RCR Wireless News
INTELLIGENCE ON ALL THINGS WIRELESS

DECEMBER 2021

The state of Wi-Fi 6 & 6E

By Catherine Sbeglia

Introduction

Thanks to recent updates, Wi-Fi has managed to remain in the spotlight even in a world buzzing with the excitement of 5G, and in many cases, is competing directly with or being used in conjunction with the latest generation of cellular technology.

When 802.11ac, or Wi-Fi 5, was released in 2014, it was the newest, fastest and most reliable version of Wi-Fi. However, 802.11ax, or Wi-Fi 6, was certified by the Wi-Fi Alliance in the fall of 2019. At the time, the Alliance's VP of Marketing Kevin Robinson predicted in a conversation with RCR Wireless News that the certification would mark a significant inflection point in terms of the adoption rate of Wi-Fi 6.

Wi-Fi 6 stands out amongst previous Wi-Fi upgrades in two important ways. The first is that unlike past upgrades, which focused solely on faster speeds and bigger channels, Wi-Fi 6 is about making the network more efficient. The second is the emergence of Wi-Fi 6E, a development considered by many to be the biggest thing to happen to Wi-Fi in the last decade.

Wi-Fi 6E, which refers to extending Wi-Fi 6 into the 6 GHz band, makes an additional 1200 megahertz of pristine spectrum available for unlicensed Wi-Fi use. Further, inefficient legacy Wi-Fi devices won't operate on the 6 GHz band, and therefore, won't bog down the network. As a result, the new technology is expected to be ideal for indoor mesh connectivity, as well as delivering more reliable video streaming and home security connections.

In terms of adoption, Wi-Fi 6 is expected to not only emerge anywhere that Wi-Fi is already being used — which, of course, is practically everywhere — but it will also allow Wi-Fi to go where previous generations of Wi-Fi have rarely gone before, as industrial IoT continues to emerge as a promising area for Wi-Fi 6 because it offers more deterministic behavior than you had with previous generation of Wi-Fi.

This report will explore user adoption and device availability of Wi-Fi 6 and 6E, as well as provide a brief look at what's next for the evolution of Wi-Fi.

What makes Wi-Fi 6 so special?

Spectrum

Wi-Fi 6, just like the version before it, will continue to use exclusively unlicensed spectrum. However, in addition to the 5 GHz band that was used for Wi-Fi 5 (or 802.11ac), Wi-Fi 6 will also use the 2.4 GHz band. Wi-Fi 6 also continues to operate in the 60 GHz band and at 900 MHz (HaLow), which offers longer range and lower power connectivity for low-bandwidth IoT applications.

The generations of Wi-Fi

IEEE Standard	Frequency	Maximum data rate	Year certified
Wi-Fi 1 (802.11b)	2.4 GHz	11 Mbps	1999
Wi-Fi 2 (802.11a)	5.4 GHz	54 Mbps	1999
Wi-Fi 3 (802.11g)	2.4 GHz	54 Mbps	2003
Wi-Fi 4 (802.11n)	2.4 & 5 GHz	600 Mbps	2008
Wi-Fi 5 (802.11ac)	5 GHz	6.9 Gbps	2014
Wi-Fi 6/6E (802.11ax)	2.4 & 5 GHz/6 GHz	9.6 Gbps	2019/2021

The 60 GHz band, in the millimeter wave region of spectrum, is well-suited to deliver multigigabit speeds, but due to limited propagation, its distance is shorter than the other frequencies used by Wi-Fi- 6. Further, the development of Wi-Fi 6E — mentioned previously — delivered an additional 1200 megahertz of spectrum in the 6 GHz band, which, again, is unlicensed.

Features and opportunities

The most obvious improvement that Wi-Fi 6 will offer over previous generations of Wi-Fi is, of course, speed. In fact, when used with a single connected device, maximum potential speeds should be up to 40% higher compared to Wi-Fi 5 — a 6.1 Gbps increase.

This feat of speed is accomplished through more efficient data encoding, resulting in higher throughput. The 9.6 Gbps speed of Wi-Fi 6 is more of a theoretical maximum; however, the beauty of that 9.6 Gbps is that it doesn't have to go to a single device but can instead be split up across a whole network of devices, resulting in more speed for each device on the network.

Unlike Wi-Fi 5, Wi-Fi 6 utilizes a channel access method called Orthogonal Frequency Division Multiple Access, or OFDMA. The method allows for the division of a wireless channel into a large number of sub-channels, with each one carrying data intended for a different device.

For Extreme Networks' Director of Wireless Networking at the Office of the CTO David Coleman, OFDMA is where "you'll get the biggest bang for your buck."

"In the past," he explained, "if an access point [AP] was talking to multiple iPads, it took turns. Now, it can take a channel and divide that channel into four resource units and send data in these smaller sub-channels to four clients at the same time. The bulk of Wi-Fi use is very 'bursty' and low-bandwidth, and this particular technology is good with low-bandwidth applications and leads to better frequency reuse, reduced latency and increased efficiency."

