White Paper

IEEE 802.11ac in Service Provider Wi-Fi Deployments: Consider More Than Speed

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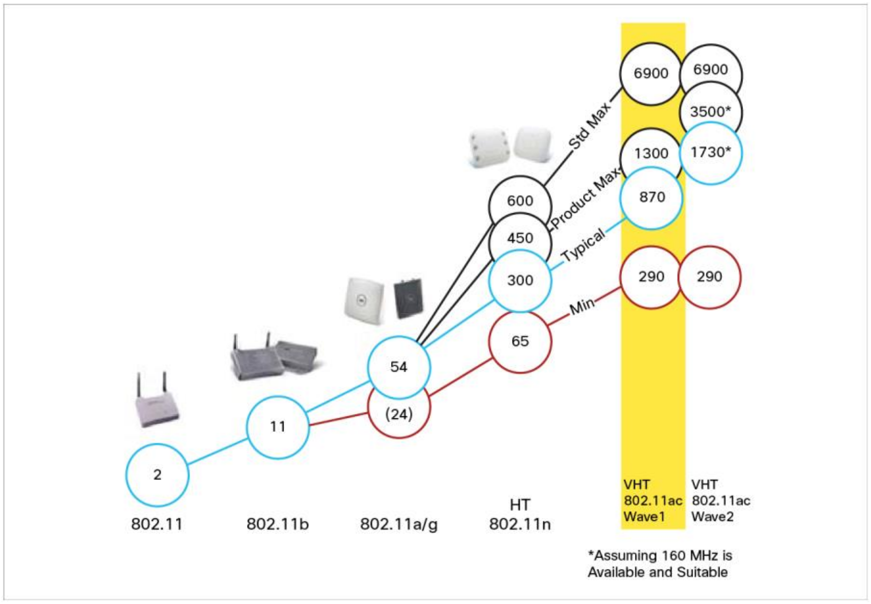
What You Will Learn

Service providers that deploy or upgrade to IEEE 802.11ac-compatible access points get a number of advantages. Top speeds are the most widely publicized and are impressive (Figure 1), but other advantages of 802.11ac-standard devices address reliability, range and throughput. This document examines the multiple advantages of the IEEE 802.11ac features and discusses additional factors to consider for deployments, including backhaul requirements and density.

Figure 1. IEEE 802.11 Speed Evolution



IEEE 802.11ac

IEEE 802.11ac is the most recently ratified radio standard in the 802.11 series. Like its predecessors, this standard includes backward and forward compatibility for 802.11a/n. The 802.11ac standard only applies to the 5-GHz spectrum. The standard has been broken into waves of functionality, starting with Wave 1, Wave 2, and the final amendment. Now that both waves have been ratified, discussions of 802.11ac functionality refer to all Wave 1 and Wave 2 features.

The major addition to 802.11ac is 256 quadrature amplitude modulation (QAM). It adds up to 33 percent more throughput, but comes at a price. The price is a higher received signal strength indication (RSSI) and signal-to-noise ratio (SNR) requirement, which translates to smaller diameter cells.

The next major element is a standard beamforming mechanism that obtains feedback from the client device. Known as explicit compressed feedback (ECFB), it provides an estimate of the channel performance at both the access point and client.

Another major feature that enhances cell performance is multiuser multiple-input and multiple-output (MU-MIMO). This feature allows an access point with single-spatial-stream clients to transmit parallel streams to multiple clients to provide better downstream performance.

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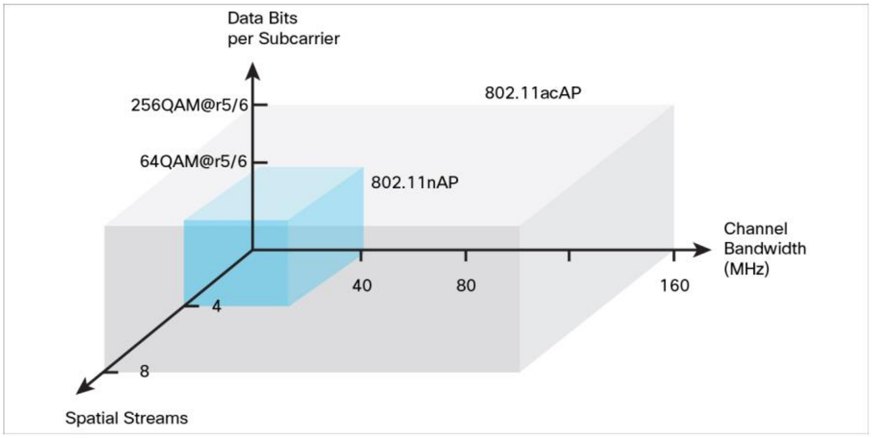
Additional features of 802.11ac are expansions to some existing 802.11n functionality (Figure 2). The 802.11ac standard now requires mandatory packet concatenation to improve throughput with MAC efficiency. The standard expands channel bonding from 2 to 8 channels. This change can effectively quadruple throughout but requires many channels of clear spectrum. The last major difference is the expansion from 4 to 8 spatial streams. These expansions can double the throughput of a cell.

