THE FUTURE OF Wi-Fi

What 6 GHz Spectrum Means for Connectivity, Key Industries, and Technology Implementers

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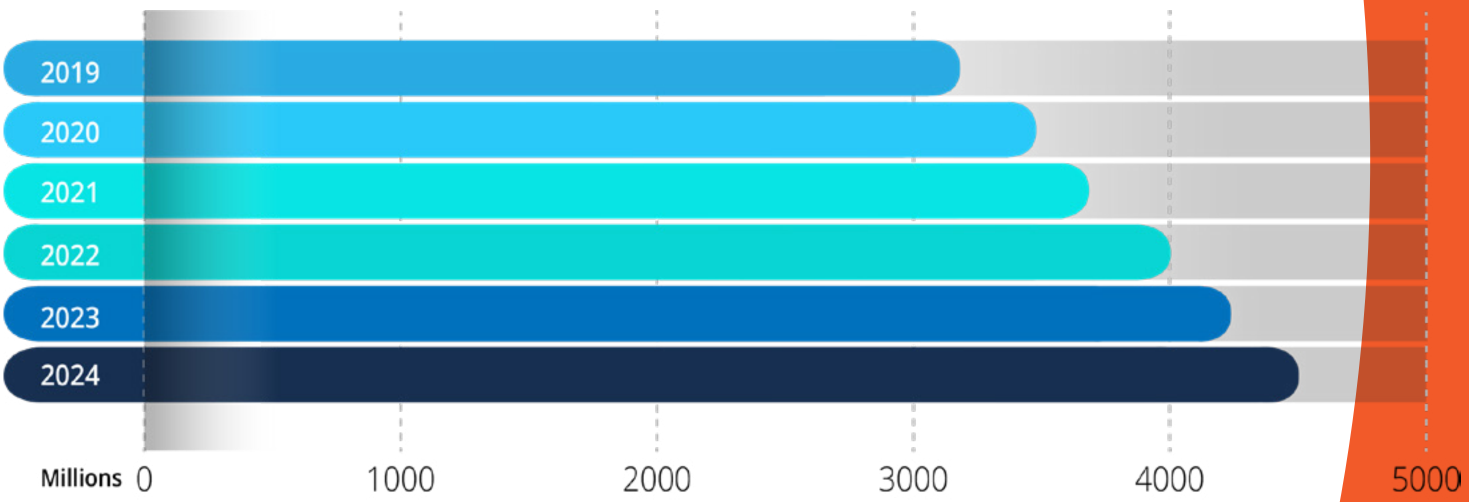
Wi-Fi: TWO DECADES IN THE MAKING

The year 2019 marked the 20th anniversary of Wi-Fi, and its adoption and evolution shows no signs of slowing down. The need for faster, more reliable, more efficient, and more widespread Wi-Fi coverage is becoming increasingly vital in a world filled with more Wi-Fi devices at both ends of the performance spectrum, from high-throughput and low-latency applications to battery-constrained Internet of Things (IoT) devices.

As the chart below shows, ABI Research forecasts that Wi-Fi-enabled devices are set to increase from 3.3 billion annual unit shipments in 2019 to more than 4.5 billion by 2024.



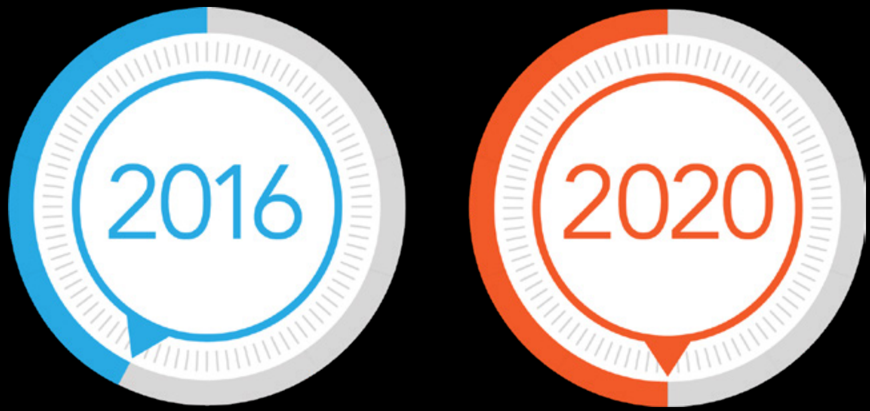
Though the growing reach of Wi-Fi will be driven by a number of advancements, such as Wi-Fi 6 and Wi-Fi's expansion into the 60 Gigahertz (GHz) and sub-1 GHz bands through WiGig and HaLow, the most exciting, and potentially transformative, change to the Wi-Fi landscape is the anticipated availability of 6 GHz spectrum over the next few years. On April 23rd, 2020, the FCC voted to approve 1.2 GHz of unlicensed spectrum in 6 GHz available for Wi-Fi, with other regions anticipated to follow.