Another key characteristic of Wi-Fi 6 is its use of 1024 Quadrature Amplitude Modulation (QAM), compared to 256 QAM with Wi-Fi 5. QAM combines radio frequency wave amplitude and phase to transmit bits per symbol; the higher the QAM, the more spectral efficiency and the more data throughput. Wi-Fi 6's QAM upgrade enables throughput increases by as much as 25% over Wi-Fi 5.

Wi-Fi 6 also has an improved version of Multi-user Multiple-Input Multiple-Output (MU-MIMO) that lets devices respond to the wireless access point at the same time that involves multiple antennas, which let the access point talk to multiple devices at once. With Wi-Fi 5, the access point could talk to devices at the same time, but those devices couldn't respond at the same time.

Another Wi-Fi 6 capability that will improve performance in congested areas is spatial frequency reuse. Currently, access points near each other that are transmitting on the same channel listen and wait for a clear signal before replying. On Wi-Fi 6, wireless access points near each other can be configured to have different Basic Service Set (BSS) "colors," which are really just a number between 0 and 7. A device on Wi-Fi 6 may notice a transmission with a weak signal and a different "color," and then ignore

this signal and move forward with its own transmission without lag.

"Target wake time" (TWT), a feature that tells the device exactly when to put its Wi-Fi radio to sleep and exactly when to wake it up to receive the next transmission, was also introduced in W-Fi 6, and according to LitePoint's Director of Product Marketing Adam Smith, represents that Wi-Fi is "inching" towards being an industrial technology by introducing the beginnings of a quality-of-service guarantee.

"If Wi-Fi 6 can deliver highly reliable, high quality and high bandwidth communications in this type of factory environment, then it can deliver it almost anywhere."
Tiago Rodrigues, CEO, Wireless Broadband Alliance

"The thing Wi-Fi struggles with in industrial settings is the lack of a managed network concept. But, if you can start scheduling traffic [...] then you can get something a little bit more like quality-of-service guarantee," said Smith, adding that while TWT's primary function is to provide battery savings for IoT products, it also introduces the ability to schedule when a device is or is not communicating with the network.

"And so, the idea of being able to schedule traffic is a step towards being able to say 'ok, here is where I can guarantee a latency.' That concept, previously, wasn't in Wi-Fi," he continued.

The Wi-Fi Alliance's Robinson similarly declared that Wi-Fi has been on "a very steady progression into industrial environments."

"With the addition of OFDMA, where you can mix high-throughput traffic and latency-sensitive small packets, you can schedule those packets in a way that ensures the expected service levels and consistent delivery."

Case study: Wi-Fi 6 in a challenging enterprise environment

In January 2020, the Wireless Broadband Alliance (WBA) announced the successful completion of its phase one trial of Wi-Fi 6 infrastructure and services with Mettis Aerospace, a U.K. designer and manufacturer of precision-forged, machined and sub-assembled components. The first Wi-Fi 6 industrial enterprise and IoT trial of its kind, it proved an important part of the WBA's Wi-Fi 6 test and development program.

The trial took place at the Mettis Aerospace facility in the West Midlands in collaboration with WBA member companies including Broadcom, Cisco, iBwave and Intel, as well as Concurrent Engineering and Keysight Technologies.

Previously, Wi-Fi failed to work in Mettis' challenging factory environment. But, during the Wi-Fi 6 trial, speeds of 700 Mbps using 80 megahertz channels were achieved, and low-latency applications, like video calling and video streaming, performed well latencies less than 6 ms.

"The completion of this initial phase marks a significant

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milestone for the adoption of Wi-Fi 6," said WBA CEO Tiago Rodrigues. "The Mettis facility is an especially challenging environment for wireless communication. Nevertheless, the field tests in this highly charged atmosphere have proven that Wi-Fi 6 technology works well and can play a vital role within the industrial enterprise and IoT ecosystem. If Wi-Fi 6 can deliver highly reliable, high quality and high bandwidth communications in this type of factory environment, then it can deliver it almost anywhere."

The trial utilized devices equipped with the Broadcom BCM4375 and Intel AX200 Wi-Fi 6 chipsets, to conduct tests that included 4k streaming from a webcam mounted on machinery within the factory, 4k YouTube streaming from a laptop with an Intel AX200 chip, uploads of very large video files over Wi-Fi, roaming, latency and persistent connectivity during Wi-Fi video calling using smartphones equipped with Broadcom's BCM4375 chip and augmented reality testing of machinery using devices with Wi-Fi 6 chipset.

At the time, Gabriel Desjardins, director of marketing for the Wireless Communications and Connectivity Division at Broadcom, expressed the belief that this demonstration of "the superior performance, scalability and reliability of Wi-Fi 6" will pave the way for new, low-cost use cases for enterprises around the world.

