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Are we done yet? Is 802.11ax as far as we need to go for Wi-Fi?

Carol Ansley
Counsel, Senior Director
ARRIS

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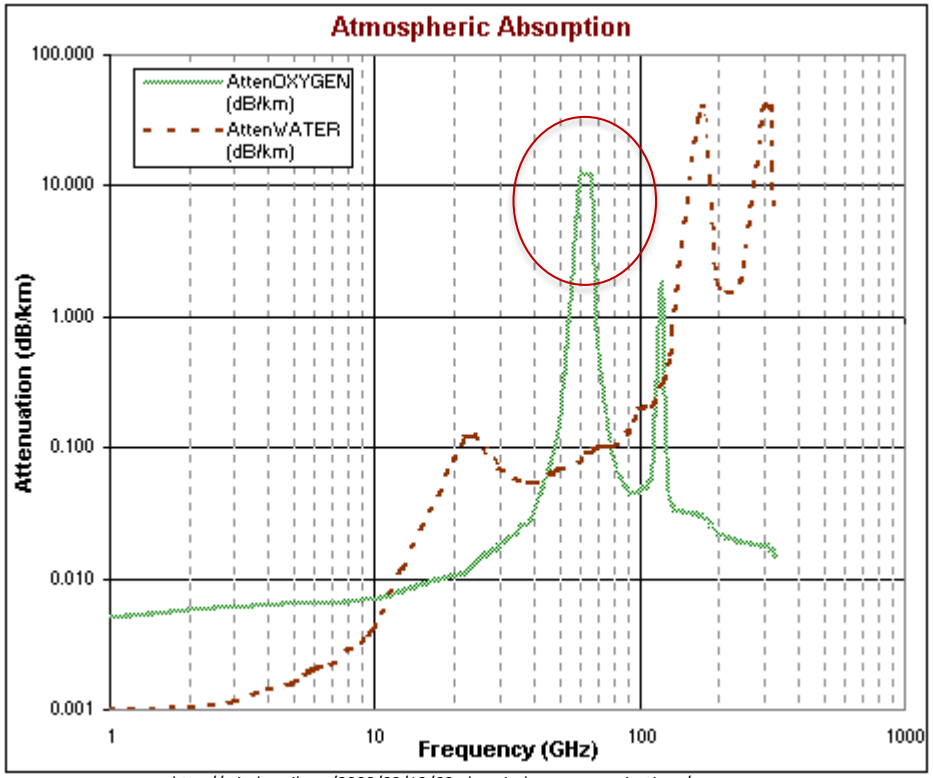
What is 60 GHz, a.k.a. WiGig, a.k.a. 11ad?

- It is part of the unlicensed ISM band (industrial, scientific, medical)
    - Recently expanded by the FCC
- Frequencies from 57 GHz to 71 GHz (14 GHz)

- IEEE 802.11ad™ supports three or four 2.16 GHz bands per AP with up to 7Gb/s of throughput

- The 11ad MAC is very close to the regular 802.11 MAC, but 60 GHz PHY characteristics are very different

- The IEEE 802.11 standards group is working on a new version called 11ay that will support up to 20Gb/s. It should come out in 2019.



http://windowsil.org/2008/03/13/60-ghz-wireless-communications/

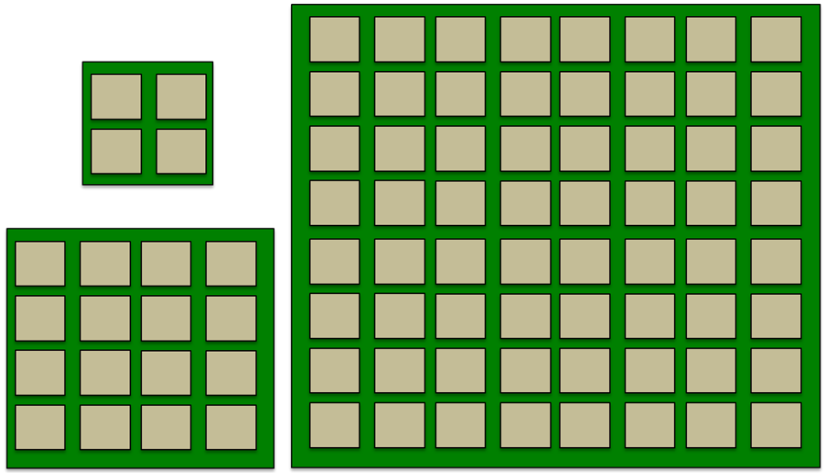
60 GHz Transmission

Oxygen absorption peaks in the 60 GHz band

The latest 7 GHz addition by the FCC adds frequencies with lower O_2 absorption

Advantages:

