Cambium Networks™

802.11AC PRIMER

Is It Really Better?

BETTER – STRONGER – FASTER.

Each new WiFi technology promises the same thing. Do we really need to upgrade the network to 802.11AC? Why?

WHAT PROBLEM ARE WE TRYING TO SOLVE?

MORE DEVICES

Since 2010, there are an average of 25% more mobile devices each year. In some markets, such as hospitality, the growth rate was over 100% year over year from 2010 through 2013 and continues to grow year over year faster than the market average. The high number of mobile devices increase the RF noise, create interference and can even block devices from connecting.

HIGHER DATARATE SERVICES

Internet video streaming now consumes 40% of prime time Internet traffic, and growing. Additionally, voice over WiFi calling is supported on every carrier network. Higher datarates and lower packet latency is required to support new services such as video streaming and voice.

RAPID CONSUMER ADOPTION

This problem is rarely discussed, but consumers change mobile devices on average every 18 months. Business travelers change devices even more frequently. As new technology is adopted on the mobile device, the wireless access point must remain current to support the new protocols on the new devices.

Thus the challenge is to increase the speed and network capacity (number of devices connected at low error rates) for all new and legacy mobile 802.11 wireless devices.

SPEED = CAPACITY

802.11AC is simply faster than 802.11n. Side-by-side, expect that an 802.11AC network will run at least 4x faster than 802.11n. A typical 802.11AC mobile devices will have two antennas, support up to 80MHz of 5GHz RF spectrum, and support at least 256QAM.

MORE DEVICES

Since each mobile device can get its data faster, 802.11AC frees up more air time to connect more devices. More air time allows more mobile devices online with less contention.

HIGHER DATARATE SERVICES

A typical 802.11AC smart phone with 2 antennas has an effective throughput over 500Mbps. This can be easily demonstrated by any lab test. When sharing this bandwidth, more phones can get the data they need with low latency. More devices, streaming higher bitrate content. All on 802.11AC.

802.11AC FEATURES

802.11AC introduces several enhancements to the 802.11n standard. However, not everything in 802.11AC standard is mandatory. Here's a list of popular 802.11AC features:

VHT Frames (mandatory)	includes new packet aggregation and adds support for the optional features noted below.
Channel bonding (mandatory)	bond 2 or 4 20MHz channels. Increase speed 2x
Channel bonding (optional)	bond 8 20MHz channels. Increase speed up to 4x
256 Modulation (optional)	increased speed by 33%. Effective range: ~10m
Airtime Fairness (optional)	faster for legacy 11n and new 11ac
Explicit TxBF (optional)	Standardized Beamform increases effective RF power
MIMO streams (optional)	2, 4, or 8. increase speed up to 4x
MU-MIMO (optional)	transmit to multiple clients simultaneously

Most Enterprise WiFi vendors such as Cambium Networks implement all the mandatory and optional features of the 802.11AC specification. However, not all features are useful in every network – so Cambium Networks offers purpose-built access points with features targeted to a specific use case.

SUMMARY OF EACH 802.11AC FEATURE

VHT FRAMING

VHT frames in 802.11AC include new packet aggregation and new code rates to increase the effective throughput. VHT frames are required to support the optional features of the standard. For example, VHT frames include the sounding protocols used for beamforming and MU-MIMO.

CHANNEL BONDING

Up to 80MHz of RF frequencies is required by the 802.11AC specification. Up to 160MHz (8 x 20MHz) is optional. Commonly, enterprise networks will use 40MHz, with 80MHz used where interference is not apparent. For the hospitality market and similar high density networks, choose 40Mhz in most cases to maximize the RF spectrum. Cambium Networks 802.11AC can be configured for 40MHz, but will fall back to 20MHz mode if interference and packet loss is detected.

256 MODULATION

802.11n supported 64QAM modulation. With 256QAM, the 4x bit density will increase the data per packet by 33%. When designing to support 256QAM, the clients will need between 30dB and 40dB of signal to noise ratio (SNR).

AIRTIME FAIRNESS

Assuming equal packet priority, older or slower wireless clients can hog the transmit time on an AP. Without airtime fairness, a slower wireless client will require more "time" to get the same amount of data as a faster wireless client. Airtime fairness ensures that all wireless clients have equal access to the transmit time slots. A recent enhancement to airtime fairness is prioritization based on WMM queues.

