Trends Reshaping Wireless Networking

Next-generation wireless capabilities are placing new demands on the wired network.

A New Era of Wireless Connectivity

THANKS TO A combination of higher-speed networks and more sophisticated devices, mobile technology has ushered in a new era of connectivity.

Consider this: According to a 2014 study by British marketing firm Tecmark, the average person picks up his or her smartphone 1,500 times a week, whether it's to check messages or access a website. That number is only going to go up as wearables and other mobile gadgets gain traction in the marketplace.

The enterprise is more mobile than ever. Employees, whether they are traveling on business or just logging in from a conference room at headquarters, are using their phones, laptops and tablets to access mission-critical applications. Professors and teachers rely on wireless technologies to teach their classes and interact with students. Healthcare workers use their devices to obtain essential medical data.

This ubiquitous accessibility, however, doesn't come without careful planning. Engineers are wasting little time to ensure their network infrastructures are up to the task. The good news? Systematic upgrades should be more than adequate to meet spiraling wireless demands.

That said, the next generation of wireless technology—802.11ac Wave 2 that supports speeds up to 6 Gbps in the 5 GHz spectrum—beckons. And now's the time to begin the planning necessary to accommodate the demands this specification will place on the network.

The transformation is just beginning and this TechGuide investigates the trends reshaping wireless networking—from back-end infrastructure to the evolving standards—to help you get a better understanding of this ever-changing market. ■

CHUCK MOOZAKIS
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802.11ac Wi-Fi Takes the Lead, but Wired Network Has To Play Backup

ALTHOUGH HE WORKS at a state university, Derek Johnson isn't typically involved in college recruitment. As a network engineer, he deals with packets all the time—just not the ones that deliver pamphlets about dormitory life.

But Johnson, the data communications coordinator at Fort Hays State University in Hays, Kan., discovered several years ago that those two paths would meet when the school invested in campus-wide Wi-Fi in a bid to attract more students. After maintaining several hundred legacy 802.11abg access points (APs) from Enterasys for years, Johnson recognized the network was due for an update. But halfway through a recent 802.11n rollout, it became apparent that the newest generation of wireless, 802.11ac, would better suit the students', faculty's and staff's need for faster Wi-Fi. The 200-acre campus is now blanketed entirely in 802.11ac APs from Aruba Networks.

But such a dramatic overhaul cannot happen in a vacuum. To support the increased speed and capacity that 802.11ac offers, Johnson also upgraded his older 100 Mbps switches to support Gigabit Ethernet. Since the 491 new 802.11ac APs have gone live, bandwidth consumption has increased by 30% in all parts of the network.

As more enterprises and other organizations start deploying the first wave of 802.11ac—which boasts a maximum theoretical throughput of 1.3 Gbps—networking professionals like Johnson are ensuring their wired networks are prepared to support the new wireless standard.

But with many enterprises already having deployed Gigabit Ethernet throughout their wired networks—and with 10 Gigabit Ethernet gaining traction as prices come down—networking pros anticipate 802.11ac will cause incremental adjustments rather than cataclysmic shifts over the next year or so.

With so few 802.11ac-capable laptops and mobile devices on the market, there is no wireless datapocalypse creating an urgent need to run 10 Gigabit out to the AP at this point. An increased reliance on wireless is, however, driving some network engineers to upgrade their core and edge networks to keep up with the ever-growing demand for faster speeds. For many early adopters, their 802.11ac deployments are just one fortuitously timed piece of a broader network strategy.

"If you're taking care of your network today and making systematic upgrades, you'll be fine," says Bradley Chambers, director of IT at Brainerd Baptist School in Chattanooga, Tenn., who is testing 802.11ac APs from Aerohive Networks. "I don't think you've got to rip and replace and put in $20,000 switches if today you're not [already] putting in that nice of a switch."

When Daniel Grim, chief technology officer at the University of Delaware, whose main campus is in Newark, Del., swapped out his traditional phone services for Voice over IP (VoIP) last year, he needed to upgrade his access-layer switches as well. He selected Juniper Networks' EX3300 series switches, which are Gigabit-capable and have 10 Gigabit uplinks. VoIP doesn't require that kind of bandwidth, but Grim needed the switches' Power over Ethernet capabilities. So when he and his networking team deployed 500 of Aruba's 802.11ac APs a few months later—adding to his cache of 2,000 legacy 802.11n APs—he was glad to have that switch capacity already in place.