Promotes secure transmissions indoors as signal leakage is small

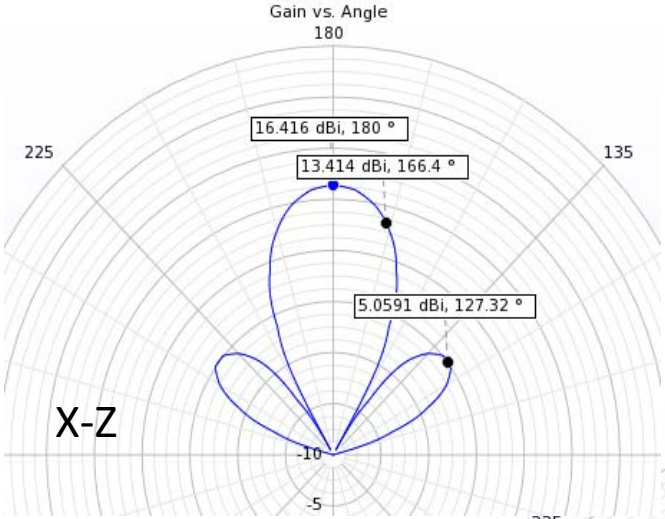


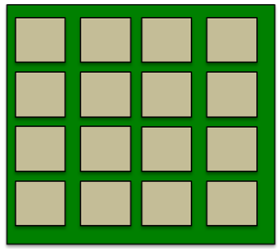
60 GHz Antennas

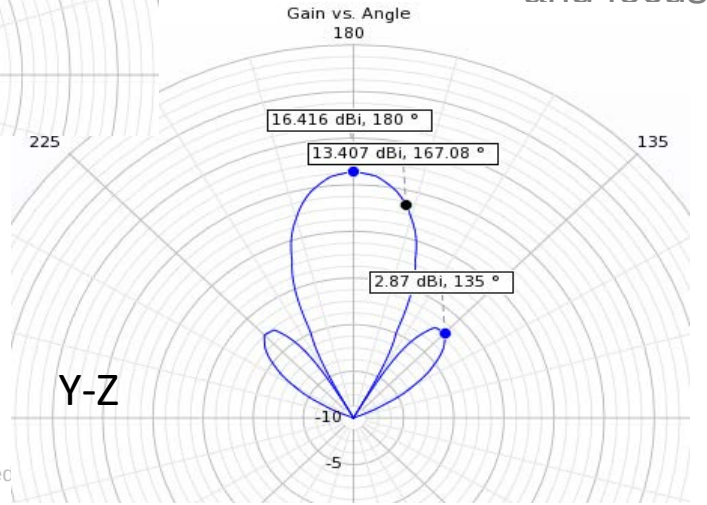
In the millimeter frequency band, the antennas we're used to for Wi-Fi get too small to be practical

Instead, antenna arrays are the way to go.

Bigger arrays give you more directivity, but also add complexity since each patch antenna must be driven separately.







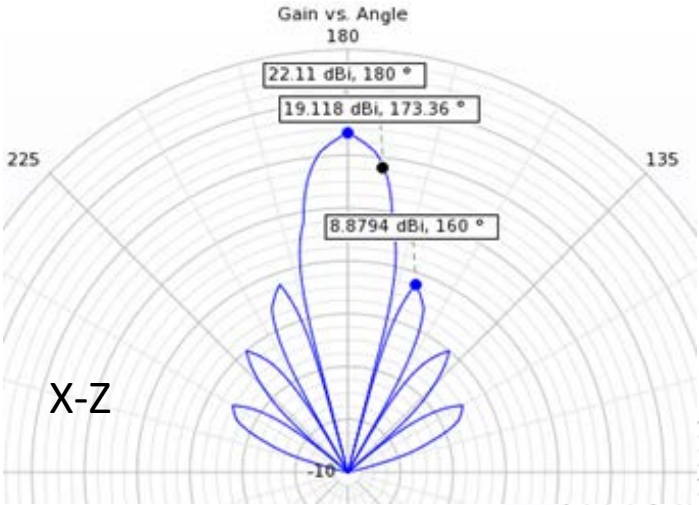
60 GHz Antennas

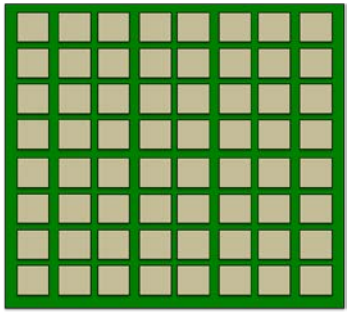
Example 4x4 array polar plots from Georgia Southern University study.