Wi-Fi 6E: 'A spectrum update, not just a technology update'

The United States Federal Communications Commission (FCC) approved opening up the 6 GHz frequency band for unlicensed use by Wi-Fi 6 technology in April 2020, a decision many called monumental and historic. At the time, the WBA's Tiago Rodrigues said that "Wi-Fi 6E will rewrite the rules of what is possible" and that it will lead to "higher speeds, low latency and service levels that are equivalent to 5G networks."

Wi-Fi 6E promises to deliver faster connectivity speeds and improved capacity when compared to both 2.4 GHz and 5 GHz Wi-Fi, making it ideal for smartphones, tablets, laptops and, perhaps most exciting, virtual/augmented devices. Further, the MU-MIMO capabilities of 802.11ax, or Wi-Fi 6, combined with 6 GHz will create a number of use cases both in the home and in the enterprise space.

When it comes to the home environment, CommScope's CTO of Home Networks Charles Cheevers, sees a huge opportunity for Wi-Fi 6E.

The problem with Wi-Fi 6 in the home, Cheevers explained, is that, at least for now, it has to share the network with several devices that are Wi-Fi 4 or 5.

"You get none of the benefits of Wi-Fi 6 from the scheduling perspective when you buy your first Wi-Fi 6 AP," he commented. "What you do get is 15-35% general improvement, but not the 4 times improvement that is possible.

"But with Wi-Fi 6 in the 6 GHz band, you are getting almost ethernet-like in quality — reliable transmission from one place to another," he said, adding that this has significant implications for gamers, who are often tethered to the wall via an ethernet to ensure the best playing experience.

This, in addition to increased determinism, will finally make consumer applications like AR and VR "work properly," according to Cheevers.

"When you can now do deterministic packet transmission and arrival,

things like AR and VR now become possible on Wi-Fi," he claimed.

Technology manufacturers were particularly excited about Wi-Fi 6E, with chipmakers like Broadcom and Qualcomm quick to develop 6E chips months before the new technology was certified. In fact, in a conversation with RCR Wireless News in May 2020, Qualcomm's Senior VP and GM of Connectivity Rahul Patel said the company is "very excited about Wi-Fi 6E. For us and our customers, we all are very enthusiastic and eager to launch [compatible devices]as quickly as possible."

"It's hard to move into the multi-user mode of Wi-Fi 6 until you get out of [the legacy] spectrum. Spectrum is a huge piece for Wi-Fi to really take the next leap."

Adam Smith, Director of Product Marketing, LitePoint

In addition, Patel claimed that, at the time, Qualcomm already had more than 70 Wi-Fi 6-enabled devices and an additional 200 or so access point and gateway designs.

Then, in December 2020, the FCC certified the first Wi-Fi 6E device, a low-power indoor transmitter from Broadcom, authorized by the FCC's Office of Engineering and Technology. In response to the news, FCC Chairman Ajit Pai issued a statement, calling the authorization "an exciting glimpse of America's Wi-Fi future."

"It's a spectrum update, not just a technology update," Extreme Networks' Coleman recently told RCR Wireless News, adding that 6 GHz operation will "carry Wi-Fi" into new areas.

"I think starting this year and into 2022, in the enterprise space, people are going to take a bigger notice [of Wi-Fi] and be more eager to update their networks [...] simply because they're going to have this new, clean spectrum that was not previously available," he continued.

Smith of LitePoint agreed, commenting that use of the 6 GHz spectrum, on which only Wi-Fi 6 clients can operate, is necessary for a real "game-change move" in how Wi-Fi is used. This is because without legacy clients bogging down the newly released spectrum, the network experiences a significant improvement in density, reliability and throughput.

"Once you're in the 6 GHz band, you're going to be a multi-user, OFDMA-compliant device rather than the ol' wait-in-line device," he explained. "Even if Wi-Fi 6 was being adopted in a major way, it's still just existing with these legacy clients, and it's hard to move into the multi-user mode of Wi-Fi 6 until you get out of [the legacy] spectrum. Spectrum is a huge piece for Wi-Fi to really take the next leap."

Global 6 GHz progress

According to the Wi-Fi Alliance, more than 41 countries worldwide have already designated 6 GHz for unlicensed use, while many more are actively working to open up the band.

Countries enabling or considering Wi-Fi 6E

Country	Status	Spectrum
Argentina	Considering	5925-6425 MHz
Australia	Considering	5925-7125 MHz
Brazil	Adopted	5925-7125 MHz
CEPT	Considering	5925-6425 MHz (only considering 5945-6425)
Canada	Adopted	5925-7125 MHz
Chile	Adopted	5925-7125 MHz
Colombia	Considering	5925-7125 MHz
Costa Rica	Adopted	5925-7125 MHz
Egypt	Considering	5925-6425 MHz
European Union	Adopted	5925-6425 MHz (only adopting 5945-6425)
Guatemala	Adopted	5925-7125 MHz
Honduras	Adopted	5925-7125 MHz
Japan	Considering	5925-7125 MHz
Jordan	Considering	5925-7125 MHz
Kenya	Considering	5925-7125 MHz
Malaysia	Considering	5925-7125 MHz
Mexico	Considering	5925-7125 MHz
Morocco	Adopted	5925-6425 MHz
New Zealand	Considering	5925-6425 MHz
Norway	Adopted	5925-6425 MHz
Oman	Considering	5925-6425 MHz
Peru	Adopted	5925-7125 MHz
Qatar	Considering	5925-7125 MHz
Saudi Arabia	Adopted	5925-7125 MHz
South Korea	Adopted	5925-7125 MHz
Tunisia	Considering	5925-6425 MHz
Turkey	Considering	5925-6425 MHz
United Arab Emirates	Adopted	5925-6425 MHz
United Kingdom	Adopted	5925-6425 MHz
United States	Adopted	5925-7125 MHz