EXPLICIT TRANSMIT BEAMFORMING

Several vendors created a proprietary version of transmit beamforming. With 802.11AC, a standardized version ensure compatibility with device and access point manufacturers. Transmit beaming is "explicit" because the device measures its own RF space and determines a matrix to help the access point direct the beam. The net effect of transmit beamforming is an increase in effective power to the client, and increased signal isolation when in a high density environment.

MIMO (MULTIPLE INPUT, MULTIPLE OUTPUT)

MIMO is easily the most powerful feature from 802.11n. It allows for a very effective doubling of the throughput by combining multiple spatial streams into one data stream. For 802.11AC, MIMO can now be extended according to the number of antennas used on the access point and device. NOTE: the device can only receive the number of streams according to its number of antenna elements. This means that a 2-antenna smart phone cannot receive 8 streams from an 8-antenna access point.

WHAT DO THESE NUMBERS MEAN?

Some access points are listed with "x" and ":" characters separating numerals.

For example: **2** x **2** : **2**

Reading from left to right, these numbers mean:

FIRST DIGIT is the number of transmit spatial streams.

SECOND DIGIT is the number of receive spatial streams.

THIRD DIGIT (after the colon) is the number of spatial streams that can be combined into a single data stream (called MIMO). Since each MIMO stream requires one Receive stream, the third digit can only be the same or less than the second.

What about **4** x **4** : **4** : **3**?

The first three digits are the same as described above. **THE FOURTH DIGIT** (after the second colon) is the number of concurrent Muli-User streams possible per transmit opportunity. Since MU-MIMO only applies to Downstream transmissions, this spec will only be found on an access point.

MU-MIMO (MULTI-USER MIMO)

There is a disparity between the typical wireless device using 2-antennas and the maximum capability of an access point to have 4 or 8-antennas. MU-MIMO attempts to put the extra streams on the access to good use. With MU-MIMO, an access point can transmit 2 streams to one phone, and 2 stream to another phone. At the same time. There are several caveats that apply however.

- Since the client must create the "feedback matrix" to generate the MU transmission, the client should be static, or moving very little. A person walking and carrying a MU-MIMO device will be in constant state of RF change and negate most of the MU benefits.
- The client must dedicate more CPU time and power to measure its RF subchannel energy and calculate a "feedback matrix". This extra time and CPU consumes more power. For this reason, most smart phone manufacturers have determined there is little benefit to offset the higher battery and CPU consumption.
- Under best of circumstances, MU (multi user) and SU (single user) packets are transmitted by the access point. SU packets are used for management frames, for other 802.11AC devices, and for legacy devices in the network. All upstream packets are SU.

CAMBIUM NETWORKS802.11AC ACCESS POINT MATRIX

	E410	E430W	E600	E500
802.11AC radio	2x2:2:2	2x2:2:2	4x4:4:3	4x4:4:3
Multi-User MIMO	yes	Yes	yes	yes
BLE Beacon radio	No	Yes	Yes	no
Antenna gain	4.25dBi	4dBi	4.25dBi	5dBi
Maximum datarate, all radios	1.167Gbps	1.167Gbps	2Gbps	2Gbps
Maximum Transmit Pwr	25dBm @ 2.4G 25dBm @ 5G	22dBm @ 2.4G 21dBm @ 5G	25dBm @ 2.4G 25dBm @ 5G	29dBm @ 2.4G 28dBm @ 5G
DFS certified	Yes	pending	Yes	Yes
MESH to other APs	Yes	Yes	Yes	Yes
Auto-RF / Auto-Channel	Yes	Yes	Yes	Yes
OKC, 11R	Yes	Yes	Yes	Yes
Enhanced Roaming	Yes	Yes	Yes	Yes
Number of Ethernet ports	1	4, 1 with PoE-out	1	2, 1 with PoE-out
Integrated Hotspot	Yes	Yes	Yes	Yes
Integrated diagnostic tools	Yes	Yes	Yes	Yes
CnMaestro Cloud Managed	Yes	Yes	Yes	Yes
Standalone Managed	yes	yes	yes	yes
Special Value	General use, high performance 11AC	Wallplate, easy to install	High Density, max performance	LTE co-existence outdoor, easy deployment
List Price, USD	$225.00	$295.00	$325.00	$425.00

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