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Considering Wi-Fi 6

Making the Case for 802.11ax

While there are many innovative technologies and solutions being introduced at the network edge, few garners as much interest as the next-generation of Wi-Fi. With over 9 billion devices globally, and 3 billion more being added each year, Wi-Fi is engrained in every area of our lives: home, work, and leisure. Many now view Wi-Fi as a utility – right up there with electricity and water. The thought of having a school, hospital, or stadium without Wi-Fi nowadays is on par with them having no teachers, beds or athletes.

Wi-Fi: Where the Human Experience and 24/7 Connectivity Converge

Today, people tend to value memorable experiences over material goods. This is due in part to the rise of the experience economy: the paradigm of selling goods or services by emphasizing their positive impact on people's lives.¹ When attending a sporting event, staying at a hotel, shopping in a store, or studying through college, consumers have high expectations when it comes to the experience of their personal journey. Every little detail counts, from look and feel to the features and benefits – Wi-Fi included.

The demand for 24/7 connectivity is only getting greater as digital transformation pervades every industry. The internet has shifted from a useful tool to a necessary, integrated component of work and life. In the office, mobile devices, tablets, laptops, and more have been adopted by the masses and employees expect to be able to work anytime, anywhere. At home, if we want to order a pizza or can't find time to go grocery shopping, the solution is a few finger swipes away.

¹ Localist. (2016, November 14). What is the Experience Economy? Retrieved June 11, 2019, from <https://www.localist.com/blog/experience-economy/>

Bringing Humanity into Wi-Fi Across Industries

Technological ingenuity has brought us a myriad of futuristic capabilities, such as artificial intelligence, machine learning, robotics, big data, IoT, and more, which once seemed dream-like. Today, technology isn't just a component of business—it is the business. Reliance on technology is evident everywhere we go, whether to increase availability of information, convenience, or speed. People, applications, and experiences all depend on their ability to connect. Though our always-on digital culture is dominated by technology and connectivity, the goal is to change and deliver new human experiences across industries.

As Digital Transformation Abounds, Wi-Fi 6 is Within Reach

It's clear that Wi-Fi today plays a critical role in our lives. Though the challenges vary slightly among industries, the outcome is the same: **Wi-Fi has reached a pinnacle of critical importance**—and the next iteration of Wi-Fi technology is here. The time to get ahead of wireless to accelerate digital transformation is now.

Wi-Fi 6, or 802.11ax, is High-Efficiency Wireless, the latest generation of Wi-Fi. Where previous generations of Wi-Fi focused on a single device throughput, High-Efficiency Wireless is designed to get more out of the entire system, rather than a single client. The timing couldn't be better, because most of the problems network OEMs and enterprises are running into with Wi-Fi deployments are efficiency-related; a drawback to relying on Wi-Fi 5, or 802.11ac.

"What we would like to see for efficiency purposes is multiple transmissions at a time on a channel, whether it be uplink or downlink. Wi-Fi 6 is clearly a step in the right direction. High efficiency is what's needed at this point."

- Perry Correll, Director of Product Marketing, Extreme Networks

What You Need to Know About Wi-Fi 6

The hype cycle begins with the initiation of any advancement in technology. Promises of a cure-all for a given tech problem pervade the media, and naturally, people get excited. Wi-Fi 6 is well-positioned to meet the

wireless demands of the enterprise, but it's worth noting that most of the technology is already used in other wireless services; it's not new.

The Current Status of Wi-Fi 6

As enterprises evaluate Wi-Fi 6, it's important to understand which components are useful and which are hype. If implemented properly, 11ax has very real potential to positively impact not just high-density networks, but all networks and organizations. However, technology decision makers shouldn't assume the technology will instantly catapult their business years into the future. It is an incremental technology that will improve protocol efficiency, leading to better handling of high client density and application performance.

"11ax is an evolutionary technology, not a revolutionary technology. It gives us another piece of the puzzle with respect to efficiency gains."