Wi-Fi 6 and 6E device adoption and availability

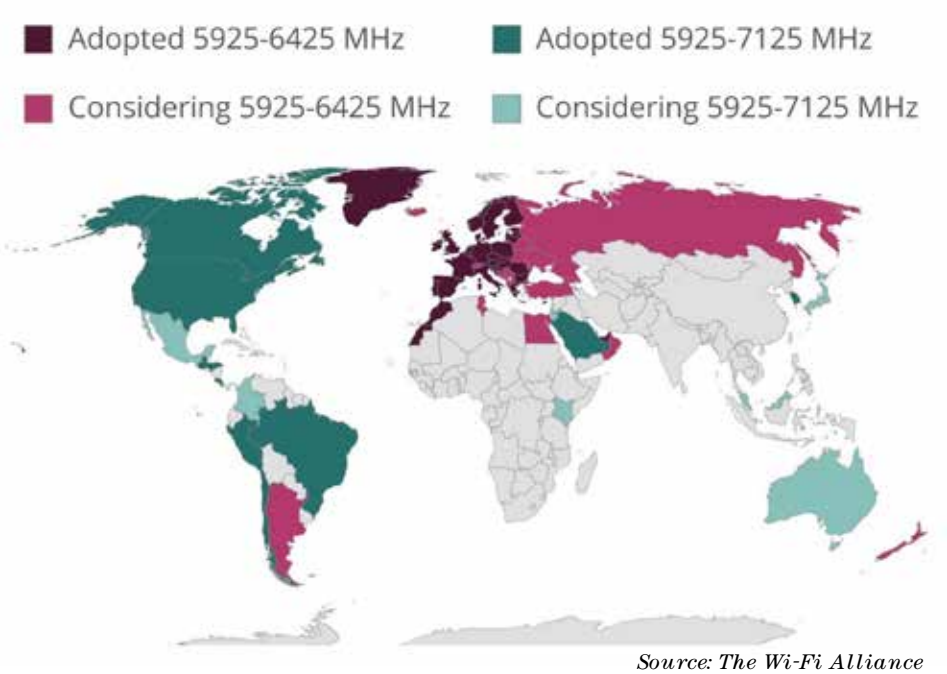
According to data published by research and advisory firm The Logistics IQ, public Wi-Fi hotspots are likely to reach 628 million by 2023, of which 11% will be Wi-Fi 6 hotspots, particularly in locations like airports, public transportation, retail, healthcare, smart cities and stadiums.

In 2026, smartphones supporting Wi-Fi 6 and 6E are expected to account for more than 90% of the total smartphone market, while more than 60 million Wi-Fi 6 & 6E chipsets are expected to be shipped for automobiles by the same year. In addition, gaming devices supported by Wi-Fi 6 and Wi-Fi 6E are expected to have a 40% compound annual growth rate between 2020 and 2026.

Cumulatively, it is anticipated that by 2026, there will be more than 13 billion devices shipped that are enabled with Wi-Fi 6 and Wi-Fi 6E, with a CAGR of approximately 26% between 2020 and 2026.

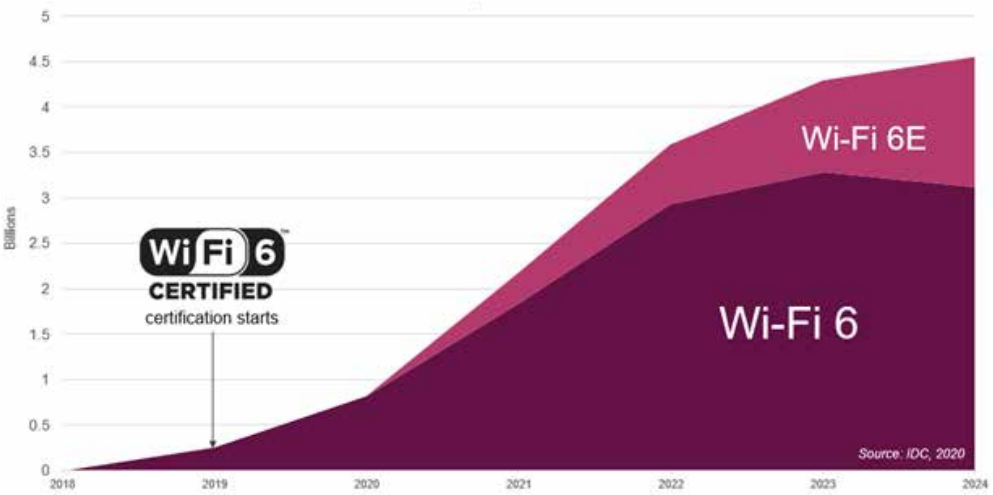
Further, the IDC estimates that by 2022, there will be more than 3.5 billion Wi-Fi 6 product shipments and almost 20% of all Wi-Fi 6 device shipments will support 6 GHz. By 2025, the IDC continued, there will be 5.2 billion Wi-Fi 6 product shipments, 41% of which will be Wi-Fi 6E devices.