"In the end, we need it to support the wireless infrastructure," Grim says. "But I can honestly tell you we didn't talk about [needing] this for ac because ac is a recent development."

WILL WAVE 2 CHANGE EVERYTHING?

Even in light of the recent ratification of Wave 2 of the 802.11ac standard—the second and final phase of specifications, which promises maximum theoretical speeds of up to 6.7 Gbps—few foresee an upcoming capacity crisis where the wired and wireless networks meet. Wave 2 also introduces a technology called multi-user MIMO that enables up to four users to transmit data simultaneously, which may require more attention to how that traffic is

backhauled but not for some time. Only a few Wave 1-capable end-user devices are commercially available now, including Apple's latest version of the MacBook Air and Samsung's Galaxy S4 smartphone. It will be several more years before Wave 2-capable laptops, tablets and smartphones hit the market.

With the exception of those networks still harboring older 10/100 Mbps switches, it's unlikely that the access layer will need significant investment to support 802.11ac for most enterprises, according to Andre Kindness, a senior analyst at Cambridge, Mass.-based Forrester Research Inc.

"You hear in Wave 2 that the throughput is going up above a gig, so you're going to hear vendors out there saying, 'You're going to need 10-gig connections to these APs,'" Kindness says. "But I struggle to [believe] that you're really going to get that much going through each AP that you're going to need more than a gig, at least not for a while. ... People don't need to go out today and buy a gig or 10 gig to the desktop."

Johnson, of Fort Hays State University, is considering 10 Gigabit Ethernet for the future, but like Kindness, he isn't convinced that 802.11ac is creating an urgent need to adopt it now.

"I would say eventually we're going to get there, but to be honest, it's probably several years out just because to get the overall high throughput of 11ac, every device would have to support it at the highest level [of the standard]," Johnson says.

Chambers, of Brainerd Baptist School, is also skeptical.

"There's a lot of talk about people's wired networks needing to be upgraded to 10 gig to take full advantage of 11ac. Those aren't bad ideas, but you've also got to look at your ROI for what you're doing," he says. "Do you need to spend 10 times the cost to get moderately better speed? In our situation, no."

With both waves of 802.11ac, however, there are some additional points to consider. Several new buildings at the University of Delaware were designed long before they were due to open last summer. Assuming that they would be deploying 802.11n APs, which only have one Gigabit uplink port, Grim and his networking team designed the buildings' networks to

have only one Ethernet cable run out to each AP. But when the 802.11ac devices from Aruba arrived, they realized something was different about these APs, something that would affect how they designed networks in the future: The devices had two Gigabit Ethernet uplinks.

It was a surprise, but not a setback. A new dormitory set to open in the fall of 2015 will have two Ethernet cables pulled for each AP. If the team sees congestion in the buildings that have pulled just one cable, they will likely just add more APs to even out the load.

"I don't think that we're going to be expecting [that much traffic now], but we want to be prepared for it," says Mike Davis, the university's systems programmer, who oversees the network. "The dual Ethernet provides not only increased bandwidth, but it also in some ways provides redundancy, so that's been one of the driving forces for getting this done."

UPGRADES LIKELY IN BACKBONE

That's not to say next-generation wireless won't affect bandwidth needs on the wired network at all.

Early adoption of 802.11ac is moving faster than it did for 802.11n, according to Infonetics Research, which counted nearly 200,000 802.11ac APs shipped in the fourth quarter of 2013. Meanwhile, the number of users connecting to the corporate network via wireless LAN devices and campus switches is also slated to increase by more than 40% by 2018, reports the Dell'Oro Group, which chalks up the growth in large part to the fast adoption rate it expects for 802.11ac.

All the traffic that follows is likely to hit a chokepoint somewhere, and many networking pros expect that somewhere to be the backbone. The good news is that many IT departments have also recently upgraded their network backbones to meet the requirements of other projects besides wireless or as part of the regular refresh cycle.