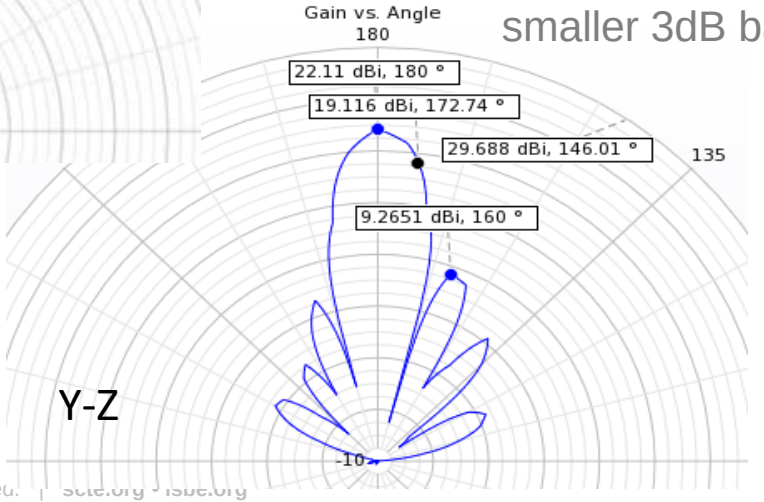
These plots show the high level of directivity and focus that arrays can provide

16.4dB gain peak

26º of arc 3dB bandwidth







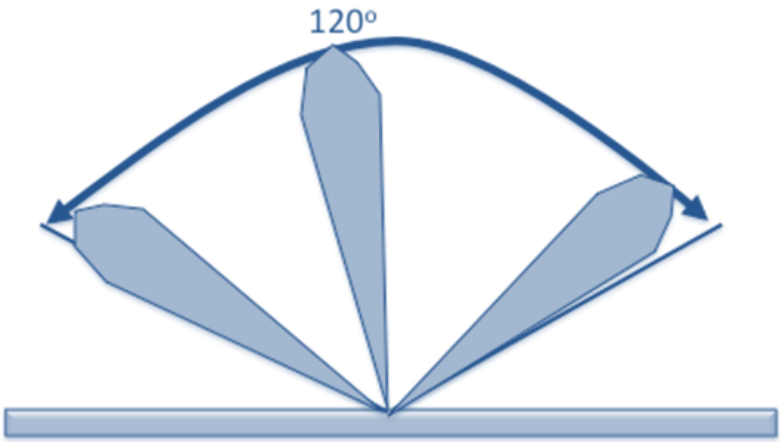
60 GHz Antennas

Example 8x8 array polar plots from Georgia Southern University.

More elements give more gain, but a smaller 3dB bandwidth

22.1dB gain peak

13.3º of arc 3dB bandwidth



60 GHz Antennas

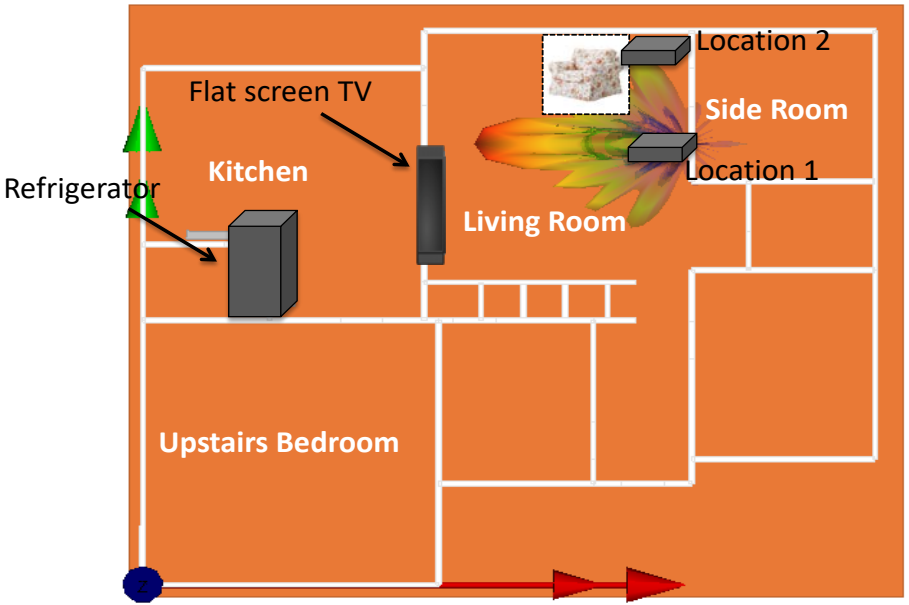
While beamforming is an important part of 11ad, a single array has some limitations compared to the beamforming we're used to in the lower bands.