- Perry Correll, Director of Product Marketing, Extreme Networks

The 802.11ax Standard

Ratification of the 802.11ax standard is expected in early 2020. However, the exact timing is still uncertain. It's important to note that most significant changes take place in the early drafts of an amendment. As the standard develops, changes decrease in size and scope, thus major modifications to the 802.11ax standard are unlikely to be introduced. Realistically, any changes moving forward will be minor, likely requiring only software updates.

Enterprises should still exercise caution in purchasing early 802.11ax solutions to ensure investments are protected. Networking products being produced currently are based on what manufacturers believe will reflect the ratified standard. It's best to ensure products state "Wi-Fi 6 or Certified." If you see "compliant" or "compatible," you should be concerned that the products may not be certifiable by the Wi-Fi Alliance. Several infrastructure quick-to-market vendors lack a primary Wi-Fi 6 requirement, OFDMA-uplink capability.

Historically, infrastructure vendors tend to go to market first to surpass their competition. On the other hand, client vendors are slower to implement the technology as Wi-Fi 6 is only one component of the new generation of the product, and not the primary reason for a new generation

of phone or other type of device. Despite the official status of the 802.11ax standard, multiple infrastructure vendors already offer 11ax access points, but there are as yet very few clients.

Wi-Fi Alliance Certification

The Wi-Fi certification process is of critical importance because it verifies that a new product has been tested using a diverse sampling of devices to confirm interoperability with Wi-Fi certified equipment. Even though ratification of the IEEE 802.11ax standard is targeted for early 2020, the Wi-Fi Alliance will launch Wi-Fi 6 certification prior to final standard ratification as the standard's technical requirements are firmly established at this point.

The most important features of the 802.11ax standard

"Wi-Fi CERTIFIED™ is an internationally-recognized seal of approval for products indicating that they have met industry-agreed standards for interoperability, security, and a range of application specific protocols."

- Wi-Fi Alliance⁴

will be selected to measure against all vendor products to ensure connectivity in a standard fashion. After the certification is officially prepared for issuance, vendors will undergo interoperability testing through the Wi-Fi Alliance's Authorized Test Laboratories. When a vendor's product passes testing, they are granted certification and the right to use the Wi-Fi certified logo.

To be clear, the IEEE writes the standards; the Wi-Fi Alliance does not. The Wi-Fi Alliance is not a group of people, but a group of vendors who facilitate task groups of industry experts to make decisions and validate interoperability. The Alliance identifies the key components of the IEEE standard that new 11ax vendor products should interoperate with.

11ax Versus 11ac

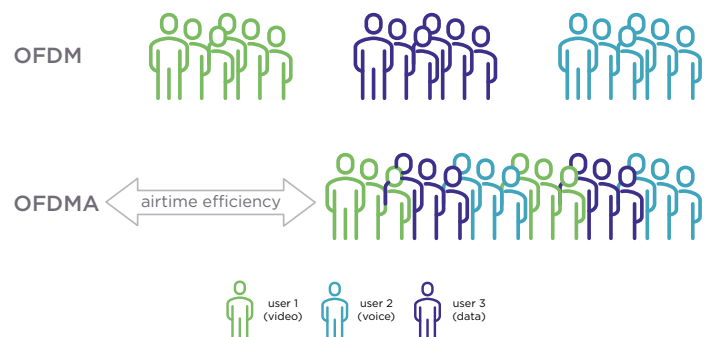
802.11ac is a solid Wi-Fi standard that has done its job well since its inception. The next evolution of Wi-Fi, 802.11ax, is built on this technology, but with several variations, enhancements, and new features. 802.11ac certainly achieved performance improvements, with a theoretical maximum rate of 1.3Gbps.⁵

Fast forward to today, an exponentially increasing demand has called for a new round of efficiency gains. 802.11ax is designed to alleviate congestion, even in highest-density environments, but will also bring numerous other supportive benefits to the enterprise - from optimizing IoT deployments to increasing capacity for videoconferencing.