Map of Wi-Fi 6E adoption



Source: The Wi-Fi Alliance

Wi-Fi 6 shipment forecast



Source: The Wi-Fi Alliance

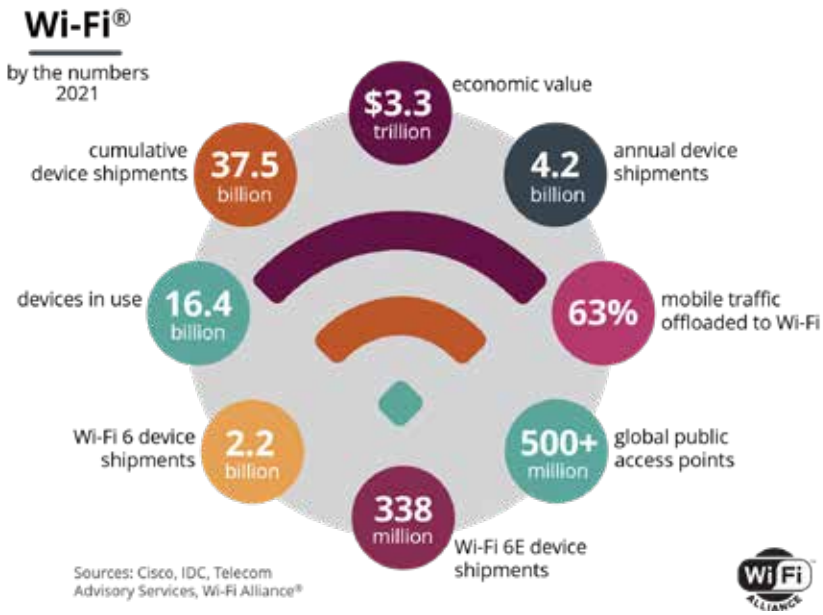
It appears that how the adoption rate of Wi-Fi 6 compares to previous generations of Wi-Fi technology, however, is a matter of perspective. For LitePoint's Adam Smith, Wi-Fi 6 adoption is really only being seen in the smartphone segment, while he says "none" of the smart home products have Wi-Fi 6 today.

"Considering that Wi-Fi is still handling all of our indoor traffic, there just aren't that many devices out there," he offered. "With APs, unless you've gone out and specifically purchased a Wi-Fi 6 access point, you're probably running Wi-Fi 5 at home, and so even if you've got your Wi-Fi 6 phone, you're operating in legacy mode."

Wi-Fi Alliance's Kevin Robinson, on the other hand, claimed that the adoption of Wi-Fi 6 "has far outpaced the adoption of previous generations of Wi-Fi," and further, that adoption is "across the board."

"Particularly with Wi-Fi 5," he argued, "you saw adoption in specific segments, and in those segments, you still had a sizable number of devices that remained on Wi-Fi 4, and in fact, continue to stay on Wi-Fi 4."

Because there are still Wi-Fi 4 devices out there, there is essentially a double migration going on as both Wi-Fi 4 and 5 devices are being swapped out for Wi-Fi 6 devices.



A closer look at the opening of the 6 GHz band for unlicensed Wi-Fi use in select countries:

The U.K. regulator Ofcom freed up 500 megahertz of spectrum in the 6 GHz band, at 5925-6425 MHz, for unlicensed indoor Wi-Fi and low-power outdoor Wi-Fi usage in July 2020, making it the second country in the world to do so. While less than the U.S.'s staggering 1.2 gigahertz-wide spectrum release, the 500 megahertz of new Wi-Fi spectrum was still considered a huge step forward for the U.K.'s wireless industry. The new spectrum will accommodate three new 160 megahertz Wi-Fi channels or up to 24 new 20 megahertz Wi-Fi channels at an EIRP of 250 mW.

South Korea approved 1.2 gigahertz of spectrum in the 6 GHz band, at the 5.925 MHz to 7.125 MHz range, for unlicensed Wi-Fi use in October 2020. Like the U.S., South Korea made the entire 6 GHz band available for free indoor use. When the country's Ministry of Science performed 6 GHz Wi-Fi testing, it found that wireless speeds were capable of reaching 2.1 Gbps, which is five times faster than the currently available Wi-Fi speeds. In addition, spectrum in the 5.925 MHz-6.455 MHz range will also be usable for device-to-device connections, regardless if it is indoors or outdoors.