This whitepaper provides insight into what is driving 6 GHz adoption, the significant benefits that 6 GHz will provide, and the expected timeline surrounding its launch. Finally, ABI Research provides strategic recommendations for technology implementers.

WHY IS 6 GHz SO IMPORTANT?

Over the next decade, Wi-Fi faces a number of difficult challenges. Key among them are the growing demands being placed on Wi-Fi networks, leading to increased congestion, performance limitations, and reduced Quality of Service (QoS). Most Wi-Fi devices are using increasing amounts of data per device, including streaming high-resolution music and videos, video calling, application and firmware updates, digital downloads, social networking, data-heavy web content, and online gaming, among others. The tremendous surge in active Wi-Fi devices at home in recent months and resulting increase in traffic as a result of COVID-19 have reaffirmed Wi-Fi as a vital utility, acutely demonstrating both its importance and limitations.

Demands will only increase over time as the resolutions increase to 4K and 8K in the future, and greater performance is demanded. The growth of cloud services and uploading of content to social media and sharing websites is also resulting in more uplink traffic. A recent report commissioned by the Wi-Fi Alliance indicated that, by as early as 2020, Wi-Fi networks will need significantly more spectrum in order to satisfy increased traffic demands. The report also indicated that, by 2025, between 500 Megahertz (MHz) and 1 GHz of additional spectrum at the very least would be needed to satisfy peak usage, with upper estimates placing this between 1.3 GHz and 1.8 GHz.



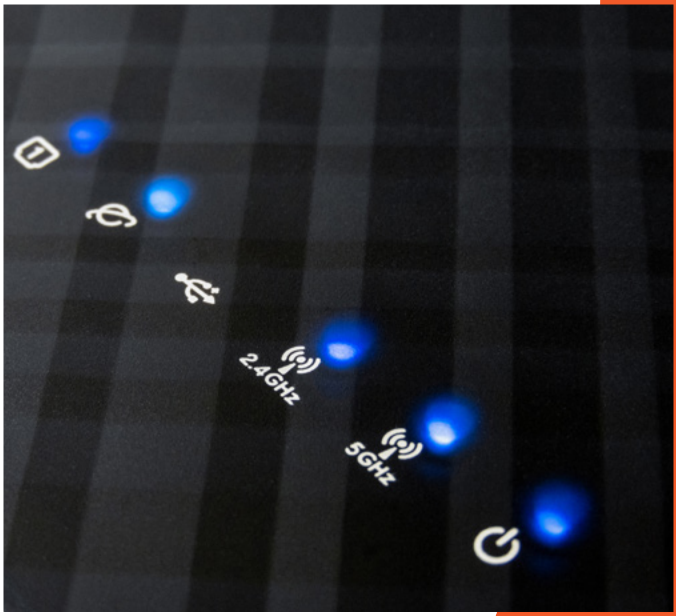
Cisco anticipates that Wi-Fi devices will account for almost half of all IP traffic by 2020, up from 42% in 2016.

As a result of this traffic explosion, cellular operators are increasingly looking to offload traffic onto Wi-Fi. Similarly, consumers with limited data plans are deciding to connect to Wi-Fi when at home or in public areas to circumvent these limitations. In order to do so, however, the user experience must be comparable to that of the existing cellular network, and the Wi-Fi network must be able to accommodate this extra traffic. Cisco anticipates that mobile offload is set to increase from 60% (10.7 exabytes/month) to 63% (83.6 exabytes/month) by 2021, with 64% of traffic from smartphones and 72% from tablets forecasted to be offloaded onto Wi-Fi by 2021, placing additional burdens on the 5 GHz band.