OFDMA

The pervasive use of mobile devices and data-hungry applications has created an insatiable appetite for Wi-Fi capacity. This is exacerbated in dense user environments such as lecture halls, auditoriums, and dormitories where many Wi-Fi devices contend for the same airwaves. 802.11ax introduces several new technology building blocks to address these challenging environments. The most important of these is OFDMA, an uplink/downlink resource scheduler, designed to manage airtime utilization and improve spectral efficiency.

Orthogonal Frequency Division Multiple Access (OFDMA) is a methodology to allow an RF channel to be dynamically divided multiple ways. For example, it's possible to carve 20 MHz channel nine different ways, leveraging a new capability called resource units, this allows up to nine clients to communicate simultaneously, either uplink or downlink.



OFDMA, has been used in other wireless technologies since at least 2007, is an extension of Orthogonal Frequency Division Multiplexing (OFDM), which takes an RF channel, such as 20 MHz, and rather than using a single carrier-frequency to support a single client, it subdivides the channel to support multiple users simultaneously.⁶

In theory, utilizing OFDMA allows up to 74 clients to share each channel rather than switching between broadcasting and listening on each. In actual use, the number of

⁴ Wi-Fi Alliance. (n.d.). Certification. Retrieved June 11, 2019, from <https://www.wi-fi.org/certification>

⁵ Weinberg, N., & Network World from IDG. (2018, February 27). What is 802.11ax Wi-Fi, and what will it mean for 802.11ac. Retrieved from <https://www.networkworld.com/article/3258807/what-is-802-11ax-wi-fi-and-what-will-it-mean-for-802-11ac.html>

⁶ Network World from IDG, & Thornycroft, P. (2018, October 18). Why is OFDMA a Magical Feature in the 802.11ax Standard? Retrieved June 11, 2019, from <https://www.networkworld.com/article/3315056/why-is-ofdma-a-magical-feature-in-the-802-11ax-standard.html>

simultaneous communications will be far less, actual totals still TBD. From the standpoint of an end user, the network will seem significantly less congested than with 802.11ac.

The ability to take many small transmissions and send them in parallel using OFDMA is a major driver of efficiency. Further, it can be applied to wider channels, such as 40 or 80 MHz. At present, the industry is mainly focused on the 20 MHz channel and subdividing it to drive system-wide capacity, as well as per plot throughout. As is frequently publicized throughout the media, the long-term goal is 4x faster, but this increase will occur progressively over time.

Changes in POE Requirements

With the onset of 802.11ax comes the need for higher power levels with respect to access points. Since 802.11ax access points are higher performing, they have more antenna elements, handle more devices and greater traffic loads. As a result, power consumption increases. In addition, Wi-Fi 6 will affect campus edge connectivity.

Most WLAN vendors with 4x4 architectures will recommend 802.3at (POE+), with limited support at 802.3af (POE). Several vendors supporting 8x8 architecture or other services will require 802.3bt, and some even require dual POE power to the AP.

Increased bandwidth demands generated by 11ax access points has the potential to saturate the current wired edge and require port speed upgrades. The best path forward is to perform due diligence when selecting access points and verify power requirements as your selection of APs may require a significant, and costly upgrade of existing edge switches.

MU-MIMO and Antennas: Comparing 4x4 vs. 8x8 Designs

As the 802.11ax standard nears release, multi-user, multiple input, multiple output (MU-MIMO) is likely to become more popular. MU-MIMO is wireless technology first offered in 802.11ac that is supported by endpoint devices and routers. It's an extension of MIMO, originally designed to increase the number of antennas on wireless routers for receiving and transmitting, as well as improving capacity for wireless connections.⁷

Bandwidth is divided into separate, single streams which share the connection equally. MU-MIMO routers come in 2x2, 3x3, 4x4, and now, 8x8 variations.