Jacob Red, network administrator at the Senatobia Municipal School District in Senatobia, Miss., recently upgraded 55 of the radios in his legacy 802.11abg and 802.11n arrays from Xirrus to support 802.11ac in order to meet the requirements set by the Common Core State Standards Initiative, a set of nationwide

educational standards that include bandwidth benchmarks. The current school year requires all parts of a network to support at least 100 Mbps per 1,000 students and staff—translating into 250 Mbps for Senatobia. But that benchmark is expected to rise to 1 Gbps per 1,000 students and staff by 2018.

The move also drove him to upgrade his backbone switches from 1 Gbps to 10 Gbps, since he anticipates the network backbone will be the most taxed by the increasing traffic 802.11ac will likely bring.

"I can see the connection between our switches getting hit the hardest first," Red says. "As far as servers in-house that we host content on, those will eventually get hit, but we don't have a lot of stuff that gets a lot of bandwidth inside the data center. But I can see [that need emerging] in the next two to three years."

Chin Song, director of technology at the Milpitas Unified School District in Milpitas, Calif., which recently finished beta testing 802.11ac APs from Cisco Systems' Meraki unit, agrees that the new wireless standard is unlikely to be so "radically different" that it will require significant network upgrades outside the normal refresh cycle.

"When we upgraded [our APs to 802.11n], we put in CAT6a wiring for everything, so we have the ability to do a gig and even 10 gig through that copper," says Sean LaRussa, systems manager at the district, which serves 10,000 students across 13 schools. "With that forward-looking mentality Chin had, we didn't have to change anything [for 802.11ac]."

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At the University of Delaware, Grim had already upgraded his backbone to support 10 Gbps across most of the school before he deployed 802.11ac, and he already has his eye on moving to 40 Gbps or 100 Gbps in a few years. He also believes wireless will be driving much of the need for more capacity. But Grim acknowledges the timing of his move to 10 Gigabit was a fluke. Some much-needed grant

money came through, and the price of long-range 10 Gigabit optics had fallen from $4,000 per port to $200 per port within a year.

"I would like to hope the next time around, when we're talking about the next generation of Wi-Fi, we're thinking about this a little harder because Wi-Fi, in our experience, is really what's driving the demand for backbone bandwidth," Grim says. "It really would make sense for us to be designing around what the wired network requires, rather than just happening to put in enough capacity to handle it as a lucky break."

LARGER PIPES, FASTER WAN

Several networking professionals also say they expect the edge of the network—points connecting to the Internet or a wide-area network (WAN)—will also need larger pipes to handle increased wireless traffic if they want to take full advantage of 802.11ac.

"I think for most [people], their bottleneck is still their bandwidth coming into their building," says Brainerd Baptist's Chambers. "11ac is very fast, no doubt, but it ultimately depends on what your client is and what you're connecting to … so if you've got a 50-meg Internet pipe, and all you're doing is connecting to cloud services, 11ac isn't necessarily going to dramatically increase your speed."

Senatobia school district's Red has a Gigabit fiber WAN link and about two years left on the contract with his current service provider. He plans to request 10 Gbps the next time it goes out to bid, and he expects increased wireless traffic to need that bandwidth the most.

"Once they have that gig connection, I can see how your bottleneck is going to be your Internet [pipe] because people are going to start wanting faster connections. It's just a matter of time," Red says.

Grim, who has three aggregated Gigabit links out to the Internet at the University of Delaware, says he's concerned not just about performance, but also about cost.

"I worry that as we get more capacity in the Wi-Fi network that people are going to start using services that aren't local here," he says. "A nightmare I have is that once we put all this traffic on the backbone, what's it going to cost to send it out to the Internet?" —*Jessica Scarpati*

New Wireless Network Capabilities Promise Higher User Capacity

MANY ENTERPRISES ARE experiencing challenges with their wireless network capabilities. With a skyrocketing population of wireless devices and bandwidth-thirsty applications, speed and data capacity have become difficult to keep up with. To meet escalating demand, WLAN administrators can take a two-prong approach: more efficiently use existing channels and tap new frequencies to offload bandwidth hogs. Together, these strategies offer hope to enterprises already approaching the limits of 802.11n.

The most immediate step enterprises can take to boost WLAN capacity is to migrate existing access points (APs) to 802.11ac. Commonly known as Gigabit Wi-Fi, the draft 802.11ac standard further refines advances introduced by 802.11n, combining them to significantly boost total WLAN capacity.