Figure 2. 802.11ac Extensions Over 802.11n



Together, these enhancements can take a Wi-Fi hotspot up to a 6.8-Gbps physical rate and nearly 4.9 Gbps of data throughput. These results are achieved, of course, in a perfect world.

Real-World Deployment

The effect of new 802.11ac functionality in a real-world deployment will depend on the environment in which cells are deployed and the capabilities of the client devices. This section examines the pros and cons of each enhancement.

Initially, the intended use of 802.11ac (like 802.11n) was to allow multimedia wireless performance within indoor residential or controlled enterprise environments. The explosion of service provider deployed hotspots, in both outdoor and indoor venues, has taken these standards into more challenging environments.

Client devices will be a major factor in overall throughput. The majority of portable devices do not have enough space to house multiple transmitters and receivers. The lack of this MIMO capability limits the number of spatial streams that can be sent and received. In reality, even access points rarely have more than a 4x4 MIMO, and client devices are generally in the range of 2x2 or 2x1. The loss of these additional streams will result in a 100 percent drop in total throughput per lost spatial stream. The exceptions to these limits include high-end laptops and, potentially, tablets that can support greater MIMO.

The challenges of outdoor deployments include physical location and co-channel interference. Specifically, most outdoor deployments are located on cable strand or are attached to a building. These mounting locations are generally more than 20 feet from the ground. This distance makes the RSSI too low to achieve 256 QAM. The loss of modulation drops top speeds by about 33 percent. In addition, co-channel interference limits the number of available channels that can provide bonding. This loss of bonded channels can drop total possible throughput by 900 percent.

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Indoor deployments present fewer challenges. The access points are generally mounted at lower heights, allowing for higher modulation rates. Exceptions will still exist in large venues such as convention halls and arenas. These locations can increase signal strength by using directional antennas. Indoor locations should also allow the use of bonded channels, since these are more controlled environments.

In both indoor and outdoor deployments, MU-MIMO will benefit users, particularly in crowded venues.

Backhaul

Hotspot backhaul will need to be reviewed. The potential throughput of 802.11ac radios will generate several hundred megabits per second and will need sufficient bandwidth to handle the potential throughput. The next generation of access points will have two physical gigabit interfaces, and cable modem-based units will be capable of 16x4 and 24x8 channel bonding, which will require DOCSIS® planning.

Deployment Strategies

Using 802.11ac access points will give service providers more deployment flexibility. To increase hotspot speeds, they could simply deploy 802.11ac access points in current 802.11a/b/g/n locations. The upgrade should deliver an immediate increase in speeds, as a result of the 802.11ac enhancements and through the use of increased MIMO radios for legacy 802.11a/g/n. Greenfield deployments will generally benefit from these increases to allow for larger cell sizes. The larger cell sizes may not be straightforward since one also has to consider environmental issues such as interference and hidden and exposed nodes.

Conclusion

Implementation of IEEE 802.11ac should be considered not just on the basis of increased speed, which may or may not be realized in most deployments. Instead, the total benefit from 802.11ac should be examined.

The factors to consider include:

- Increase in the number of 5 GHz clients
- Additional MIMO capabilities to increase performance in 802.11a/g/n clients through maximum ratio combining and beam forming
- Multiuser MIMO for better cell performance in dense user populations
- Packet concatenation for better MAC efficiency

The expected costs of 802.11ac access points will be in line with current costs. The added benefits will enhance performance and customer satisfaction. These should make it a simple decision to deploy 802.11ac in all new deployments and use it to increase performance in challenging locations due to density or RF degradation.

For More Information

For a more detailed explanation of 802.11ac please refer to this technical white paper: [802.11ac: The Fifth Generation of Wi-Fi]

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