Vendors have taken divergent paths in selecting 11ax chipsets, and antenna architecture is one of the significant differences. Some chips support a 4x4 architecture, while others have embraced an 8x8 architecture. There is no real difference in potential network performance or even capacity limits; rather, the only difference will apply to operation in MU-MIMO networks, with 8x8 offering double the number of spatial channels over 4x4. However, full 8x8 MU-MIMO support is not expected on any clients and the full MU-MIMO certification is not scheduled until 11ax Wave 2. In the meantime, 8x8 APs will be more expensive and require significantly greater power at PoE+ or higher and not offer any real performance improvements.

Increased Capacity and Efficiency

While prior generations of Wi-Fi addressed greater performance, 802.11ax addresses greater capacity. It supports more devices simultaneously and makes better use of available spectrum with increased efficiencies. 802.11ax allows different types of traffic (e.g., high bandwidth video, voice, low bandwidth IoT traffic) to be bundled together for more efficient transport.

To use a simple postal analogy: instead of sending separate parcels for each traffic type – often with empty space in each parcel – all the traffic is packaged into one parcel for more efficiency.

Optimized IoT Support

802.11ax supports flexible channel sizes and resource units that allow operators to offer more efficient IoT support and better scale to address the thousands of IoT devices that will connect to Wi-Fi networks around the globe. In addition, IoT devices that require lower data rates can use narrow dedicated channels to save power.

802.11ax also includes support for Target Wake Time (TWT) that will be very useful for IoT devices to improve Client Battery Life. The TWT has first proposed under 802.11h. TWT uses negotiated policies based on expected traffic activity between 802.11ax clients and an 802.11ax AP to specify a scheduled wake time for each client. 802.11ax IoT, as well as other clients could potentially 'sleep' for longer periods of time, providing extended battery life.

Dual 5 GHz Capability

Dual 5Ghz capability in an AP, also called software-configurable radios offers the ability to allow both radios in an AP to operate simultaneously on the 5GHz band. This

⁷ Network World from IDG, & Shaw, K. (2018, January 26). What is MU-MIMO and why you need it in your wireless routers. Retrieved June 13, 2019, from <https://www.networkworld.com/article/3250268/what-is-mu-mimo-and-why-you-need-it-in-your-wireless-routers.html>

allows the AP to take advantage of the additional spectrum available in 5GHz over the 2.4GHz band. It also allows Wi-Fi infrastructure to optimize the network by more closely match the 5GHz/2.4GHz client mix which is typically in the 80/20% range.

When applied to use in a Wi-Fi 6 environment, the ability to have two radios operating in the 5 GHz band on a single radio means that 'client steering' can segregate clients based on their technology. As a result, all Wi-Fi 6 clients can be grouped on one radio with the other radio supporting non-WiFi-6 clients, optimizing the operation of both environments. Additionally, if MU-MIMO is used the performance of two radios operating on 5GHz with a 4x4 architecture exceeds the capability of a single 5GHz radio operating in 8x8 due to spatial separation requirements of clients.

While dual 5 GHz is not a component of Wi-Fi 6, it will optimize network performance.

How 802.11ax Alleviates Wi-Fi Pains

802.11ax certainly brings new features and capabilities to the table, but how does it alleviate the Wi-Fi pains of the enterprise?

Around the world, throughout schools, stadiums, homes, hotels, and airports, people are connecting to the network with multiple devices per person, and in some cases, they're wondering why the wireless is slow. We live in a hyper-connected world, and our reliance on technology, and consequently, Wi-Fi, continues to increase. Here are the primary Wi-Fi challenges that 802.11ax can effectively eliminate.

Wi-Fi Contention

If a network environment has high contention, many clients will be forced to wait for access. Faster Wi-Fi speeds, enabled by the progression from 11n to 11ac, do not reduce contention on their own. Wi-Fi 6 is built to resolve contention through OFDMA. As mentioned, multiple simultaneous transmissions on a channel, whether uplink or downlink, increase efficiency significantly.

Application Performance

Improved application performance is another benefit of Wi-Fi 6 as a result of OFDMA. Real-time voice and multimedia services are enhanced significantly.

Subdividing the channel enables applications that use small frames to be transmitted to multiple endpoints at the same time. This reduces overhead and congestion at layer two and effectively improves application performance.

