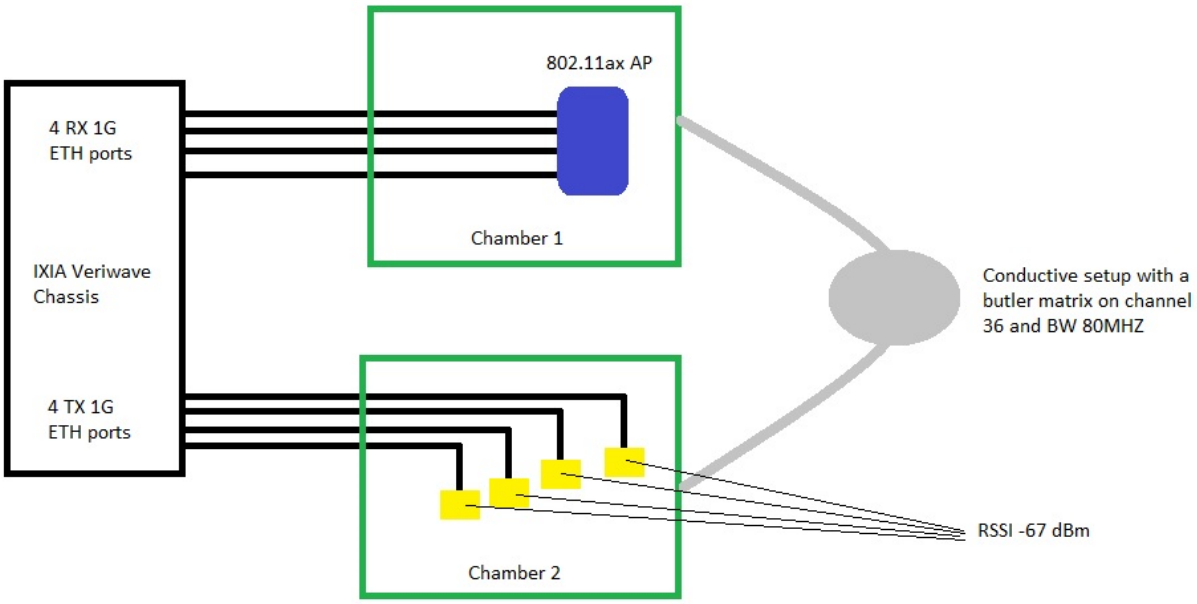


Figure 1

Another indirect benefit that can be seen by doing OFDMA on the UL is the fair share distribution of resources over multiple clients. It manifests itself as a behavior like Airtime fairness but on the UL. Figure 1 shows how by setting 4 2x2 80MHz 802.11ax OFDMA capable clients at -67 RSSI and an average MCS6 they can either contend for the channel and that may result in one of them taking over most of the available Airtime or they can do UL OFDMA in which the AP divide the bandwidth between them which lead to more uniformly distributed throughput.

These results were obtained by using an IXIA Veriwave chassis and their WaveDynimax App. As shown in Figure 2. 4 clients with the BCM4375 chipset are set in an isolated chamber. An 802.11ax AP is set in another chamber. Each client is connected to a 1G ETH TX port on the IXIA to driver the UL traffic. Another 4 1G ETH ports are connected to the AP to receive the traffic.



All 4 clients in chamber 4 are engineering platforsm with BCM4375 chipset. They run Fedora and are configured as NAT routers so they would route traffic coming from the IXIA 4 1G ETH TX ports through their WiFi interfaces which is then routed by the AP back to the IXIA chassis through the IXIA 4 1G ETH RX ports

Figure 2

Antennas are removed on both AP and clients and replaced by cables running through a butler matrix which sums all spatial streams and add a phase shift to simulate multipath. UDP traffic is generated in the IXIA TX ETH ports and routed through the clients from their ETH ports to their WiFi. The traffic goes over the cables and through the butler matrix then is received by the AP. The AP then routes the traffic from its WiFi to the IXIA ETH receiving ports. The Ixia compares what have been sent on the TX ports to what have been received on the RX ports and plots per client throughput graphs.

In a similar setup to what is shown in Figure 2 with the only different is the RSSI level for the 4 clients in which the first client was set at -49dBm, second client at -59dBm, third -70dBm, and the fourth one at -83dBm. The maximum aggregated UL UDP throughput of all 4 clients is tested over variable frame size (64, 88, 128, 256, 512, 1024, 1280, 1518 bytes). 802.11ax CSMA/CA was tested against OFDMA and results are shown in Figure 3.

