As the latest wireless networking products come on the market, smart enterprises will take advantage of their new capabilities.

Executive Summary

The 802.11ac standard significantly improves the performance and scalability of wireless networks compared with existing gear based on the older 802.11n standard. As Wave 2 products for 802.11ac emerge, they deliver vital new capabilities that enable wireless networks to meet the growing demands being placed on them.

In fact, the Cisco Visual Networking Index reports that global IP traffic will reach 11.1 zettabytes per year or 91.3 exabytes per month in 2016 (an exabyte equals a billion gigabytes). Wave 2 of 802.11ac addresses this demand through a series of innovations that include:

- Powerful beamforming technology and support for as many as four antennas to enable multiple data streams
- Sophisticated modulation to pack more information into the wave form
- Innovative multiuser streaming that enables a single access point (AP) to simultaneously serve as many as four different clients

Designed to handle the massive proliferation of mobile devices on enterprise networks, moving to 802.11ac Wave 2 provides assured performance increases that can future-proof busy Wi-Fi networks. Organizations should position themselves to take advantage of Wave 2 capabilities or risk being left behind by the competition. Learn how Spencer-East Brookfield Regional School District upgraded its aging network to 802.11ac, online at cdw.com/wifi.
The Wireless Landscape

When the first wireless networking specification (802.11b) was ratified in 1999, it heralded a revolution that transformed the way devices interact over networks. It delivered a modest 11 megabits per second of specified bandwidth, but in the years since then, wireless networking technology — widely known as Wi-Fi — has expanded and evolved from a consumer oddity into a vital, enterprise-grade tool for productivity.

Today, wireless mobility is ubiquitous, and the number of devices connecting to wireless networks is expanding rapidly. Look no further than the bring-your-own-device phenomenon in the workplace, in which many organizations support the use of personal devices on their enterprise networks. The research firm Dimensional Research found that three-quarters of organizations today allow personal devices to connect to corporate networks. Further, 72 percent of respondents said that the number of personal devices connecting to their corporate networks more than doubled over a two-year span. One-quarter cited a greater than fivefold increase in connected devices.

This represents a daunting technological challenge. Networks must reliably link and serve an increasing number of devices — including the emerging class of intelligent devices that fuel a trend known as the Internet of Things (IoT) — even as they transact unprecedented amounts of data. Fueling the mobile traffic surge are rich, digital voice and video communications, streaming media and a host of business-critical apps transacting data over the air.

The mandate is clear: Wi-Fi networks must be prepared for the harsh demands expected to be placed on them — not just today, but three, five and even 10 years from now. Network gear and devices based on the 802.11ac Wave 2 specification enable IT organizations to do exactly that.

Inside 802.11ac Wave 2

The 802.11ac standard is an important refinement that significantly improves the performance, reliability and scalability of Wi-Fi networks. The new standard leverages the 5-gigahertz radio spectrum (versus 2.4GHz employed by older 802.11n gear) to avoid signal conflicts and boost data rates.

It also employs several techniques that enable access points and devices to transact more data than ever before. In theory, 802.11ac-equipped devices connecting to compliant APs can achieve data rates as high as 6.9 gigabits per second (though there are many reasons why this won’t happen in real-world use). By comparison, 802.11n networks promise peak throughput of 450Mbps. Wave 2 supports speeds up to 2.34Gbps (up from 1.3Gbps in Wave 1) in the 5GHz band.

Over the past year, the 802.11ac standard has emerged in two phases: Wave 1 and Wave 2. While Wave 1 products introduced most of the new capabilities baked into the 802.11ac standard, a few key enhancements are emerging with Wave 2. Wave 1 gear will interoperate with Wave 2 APs and devices, but will not take advantage of any Wave 2 features. To get the full benefit of the latest standard, Wave 2 hardware must be deployed by both devices and APs.

In many ways, 802.11ac is a refinement of the widely deployed 802.11n standard, extending and perfecting many of its innovations. The result: much better performance, improved network capacity and more robust operation. Among the key capabilities of 802.11ac Wave 2:

- **Channel bonding:** 802.11ac expands the two 20-megahertz channels (40MHz total) available in 802.11n, bonding channels together to support 80MHz and even 160MHz operation to transmit more data. Conflicts with other APs and signal sources limit the benefit of the widest channels, but 802.11ac Wave 2 can enable IT organizations to deploy dedicated, high data rate access.

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**497 million**

The number of mobile devices and connections added to networks globally in 2014


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**802.11AC WAVE 2: CATCHING WI-FI’S NEW WAVE**

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**WICKEDLY FAST WI-FI: THE WAY TO SAN JOSE**

When the city of San Jose, Calif., launched its free, outdoor Wickedly Fast Wi-Fi service in 2013, it represented a major effort by the city to improve the way it delivers services and conducts operations downtown. San Jose officials planned for the wireless network to enable free Internet connections for downtown visitors and residents, support pay-to-park transactions at downtown meters and provide robust, digital connections among city facilities.

Two years later, San Jose significantly enhanced that effort, becoming among the first organizations to deploy 802.11ac Wave 2 access points. The city deployed Ruckus ZoneFlex R710 APs downtown, achieving data rates of 445Mbps on dual-stream capable devices and 200Mbps on single-stream smartphones. The MU-MIMO capability of the Wave 2 APs promises to expand network-carrying capacity for the city’s busy downtown core.