Improved Network Efficiency - Speed Over Capacity

The assumption that the primary benefit of Wi-Fi 6 is about speed is inaccurate. Rather, Wi-Fi 6 encompasses numerous features designed to increase capacity and lower latency in dense network deployments (Wi-Fi Alliance).⁸ The potential for faster speeds is a natural positive result.

5G Won't Displace Wi-Fi

Wi-Fi is a staple for enterprise connectivity, or as Claus Hetting of Wi-Fi NOW stated so well, "it is the Swiss Army knife of wireless communication, able to support almost any type of device, deployment, market or use case."⁹

It's the default wireless technology in almost any device, and it's not going to change any time soon.

In many ways, Wi-Fi is like Ethernet technology in the 90s; it just works. In the mid-nineties and through the early part of the century, new wired technologies came along to challenge it with advanced features. Frankly, Token Ring, FDDI, and ATM all had technical advantages they positioned against Ethernet, but those technologies never were able to displace Ethernet.

"For more than 20 years, Wi-Fi has been the staple of enterprise connectivity, and it remains so today. Its ubiquity will ensure that even as the wireless ecosystem continues to expand, Wi-Fi will be a core, irreplaceable infrastructure coexisting with the likes of 5G, CBRS, and other next-generation wireless innovations, to connect people, technology and communities."

- Perry Correll, Director of Product Marketing, Extreme Networks

⁸ White paper: High performance, next generation Wi-Fi. Wi-Fi Alliance. 2018. Retrieved June 11, 2019 from https://www.wi-fi.org/downloads-registered-guest/Wi-Fi_6_White_Paper_20181003.pdf/35680

⁹ Hetting, C. (2017, November 23). Our take: The future role of Wi-Fi vs. anything '5G' | Wi-Fi NOW Events. Retrieved June 15, 2019, from <https://wifinowevents.com/news-and-blog/take-role-wi-fi-vs-anything-5g/>

Similarly, 5G and CBRS wireless technologies are not going to fade away like legacy wired technologies. Contrarily, these wireless technologies will play significant roles in operating alongside, or even in cooperation with Wi-Fi.

Compounding Costs of 5G

Different jobs require different tools, and there are multiple areas where both Wi-Fi and 5G excel. One of the best use cases for Wi-Fi is connecting the ever-growing number of Wi-Fi only devices. In a high-density network environment, equipping every single device with cellular technology wouldn't make sense. If any organization has bandwidth-intensive needs such as streaming video or transferring large files, then Wi-Fi is a faster, more reliable option. Achieving the same thing over 5G would lead to an astronomically high bill. 5G simply isn't cost effective for this kind of use case.

Enterprise vs. Carrier Ownership

Other benefits of Wi-Fi don't necessarily come from the technology itself, but the ownership of it. An organization that provides Wi-Fi can garner real-time, analytic insights from their own network. This is beneficial from an IT perspective because it helps identify and solve any network issues that arise, but it can also add real business value.

A retailer providing free Wi-Fi to customers can use an analysis of the data generated to engage with shoppers and optimize services. This wouldn't be the case if the retailer was using a mobile carrier, who would own that data, making analysis difficult. The evolution of Wi-Fi allows those deploying networks to enhance their security posture, and new standards like WPA3, a prerequisite for Wi-Fi 6, are bringing new capabilities to keep networks safe.

Limitations of CBRS and 5G

As far as 5G is concerned, no other technology offers as much mobility and reach as cellular technology. It's available in homes, businesses, cars or simply walking down the street. Cellular technology is almost always there, and with additional advancements offered by 5th generation technology, its value will extend beyond basic connectivity.

Its shortcoming is a significant lack of services beyond the phone, such as with laptops and tablets. Additionally, trying to use 5G as a replacement for enterprise Wi-Fi would result in data traffic transiting the carrier network even if the destination is a local server, which is not an optimal solution.

Then there's CBRS; not a competitor to 5G, as CBRS is expected to become a Radio Area Network (RAN) for 5G services. With respect to Wi-Fi, the implications are similar to those of 5G. CBRS is essentially indoor, small cell operation on a shared license spectrum.