Wi-Fi certified ac products use faster data rates, more tightly packed transmissions, cleaner 5 GHz channels and wider channels to support very high throughput applications such as HD video. Specifically, enterprises can obtain the following improvements by migrating to 802.11ac:

- **Speed.** 802.11n data rates top out at 450 Mbps to 600 Mbps, using three to four spatial streams to deliver traffic. The first wave of 802.11ac products uses the same spatial streams to reach speeds up to 1.3 Gbps. By late 2014, the next wave of 802.11ac products will top out at 6.93 Gbps. But real-world results still depend on client capability and distance. For example, a single-stream smartphone that transmits at 150 Mbps with 802.11n can be expected to hit 433 Mbps with 802.11ac. Because sending data faster requires one-third as much airtime, 802.11ac may permit administrators to see a corresponding increase in the maximum number of users per AP.

- **Spectral efficiency.** Both 802.11n and 802.11ac use quadrature amplitude modulation (QAM) to send data, but 802.11ac can pack four times as much data into each transmission. Unfortunately, 256-QAM only works over short distances and thus will only quadruple capacity for clients within about 20 feet.

- **5 GHz only.** Unlike 802.11n, which operates over channels chosen from both the noisy, crowded 2.4 GHz band and the less-congested 5 GHz band, 802.11ac serves clients in the 5 GHz band only. Due to reduced interference at 5 GHz and related radio frequency engineering advances, 802.11ac devices are likely to experience a better rate over range than their 802.11n counterparts, again increasing total WLAN capacity.

- **Wider channels.** 802.11n doubled throughput by combining two 20 MHz-wide channels into one 40 MHz-wide channel. The first wave of 802.11ac products repeats this by adding 80 MHz-wide channels; next year's second wave will add 160 MHz-wide channels. Fatter channels do not increase available spectrum—the 5 GHz band is roughly 1 GHz wide, no matter how it's divvied into channels. But double-wide channels give high-throughput applications their own express lane in which to move faster, without being impeded by or sapping bandwidth from slower, latency-sensitive applications.

For these reasons, enterprises replacing older 802.11a/g or 802.11n APs with Wi-Fi-certified ac APs are likely to see an immediate increase in WLAN capacity, especially when used by newer smartphones, tablets and notebooks now shipping with 802.11ac. Legacy clients won't reap all of the standard's benefits but may still see some improvement, enabling

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administrators to increase the total number of devices each WLAN can support. When the second wave of 802.11ac products emerge in late 2014, multi-user multiple-input multiple-output will let each AP converse simultaneously with up to four clients, further boosting wireless network capabilities.

ADDING MORE WLAN CAPACITY WITH 802.11AD

Migrating existing WLANs to 802.11ac benefits all Wi-Fi devices and applications. However, certain devices and applications—most notably tablets and video—are very demanding, guzzling limited shared bandwidth. While quality-of-service methods such as Wi-Fi Multimedia (WMM) help to prioritize traffic and avoid starvation, all 802.11ac devices ultimately compete for the same finite patch of 5 GHz channels.

Fortunately, enterprises will soon be able to slake escalating bandwidth thirst by using 802.11ad to relocate bandwidth hogs onto unused 60 GHz channels. The emerging 802.11ad standard—commonly called WiGig—leverages many of the same technologies used by 802.11ac to reach data rates up to 7 Gbps. However, 802.11ad works its magic over a completely different set of channels, thereby increasing the total spectrum available for WLAN use by nearly an order of magnitude.

That said, the 60 GHz channels used by 802.11ad are far more limited in range and penetrating power. But its properties make 802.11ad suited for very high throughput communication between nearby devices, preferably in the same room. Enterprise WLAN administrators may therefore use 802.11ad to expand capacity by offloading devices and applications that thrive under such conditions. Examples include HD video transmission to wall-mounted wireless displays and sustained communication between desktop-replacement tablets and external monitors.

PLANNING FOR CAPACITY

Wi-Fi certified ad products are expected to become available in early 2014. At that point, a growing number of devices will support both 802.11ac and 802.11ad, enabling both short-distance and long-distance high-throughput

communication. Enterprise administrators should therefore start thinking about how and where to best use 802.11ad in the workplace—for example, to offload edge-video traffic from increasingly-consumed 802.11ac APs.