Antenna arrays can shift their focus through 120º typically, with beam distortion increasing at the extremes.

Lower frequency Wi-Fi often performs best when placed in the middle of a home.

In Home Coverage

For a simple 60 GHz device, placement in the corner of a room should provide the best coverage.



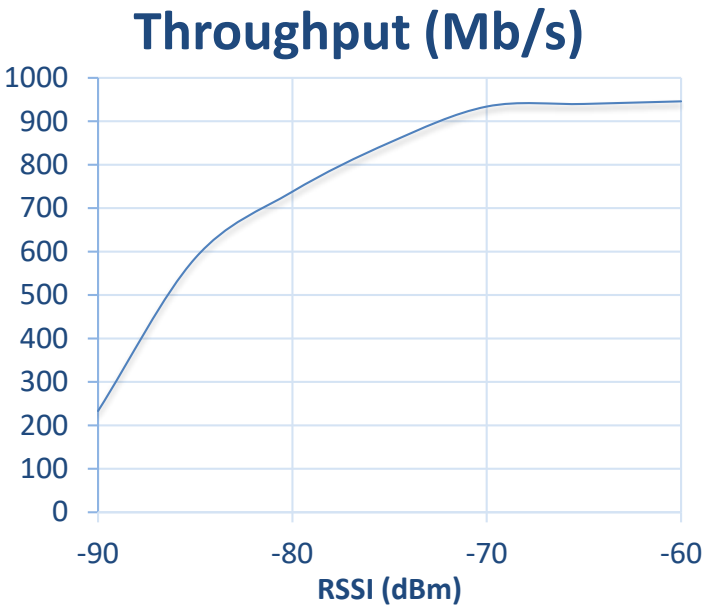
Residential Testing

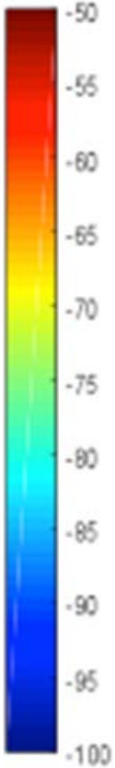
Most of the WiGig testing efforts have concentrated on enterprise environments, which is often very different from the environment of a residential setting.

ARRIS worked with Georgia Southern University to test the performance of WiGig reference design products in the ARRIS Wi-FI test house in Suwanee Georgia.

Two locations were tested in the living room of the house. Also a large chair was placed in front of the AP for another test.

The throughput was measured from the AP to a laptop moved around the rooms in a grid.



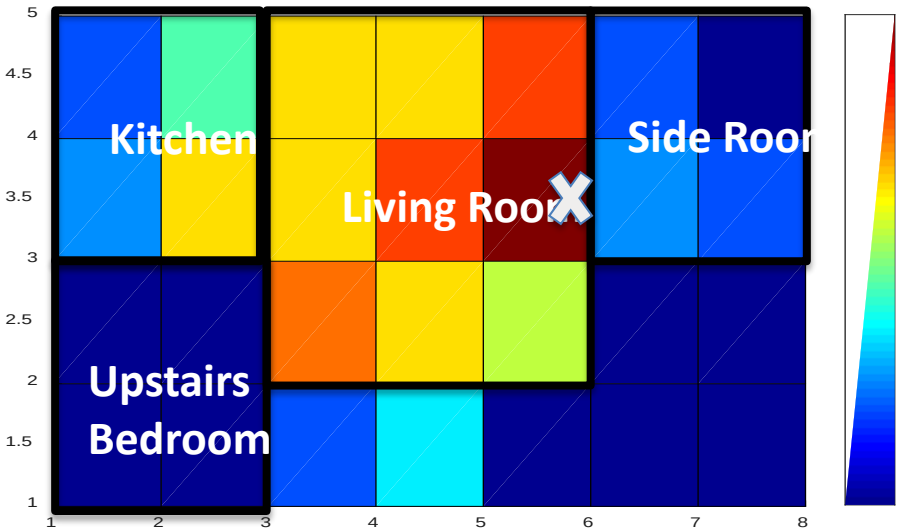


Residential Testing

The results on the following pages are color-coded based on the measured throughput.