As a result of the above, 5G will continue to dominate the realm of outdoor mobility, with CBRS offering a more reliable cellular service for challenging indoor environments. Wi-Fi has, and will continue to dominate the enterprise and hotspot wireless market due to its simplicity and economical deployment capabilities. Further, with more spectrum expected in the future (6GHz), there is no slowdown in sight. All technologies will co-exist for the foreseeable future.

Wi-Fi, 5G, and CBRS each have individual value propositions and advantages unique to their technology and capabilities that cannot be 100% emulated by alternatives. However, in some cases, another technology can offer a reasonably acceptable level of service, allowing it to support all use cases. All three technologies may be leveraged in the future to design a single wireless infrastructure.

Wi-Fi 6 Buying Tips

In your Wi-Fi 6 evaluation process, consider the long-term, as well as your current upgrade cycle—most networks last five to seven years. When the time comes for an upgrade, you'll have two choices: 11ac or 11ax.

11ac is a proven technology that's been around for several years and will continue to provide the same level of service for the life of a new network. Conversely, 11ax clients are just cropping up. However, in 12-18 months, large quantities of 11ax devices will be commonplace on the network. At that juncture, supporting and taking advantage of greater network efficiency and performance offered by the infrastructure will be viable.

If you're in a very specific vertical industry with a high number of 11ax clients coming in, you should consider making the upgrade. For example, if you're a primary/secondary school system planning to upgrade to new Chromebooks and your product of choice is 11ax, it's best to evaluate 11ax infrastructure because you'll be able to reap the benefits as soon as you onboard the clients.

If your upgrade cycle isn't nearing its end, it won't be cost effective or immediately beneficial to rip and replace all APs because a new 11ax is being released. Altering your purchasing methodology should have a major purpose behind it, otherwise, you're unlikely to reap the benefits.

"Our customers are testing the limits of today's Wi-Fi standards daily at football games, eSports tournaments, emergency rooms, retail shops, college campuses and more. And if there is a failure – if they get it wrong – it won't just be providing a poor experience, they'll lose customers."

- Mike Leibovitz, Senior Director of Product Management and Strategy, Extreme Networks

Don't forget, regardless of the status of the standard and certification, the technology is set. If your organization is considering moving forward with Wi-Fi 6, vendors with certifiable products are safe to purchase from. Be advised that "certifiable" is the key word to look for. Some vendors have rushed to market with 802.11ax products and selected a chipset produced too early in the design cycle; these products will never meet Wi-Fi 6 certification requirements because of an unalterable hardware issue, not a software issue.

Wi-Fi Usage and Challenges Across Industries



Retail

More than **60%** of C-level executives agree that an effective digital/mobile strategy is essential to improve the customer experience¹⁰.

Future-forward initiatives

- Creating a personalized shopping experience
- Making it possible for shoppers to get what they want, even if it's out of stock
- Providing next-level customer service

Digital technologies have significantly altered the way retail consumers shop. With the rise of the internet, social media, and mobility, consumers have particular expectations related to their shopping experience, as well as their access to information to guide them along their path to purchase. To complement the service and convenience of online retailers, brick and mortar stores must attract customers with a superior, value-driven experience.

By leveraging Wi-Fi, brick and mortar retailers can exceed the expectations of today's connected shopper, optimize their in-house operations, and build a powerful business asset to leverage in today's digital society.



Healthcare

90% of healthcare organizations agree that investments in new tools and technology are required to transform healthcare.²

Future-forward initiatives

- Connecting a life flight to doctors on a helipad
- Monitoring the IV pumps keeping a patient alive
- Metering pill distribution and tracking volume to compare with other hospitals and clinics

Technology innovations in healthcare are evolving, aimed at improving the patient and clinician experience while bettering the bottom line. With technologies like AR/VR, robotics, and IoMT becoming an everyday part of the modern intelligent hospital, investing in tools and technologies on an ongoing basis is key to healthcare transformation. As a result, healthcare organizations are facilitating engagement in a transparent, accessible fashion, using patient portals, self-scheduling, online lab result delivery, and email and chat sessions with physicians. It's up to the hospital IT staff to ensure that services are optimally delivered.