Chile joined the growing list of countries to release the entire 6 GHz band to Wi-Fi in October 2020, and in doing so, became the first country in South America to release the 6 GHz band to Wi-Fi and only the third country to release the full 1.2 gigahertz. In a slight deviation from the U.S. FCC, Chilean regulators appear to be permitting a maximum EIRP of 1 W (30 dBm) for indoor use APs. Additional APs restrictions for using the band include the use of internal batteries and external or removable antennas.]

W-Fi 5 brought improvements to the 5 GHz band, so if you're operating a single band device in a 2.4 GHz band only, and are still on Wi-Fi 4," Robinson explained further. "There is no such thing as Wi-Fi 5 for that band, so yes, if you're looking at enterprise APs, those are all dual-band devices, so they of course moved on to Wi-Fi 5 and are now moving on to Wi-Fi 6. But now with Wi-Fi 6 bringing improvements to both bands, you're getting the adoption rates in those dual-band devices, but also for those single-band [or Wi-Fi 4] devices."

Additionally, because Wi-Fi 6 offers improved network efficiency and determinism, it brings value even to devices that don't need to operate at top speed, but will benefit from a more deterministic experience, such as low-power IoT devices.

"For that reason, even a fairly constrained device that has lower performance requirements is going to consider upgrading to Wi-Fi 6 because of the overall benefits it will provide," Robinson said, adding that this will increase Wi-Fi 6's rate of adoption.

When it comes to Wi-Fi 6E, Smith said that only premium smartphones like the Google Pixel 6 are currently compatible, and Extreme Networks' David Coleman indicated that by February 2022, there will likely be roughly another six or seven Wi-Fi 6E-compatible smartphones on the market.

Regardless of how Wi-Fi 6's adoption compares to Wi-Fi 5's, Smith thinks that the large amount of uplink traffic generated by the increasing number of smart home devices in everyone's homes will drive residential Wi-Fi 6 adoption.

"All these machines in the house or the office are starting to generate a significant amount of uplink traffic [...] whether that's machine learning up to the cloud [or something else], but all of these things do unscheduled traffic all the time, and that is potentially going to be a bit of a driver," he predicted.

Handsets with Wi-Fi 6 compatibility

(as of November 2021)

1. iPhone 11 Series
2. Samsung Galaxy Note 10 and Note 10+
3. Samsung Galaxy S10, S10+, S10 5G and S10e
4. Samsung Galaxy S20, S20+ and S20 Ultra 5G
5. iPhone SE 2020
6. Xiaomi Mi 10 5G and Mi 10 Pro 5G
7. Samsung Galaxy Fold 5G
8. OnePlus 8 and OnePlus 8 Pro
9. ZTE Red Magic 5G
10. Sony Xperia 1 II
11. LG V60 ThinQ 5G
12. Motorola Edge Plus
13. Vivo iQOO 3 5G
14. Realme X50 Pro 5G
15. Samsung Galaxy S20 FE 5G
16. iPhone 12 Series
17. OnePlus 8T 5G
18. Samsung Galaxy Z Fold 2
19. Samsung GalaxyZ Flip 5G
20. Samsung Galaxy S21 and S21 Plus
21. Vivo Z6 5G
22. ASUS ROG Phone 3 and Phone 3 Strix
23. ASUS Zenfone 7 and 7 Pro
24. Xiaomi Mi 10T 5G and Mi 10T Pro 5G
25. OnePlus 9, 9R, 9 Pro
26. Realme X7 Pro and X7 Pro Ultra
27. OnePlus Nord 2 5G
28. Galaxy Z Flip 3 5G
29. Galaxy Z Fold 3 5G (Wi-Fi 6E compatible)
30. iPhone 13, 13 Mini, 13 Pro, 13 Pro Max
31. Google Pixel 6 and 6 Pro (Wi-Fi 6E compatible)
32. Motorola Edge 20 Pro

Source: TechieTechTech, based on publicly reported information]

Q and A with **Chandan Mehndiratta**, Senior Director of Enterprise Wireless and Volume Business, Cisco

Q From Cisco's perspective, what does Wi-Fi 6 bring to the table? What about 6E?

A I am pretty stoked about Wi-Fi 6 and 6E. it gives us the opportunity to bring wireless as the technology for any access mechanism that we want.

The biggest transformation [...] is if you look at wireless, it's like every six months [the standards] are changing. The spectrum opening up [with 6E], the opportunity to talk about different wireless level of technologies not just Wi-Fi, but also Bluetooth Low Energy, IoT, Zigbee. More devices want to connect wirelessly — this is where the transformation is happening.

Wi-Fi 6 is where the determinism part of wireless started happening and that made sure that we were able to handle interference and other challenges that were keeping people from moving from wireless as a 'nice to have' to 'a must have.' That transition happened with Wi-Fi 6.

But then think about Wi-Fi 6E. It is a much cleaner spectrum than 2.4 GHz or 5 GHz, which helps us grow from a device perspective to a point where we have spectrum-level determinism with almost ultra-reliable connectivity that we could never imagine. In fact, we are able to see connectivity coming in from a wireless perspective up to a Gigabit+ speed. That was not possible in previous generations because of spectrum availability.