Based on additional testing, the throughput levels were matched with RSSI levels as shown in the graph.

For example, a yellow block in the grid means that throughput was measured to a laptop in that position around 940Mb/s.



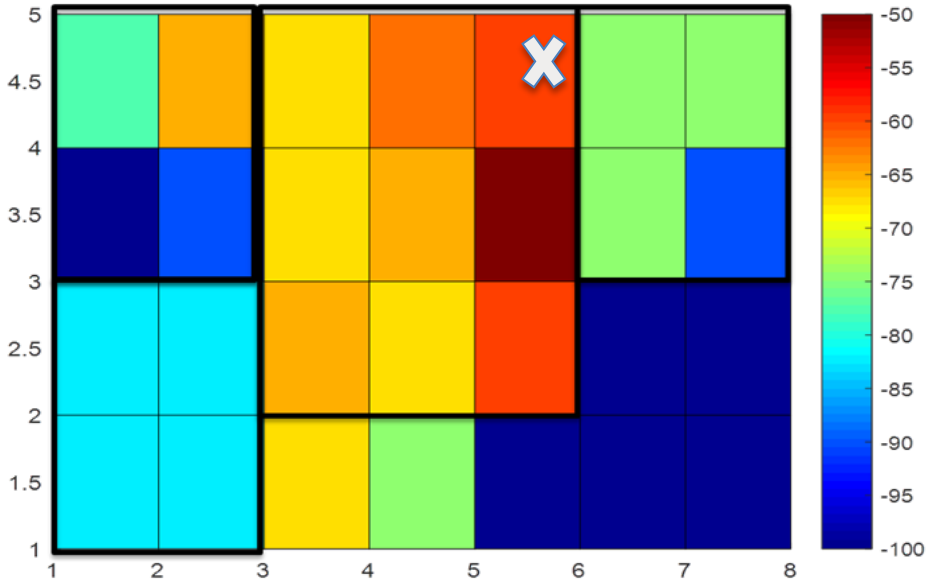
Testing – Location 1

The white X marks the location of the AP for this test.

Colors of yellow or red represent throughput measured close to 1Gb/s.

The side room's relatively low throughput isn't surprising as it relied on reflections from the main room, but was still comparable to standard Wi-Fi (100-200Mb/s).

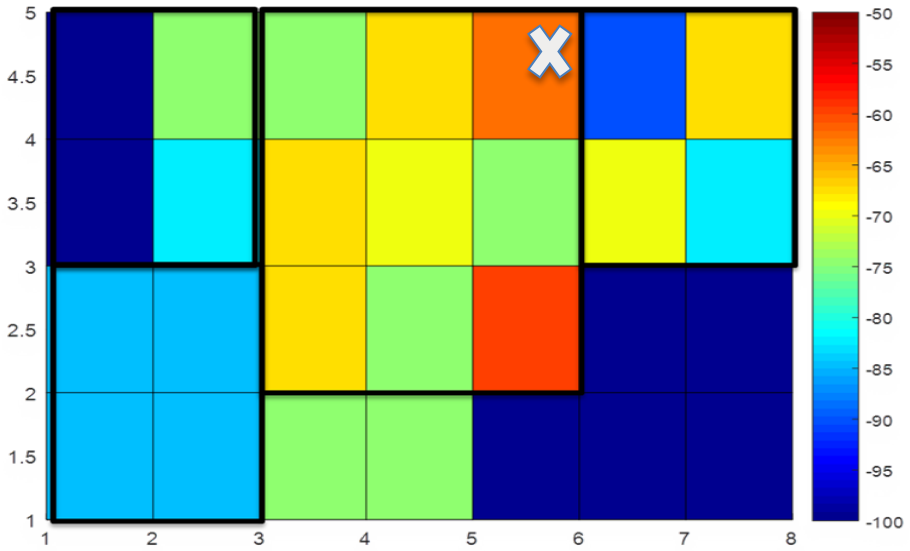
Testing – Location 2



The white X marks the location of the AP for this test.

Colors of yellow or red represent throughput measured close to 1Gb/s.

Reflections from the corner location even provided good results in the upstairs bedroom which was entirely non-line-of-sight.



Testing – Location 2

The white X marks the location of the AP for this test. A overstuffed chair was placed in front of the AP

Colors of yellow or red represent throughput measured close to 1Gb/s.

Reflections from the corner location even provided good results in the upstairs bedroom which was entirely non-line-of-sight.

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THANK YOU!

Carol Ansley
carol.ansley@arris.com
678-473-8630

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