In many ways, reliable Wi-Fi means better health outcomes for patients. From ensuring clinical applications stay online to facilitating clinician communications, Wi-Fi plays an essential role.

² Internet of Things (IoT) Healthcare Market by Component (Implantable Sensor Devices, Wearable Sensor Devices, System and Software), Application (Patient Monitoring, Clinical Operation and Workflow Optimization, Clinical Imaging, Fitness and Wellness Measurement) - Global Opportunity Analysis and Industry Forecast, 2014 - 2021. (2016, February). Allied Market Research. Retrieved June 11, 2019, from <https://www.alliedmarketresearch.com/iot-healthcare-market>

¹⁰ PlanetRetail RNG, Personalization Opportunities in Retail Stores, 6 December 2017, Miya Knights <https://www.extremenetworks.com/resources/white-paper/personalisation-opportunities-in-retail-stores-enhancing-customer-experiences-through-location-analytics/>



Education

70% of schools are moving to digital textbooks.

Future-forward initiatives

- Supporting software to help overcome learning challenges
- Powering next-level robotics programs
- Keeping at-risk kids engaged in education

Technology is shaping the primary/secondary education experience for teachers, students, and districts as a whole. From BYOD, to 1:1 computing to cutting-edge tools like smartboards and augmented reality, the way the curriculum is delivered today is vastly different from the past. As EdTech evolves, K-12 school districts must be prepared to adopt new technology that enhances the learning experience.

Higher education institutions face their own challenges. Today's college students are demanding and digital savvy; they want to communicate through social channels wherever they are, and expect access to video lectures, class discussion forums, and assignments from anywhere, at any time. Higher education has to ensure consistent connectivity to students and teachers, provide great sports events experiences, and stay ahead of advances in tech like A/R and V/R, robotics, and more.

Both primary/secondary and higher education campuses increasingly rely on Wi-Fi to enable digital transformation, improve learning outcomes, and meet student needs.



Hospitality and Venues

72% of travelers with smartphones look for the most relevant information, regardless of the travel company providing the information.³

Future-forward capabilities

- Reacting to key events on the property or in-venue in real-time
- Engaging with guests related to their location
- Enabling contextual and personalized marketing

With digital transformation in full swing, the volume of users, devices, and applications businesses need to support today has increased significantly. The demand is taxing Wi-Fi networks and heightening the pressure on hospitality organizations to meet the mobile expectations of guests, in addition to supporting business requirements.

When it comes to hospitality and public venues, Wi-Fi is an expected amenity for guests. It's also a valuable tool for business; a strong Wi-Fi solution establishes a quality guest experience, bolsters guest loyalty, creates mobile engagement opportunities, and overall strengthens the relationship between the guest and the brand. Whether it's a hotel property, retail store, sports venue or casino, Wi-Fi is the key to unlocking a personalized guest experience. A flexible, secure, smart network infrastructure that delivers on Wi-Fi allows businesses to humanize the guest experience and meet connectivity demands.

As a Wi-Fi solutions provider for 28 NFL stadiums, as well as numerous collegiate and pro sports venues, Extreme is an expert in solving the challenging issues of dense, outdoor networking. In fact, we were the first to offer 802.11ax access points that are purpose-built for stadium environments, and we've applied those learnings across our 802.11ax family to empower businesses of all kinds to get ahead of the Wi-Fi curve and support more users, and more devices, more efficiently."

**- Mike Leibovitz, Senior Director of Product Management and Strategy,
Extreme Networks**

³ White paper: Digital Transformation of the Guest Experience. Sabre, Altimeter. 2018. Retrieved June 11, 2019 from http://www2.sabrehospitality.com/digital-transformation?utm_source=PressRelease&utm_campaign=DigitalTransformation