Ultimately, combining 802.11ac and 802.11ad is like repaving a highway while adding lanes—both strategies make it possible for more vehicles to move faster, increasing total capacity. Together, these two standards can help enterprise WLAN administrators design and deploy new and upgraded networks that deliver significantly higher data rates and amplified user density. —*Lisa Phifer*

Upgrade Wi-Fi now, or wait for 802.11ac Wave 2?

ALTHOUGH THE INSTITUTE of Electrical and Electronics Engineers has approved a final draft of the 802.11ac Wave 2 specification, enterprises shouldn't let the news stop them from investing in the 802.11ac Wave 1 products that are already available on the market today.

802.11ac Wave 1 offers up to 1.3 Gbps of wireless bandwidth within the 5 GHz band. 802.11ac Wave 2 promises speeds up to 6 Gbps in the 5 GHz spectrum on wider, 160 MHz channels. Wave 2 will also introduce multiuser, multiple-input, multiple-output (MIMO) technology, which will allow access points to send multiple streams to multiple clients. All previous Wi-Fi standards, including 802.11ac Wave 1, allowed for access points to send multiple streams to only one client at a time.

802.11AC WAVE 2: WAIT OR UPGRADE?

Many IT professionals might delay their investment in 802.11ac technology until Wave 2 products are available, but wireless LANs are dynamic environments, unlike wired infrastructure. And enterprises should stay true to their refresh cycles while addressing their changing network requirements, said Craig Mathias, principal at the Ashland, Mass.-based advisory firm Farpoint Group.

Native 802.11ac Wave 2 access points are most likely still a year or two away, and many network managers will need the bandwidth offered by Wave 1 products before then. "If an enterprise can wait that long for .11ac, then great, but there is an immediate need today thanks to new devices on the network," he said. "Waiting for Wave 2 is a fool's paradise—it doesn't make sense," Mathias said.

Enterprises could benefit from upgrading their wireless LANS to 802.11ac Wave 1 today, even if most client devices are still 802.11n-compatible. Network managers can

operate 802.11ac Wave 1 access points in 802.11n mode for now, as users will experience a boost in .11n performance, Mathias said.

IT professionals already need more capacity on their Wi-Fi networks, leaving them the decision of whether to continue with 802.11n by adding more access points, or migrating to 802.11ac. "Cisco has taken some of those reasons to hold off moving to .11ac away, because the 3700 [access point] with Wave 2 is the same price as the previous generation—the 3600—that supported .11n," said Chris Spain, vice president of marketing for Cisco. "There is really no reason to wait."

802.11ac Wave 1 products have been on the market for about a year—even before the 802.11ac standard reached finalization. And Cisco has already announced a Wave 2-ready 802.11ac modular access point—the natively built 802.11ac Aironet 3700. The modular access point can accommodate a future module for 802.11ac Wave 2—most likely to start shipping in 2015, Spain said.

While the Institute of Electrical and Electronics Engineers has completed Wave 2 specification, the draft won't receive final approval for some time. However, the update probably won't see many changes from now until finalization, and it shouldn't deter enterprises from upgrading, Mathias said.

WHAT FASTER WAVE 2 SPEEDS COULD MEAN

Wave 2 modules or access points require new chipsets, which have already been announced by Quantenna Communications, and are in production with several other chipset vendors. While this technology is expected to be released soon, most 802.11ac Wave 2 access points won't hit the market until 2015. This window will buy time for enterprises to prepare their networks, said Andre Kindness, senior analyst at Cambridge, Mass.-based Forrester Research Inc. Wave 2 access points will

Enterprises could benefit from upgrading their wireless LANS to 802.11ac Wave 1 today, even if most client devices are still 802.11n-compatible.

be capable of hitting the wired network with data flows that exceed 1 Gbps, which means that Gigabit Ethernet edge switches might not be fast enough to receive that traffic.

"There's a good buffer between now and when the [Wave 2] products do come out, so it gives network administrators time to clean up their back-end infrastructure—more throughput might mean an enterprise needs to upgrade their edge switches," he said.

"I would design around Wave 2," he said. "It's going to take some time to lay out infrastructure that will accommodate a move to a pure wireless environment—a move that an enterprise might be considering when employing Wave 2." —*Gina Narcisi*

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