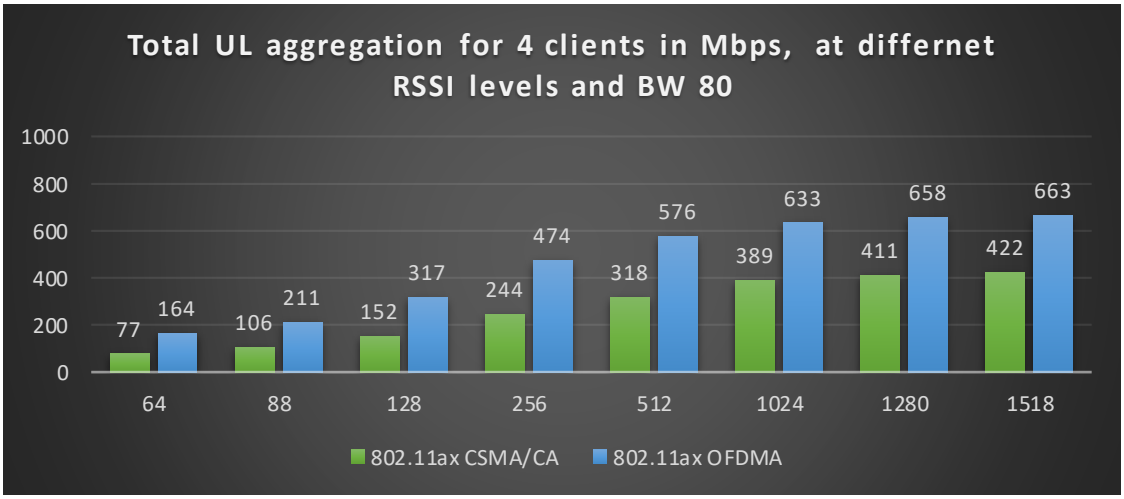


Figure 3

It can be seen clearly from the previous two examples that by using OFDMA on the UL you can guarantee better latency by evenly distributing resources and increase maximum throughput by boosting the SNR level especially for far located clients.

I would like to end this with the results from one of my first and favorite UL OFDMA testing. It's the first time I was able to see the actual spectrum sharing for 2 clients on an 80MHz BW in which each client was scheduled to do an RU484. These were obtained by tapping into the cabling and using a coupler to get a sample what was the client transmitting during while enabling UL OFDMA on the AP. The results are shown in Figure 4, 5, and 6.