6E can enable mission-critical deployments in IoT, healthcare or places you want ultra-low latency, like autonomous vehicles or robotics in a wheelhouse. Because 6 GHz comes with its own spectrum, wireless is behaving like 5G in the sense that this spectrum can be claimed, and AFC [Automatic Frequency Control] comes into play. From a technology perspective, once you get that spectrum assigned, it is yours and what that means is you can now actually run anything on it without contention and get capacities that were not possible in the past.

Q How do W-Fi 6 & 6E change the ongoing Wi-Fi vs. 5G conversation, particularly in enterprises?

A Because both of them are wireless and they both have endpoints, some people might wonder why you would pick one over the other. Engagement with our customers shows that 5G has its own merits, mainly

around determinism. In the past, Wi-Fi was 'best effort' when it came to sending data, but Wi-Fi 6E changes that, as I mentioned, so now, the question is do [Wi-Fi and 5G] overlap? What our customers are teaching us is that they will coexist depending on the technology being used.

It's important to consider the radio infrastructure investment. Wi-Fi is backward-compatible, so if you replace 2.4, GHz or 5 GHz with 6E infrastructure, you can just start supporting it with the same backend infrastructure; on the other hand, with 5G, you have to start thinking about a new RAN. In some cases, like outdoor locations or factory warehouses, it might make more sense to have RAN instead of having to put a Wi-Fi 6 access point every few feet or so.

Those are some of the cost differences between upgrade to Wi-Fi 6 versus 5G.

But where it becomes more interesting for our customers is looking at how they can achieve a common policy, security, authentication, segmentation of the network irrespective of the technology choice that they made for the endpoint to connect to. That is where Cisco's strength is. We understand client onboarding whether user or machine, we understand how network segmentation need to work and third, we can give a comprehensive end-to-end view of the entire infrastructure being run as one.

So, depending on the use case, the customer may make the choice to go with a 5G-based RAN or Wi-Fi 6E infrastructure, but at the backend, that is where integration it going to be a lot more exciting.

Q Tell me more about where Cisco's customers are when it comes to upgrading to Wi-Fi 6 and beyond.

A Based on our current transitions, almost all customers that we talk to are looking into deploying Wi-Fi 6 today. They are waiting for 6E to be standardized and for the products to be available. A lot of the AFC mechanisms, like switching from low-power to high-power mode, is yet to be determined depending on the country and related regulations.

Wi-Fi 6E is yet to roll out for all vendors and is more in the trial phase for most. We anticipate that it is going to be a 6 and 6E game for the next 18 to 24 months before Wi-Fi 7 standardizing starts happening. Again, because of backwards capability, the customers that deploy Wi-Fi 6 in the meantime and move onto 7 later will be able to enjoy the same level of architecture benefits on 6E and 7.

Q What is the impact of offering Wi-Fi as a service? What impact might that have on deployments?

A Different customers have different viewpoints. Some start at the infrastructure level itself by offering the whole Wi-Fi infrastructure as a service. That's the first approach.

The second, and where we're seeing a lot of interest is where a customer has its Wi-Fi network, or the entire infrastructure set up, but instead only certain parts of the network are offered as a service as line of business activities. These services run on the same infrastructure, but the right level of ROI can't be guaranteed because many of these use cases are ephemeral; they may only be used for the next few years, like remote working use cases. Once everything opens up, the way we work may go back to normal. So, they ask: Should I invest in technology that I may not need in two years?

If you enable as-a-service at any layer, you could deploy the entire infrastructure as a service, or you could deploy the network and only offer a certain part of it as-a-service. But, if you're network architecture is not modular enough, and you're tied to everything in a monolithic way, it is very tough to open up that layer and start interacting with a vendor or partner to say hey I can offer this as a service.

So that is what Cisco is working towards: Making sure there is modularity at every layer, so that our customers will get the benefit of saying it's not just infra-as-a-service, it might be line of business that I can offer a certain customer.

What's next for Wi-Fi?

According to Robinson, the Wi-Fi Alliance is already working on the definition of Wi-Fi 7. While the majority of its features are not yet finalized, there are a few direct enhancements over Wi-Fi 6 that are likely, including support of 320 megahertz channels, which is double the 160 megahertz of 802.11ax, the use of higher modulation orders, optionally supporting 4096-QAM — up from 1024-QAM in 802.11ax; and the allocation of multiple resource units, such as groups of OFMDA tones.

"Potential capabilities include low latency and more determinism," said Robinson. "With Wi-Fi 7, we're getting to the point of very high probability determinism. And, of course, it would not be a new generation of Wi-Fi without higher speeds, as well."