“We need to be able to plan and prepare for devices and services we haven’t even seen yet,” said Vijay Sammeta, CIO of San Jose. “Wave 2 represents an investment in a platform that not only meets our current needs, but will also meet those in the future that we can’t even predict.”
**Beamforming:** This enhancement enables APs and devices to employ multiple antennas to shape signals so they are focused toward the location of a connected client. The technique enables higher data rate operation over longer distances.

**Modulation:** Beamforming also enables improved signal modulation in 802.11ac, improving to 256-QAM from 64-QAM available under 802.11n. QAM, short for quadrature amplitude modulation, defines the number of bits that can be embedded in a waveform. The refinement to 256-QAM promises a one-third increase in network throughput over 802.11n.

**Spatial streams:** The 802.11n standard also introduced the concept of multiple antennas driving multiple input, multiple output (MIMO) spatial streams. MIMO splits Wi-Fi data into pieces, so it travels along parallel streams to a connected client. With 802.11ac, the number of available streams can be doubled, to eight.

**Multiuser MIMO:** Perhaps the most important feature of 802.11ac (and available only in Wave 2) is support for Multiuser MIMO (MU-MIMO), which lets an AP transmit to as many as four clients simultaneously. Applicable only on the downstream, MU-MIMO nonetheless promises to act as a valuable multiplier for busy Wi-Fi networks supporting numerous clients. Because a Wave 2 AP can segregate bandwidth for each MU-MIMO client, the result is very similar to what occurs when moving from an Ethernet hub to an Ethernet switch. Higher, more durable data rates and reduced latency combine to significantly improve network performance.

What can enterprises expect from these improvements? The enhancements in 802.11ac Wave 2 combine to multiply the maximum performance far beyond that of 802.11n. While theoretical maximum data rates remain a gauzy myth obscured by signal noise, processing overhead and the need to leave channels clear for other APs, the net impact in daily use is profound.

The first Wave 2 APs are now reaching the market, while the first Wave 2-equipped client devices — mostly notebook computers — are expected to arrive toward the end of 2015. Smaller devices such as tablets and smartphones will become available with Wave 2 equipment in 2016.

Early examples of entry-level 802.11ac Wave 2 APs include the Cisco Aironet 1850 Series AP and the Ruckus ZoneFlex R710 AP. Aruba Networks, an HP company, has released its Aruba 320 Series of APs, which also support Wave 2. These products are outfitted with a pair of 1 Gigabit Ethernet ports to connect to the network backbone.

### The Capabilities of Wave 2

The 802.11ac Wave 2 standard redefines the upper boundaries of wireless network performance and promises to yield more robust, efficient and capable mobile environments. But new Wave 2 products are heralding changes that go beyond the radio waves linking clients and APs.

### Ethernet Effects

With 802.11ac Wave 2, Wi-Fi performance is fast enough that it threatens to outstrip the 1 Gigabit Ethernet that links access points to back-end switches and network infrastructure. In short, Wave 2 shifts the bottleneck from the radio to the cabling, which has huge implications for any 802.11ac Wave 2 deployment.

Ripping out existing cable to move to 10 Gigabit Ethernet is hardly an economical option. According to figures from consulting firm ZK Research, the average cost for deploying a single 100-meter run of Ethernet cable is $300 — a figure that adds up quickly as organizations run multiple cables.

Intermediate efforts can boost data rates over existing CAT 5e and enhance cable speed up to 5Gbps and up to 10Gbps on CAT 6a. Cisco's Catalyst 3850 Multigigabit Ethernet Switches, for instance, leverage technology developed by Cisco and the NBASE-T alliance to enable 2.5Gbps and 5Gbps links. Wave 2 APs with compatible multigigabit Ethernet ports will have ample back-end bandwidth to support even the fastest Wi-Fi connections.

Another Ethernet-related issue that emerges with 802.11ac is Power over Ethernet (PoE), which has been well defined and deployed under the 802.3af specification since 2003. More recently, the 802.3at specification, known as PoE-plust, boosts peak power from 15 watts to 30 watts, to support more numerous and power-hungry network devices. A wide variety of HP switches, including its 2920 series, support PoE-plus.

To learn how CDW helped the Arizona Cardinals upgrade its stadium to 802.11ac, check out our case study at [CDW.com/wifi](http://CDW.com/wifi).
Power over Ethernet helps streamline device deployments, eliminating the need to place APs and other Ethernet-equipped gear near electrical outlets. This flexibility is critical for optimizing Wi-Fi signal coverage over a large area among multiple APs, because the best locations for transmitters are often far from a dedicated power source.

In the case of 802.11ac, the shorter-range 5GHz spectrum may require deployment of additional APs to ensure adequate Wi-Fi coverage. More important, the explosion of wireless clients, including innumerable IoT devices, will likely drive the proliferation of PoE–powered APs.

Enabling PoE-plus will require some IT shops to update or replace existing Ethernet switches and other network gear with products equipped with PoE-plus ports, or to deploy midline power injectors that comply with PoE-plus.

**CDW: A Network Partner That Gets IT**

CDW can assist with all phases of an 802.11ac network upgrade, serving as a one-stop shop for all wireless networking needs. Our network solution architects specialize in integration between the wired and wireless networks, ensuring the best performance while securing data.

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