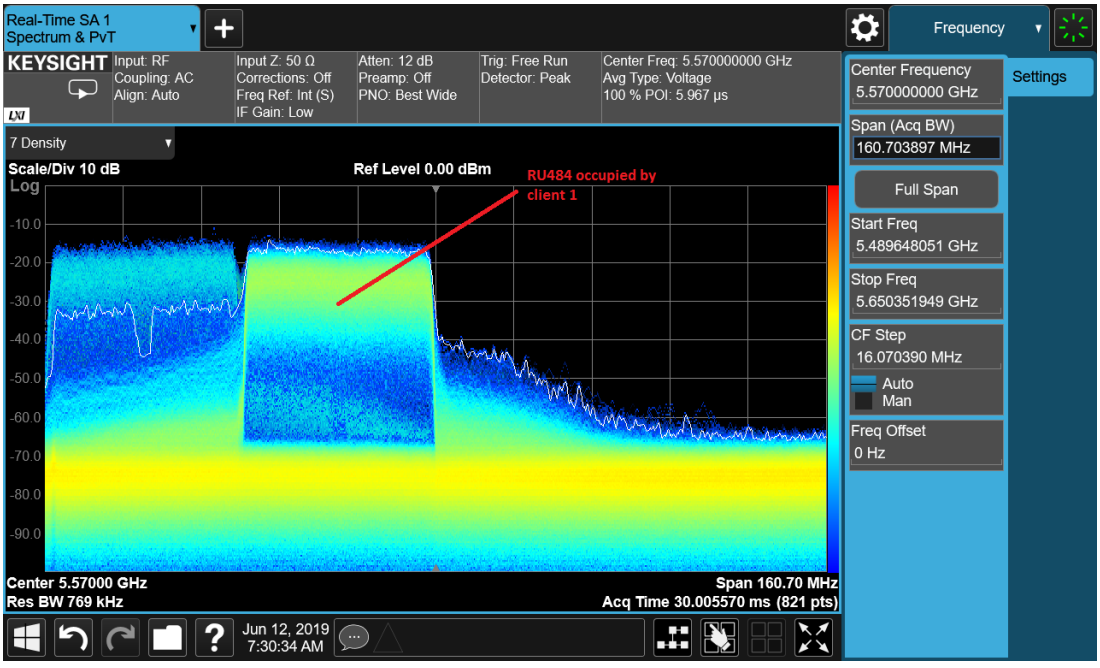


Figure 4

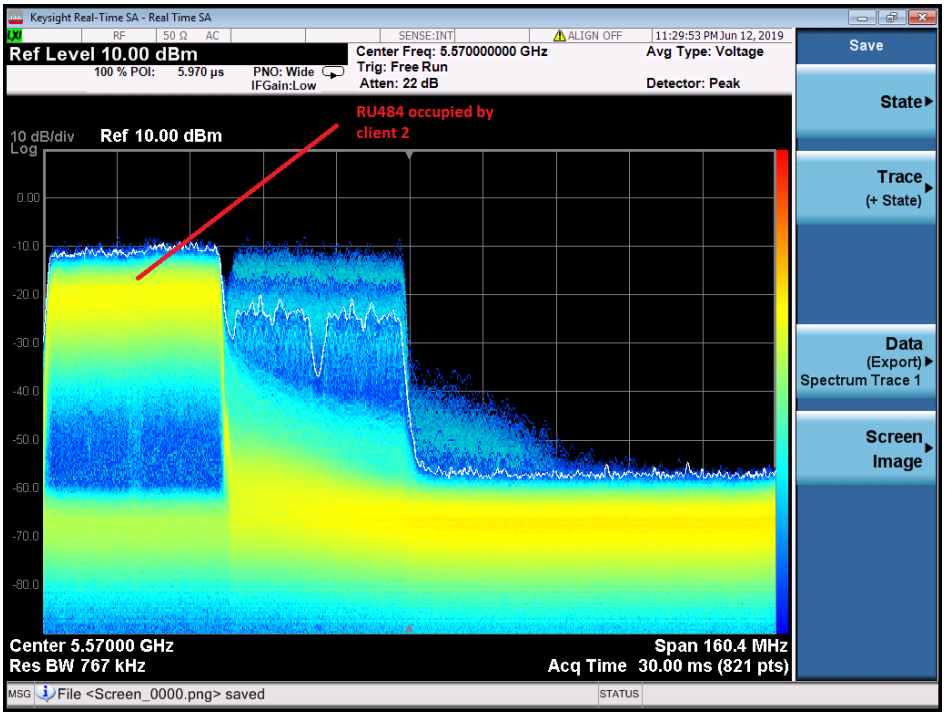


Figure 5

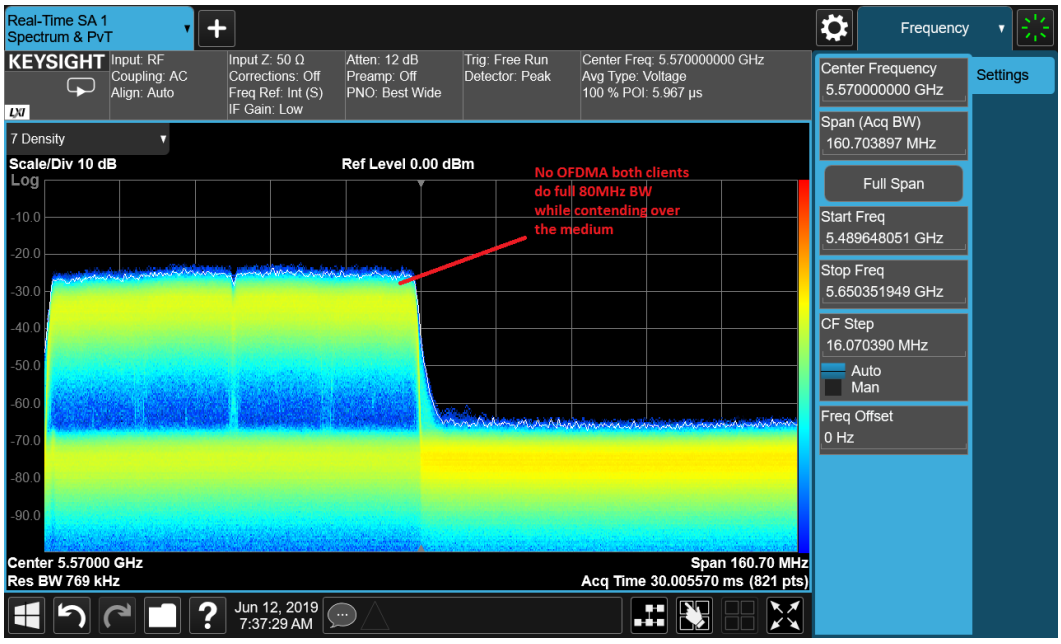


Figure 6