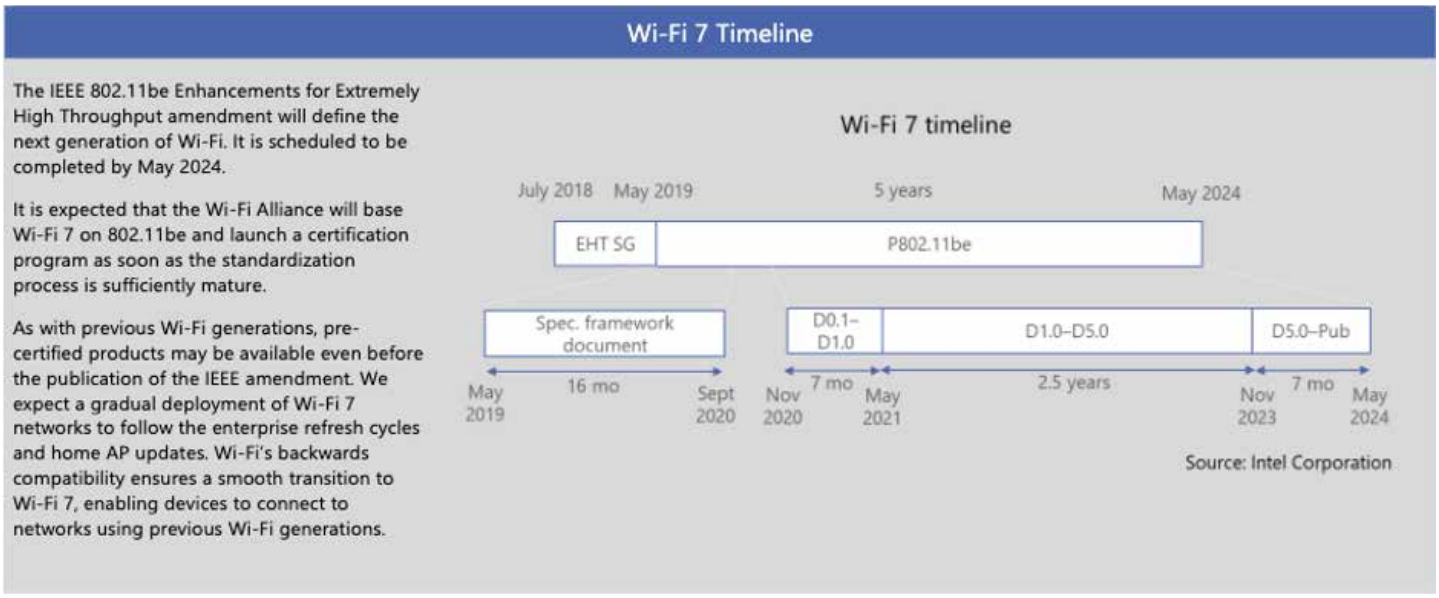
Robinson also shared that regardless of which features end up in the Wi-Fi 7 standard, it is going to leverage the 6 GHz band "extensively."

"In order to really use Wi-Fi 7," he continued, "it is imperative that Wi-Fi and other unlicensed technology get access to the 6 GHz band."

Like Wi-Fi 6, Wi-Fi 7 (or 802.11be) will also use multi-band/multi-channel aggregation and operation and deliver higher spectrum and power efficiency, better interference mitigations, higher capacity density and higher cost efficiency. The seventh generation of Wi-Fi is also referred to as Wi-Fi Extremely High Throughput as result of its projected ability to support up to 30 Gbps throughput, roughly three times faster than Wi-Fi 6.

Wi-Fi 7 is expected to have more efficient spectrum utilization, making it ideal for enterprises as they continue their digital transformations and potentially add

AR/VR, IoT and IIoT applications to their workflows. In addition, Wi-Fi 7 will be optimized for video



Courtesy of Intel Corporation

applications, which will prove valuable in the enterprise space, but also inside homes for use cases like gaming, streaming and other smart-home devices and services.

And the focus on video is paramount, as it is expected to become the dominant traffic type very soon. In fact, Cisco's Visual Networking Index indicated that global IP video traffic will be 82% of all IP traffic, both business and consumer, by 2022.

IEEE plans to publish the 802.11be amendment sometime in 2024, with commercial deployment occurring around the same time. Then, just like Wi-Fi 6 and 6E, the Wi-Fi Alliance will release its Wi-Fi 7 certification program to ensure interoperability and security standards.

Conclusion

Wi-Fi operation in the 6 GHz band is considered an unprecedented development in Wi-Fi evolution and is widely expected to be a driving force behind the adoption of Wi-Fi 6 devices, both in the home and in the enterprise space.

But, with Wi-Fi 7 already in the works, many end users might be wondering if they should wait to upgrade their Wi-Fi 5 devices. However, according to Smith, the leap from 5 to 6 was "huge," while 6 to 7 is "just like if they put the afterburners on 6."

Robinson agreed: "Wi-Fi 6 is today's generation of Wi-Fi. For many applications, the capabilities that it delivers will be perfectly adequate. People should be very comfortable going out and purchasing Wi-Fi 6 and they should feel future-proofed. We have a very strong foundation right now in 6 and 6E."

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