CURRENT TECHNOLOGIES FALLING SHORT

Most deployments today are also now characterized by several overlapping Wi-Fi networks. Real-world performance is already beginning to suffer in these dense deployment areas and this will continue the transition to high-density environments. Furthermore, with the 2.4 GHz band already congested, and the growing transition to the 5 GHz band, interference from neighboring devices is significantly impacting performance; reducing overall throughput; increasing latency and errors; and ultimately reducing power consumption and reliability. Performance can no longer be improved by adding more hotspots, which only increases the chance of interference and collisions. With many new potential applications and 5G class services demanding high throughput, low latency, robust, reliable, and efficient networks, there is a strong need for Wi-Fi to address these challenges in order to play a fundamental and complementary role to 5G cellular connectivity within indoor environments.

New Wi-Fi standards like Wi-Fi 6 (also known as 802.11ax) are helping to address some of these challenges; however, there is an increasing acknowledgment that the existing unlicensed spectrum available for Wi-Fi will be insufficient in addressing the future needs of the Wi-Fi ecosystem. In 2017, leading companies that are invested in the Wi-Fi ecosystem, including Broadcom, Cypress, Intel, Qualcomm, MediaTek, Cisco, HPE, Google, Apple, Microsoft, and Facebook, among others, came together to press the U.S. Federal Communications Commission (FCC) on the need for unlicensed spectrum in the 6 GHz band (*i.e.*, 5925 MHz to 7125 MHz) to be opened and used by Wi-Fi technologies. In October 2018, the FCC voted in favor of opening up 1200 MHz of spectrum for unlicensed devices in the 6 GHz band, with final approval granted in April 2020.



BIGGEST BENEFITS OF 6 GHz

While the global regulatory landscape for 6 GHz outside the US is still being finalized , it is hard to overstate the potential that 6 GHz can bring to Wi-Fi networks. The technology could bring about much higher throughput, much more capacity, greater reliability, lower latency, and better QoS than ever before, solving many of the key challenges that Wi-Fi is facing today.

More than Double the Existing Available Spectrum: Up to 1.2 GHz of additional spectrum will be allocated for Wi-Fi, effectively doubling the existing spectrum available to Wi-Fi today. High-density deployments, such as stadiums, airports, conference halls, and other venues suffering from congestion, will benefit greatly from this additional capacity, while the greater availability of 160 MHz channels in the 6 GHz band will enable low-latency multi-gigabit connectivity to better support a number of advanced use cases.

A Clean Band: 6 GHz Wi-Fi will only support Wi- Fi 6 and beyond devices. In essence, a 6 GHz Access Point (AP) will only be able to talk with Wi-Fi 6 and beyond clients, and will not be sharing airtime and bandwidth with legacy generations of Wi-Fi, such as Wi-Fi 5. This keeps the band clean and ensures that slower devices do not congest the network.

Improved Legacy Networks: Without the availability of the 6 GHz band, 5 GHz could become extremely congested over time. The availability of 6 GHz could, therefore, bring definite benefits for Wi-Fi 6 clients and legacy clients operating in that spectrum by freeing some of the 5 GHz spectrum to help boost performance, particularly as Wi-Fi 6E will be absorbing much of the high-performance use cases currently on 5 GHz.

Improved Backhaul and Multi-AP Systems: 6 GHz could enable guaranteed multi-gigabit throughput throughout the entire home by leveraging the band as the backhaul technology for multi-AP mesh deployments. While it may take some time for 6 GHz clients to become mainstream, existing Wi-Fi devices could potentially take advantage of 6 GHz backhaul throughout the home once 6 GHz networking equipment arrives. This could lead to multi-gigabit throughput coverage throughout the home, leading to better user experiences across a wide range of high-performance applications, from video streaming to gaming and Augmented Reality (AR).

Reliability: Wi-Fi 6E, unpolluted with legacy Wi-Fi devices, could provide much more reliable and consistent performance than Wi-Fi 5 has been able to achieve. Some enterprise deployments have held back on transitioning to wireless technologies due to latency and bandwidth requirements. Now, enterprises can move to Internet Protocol (IP) phones, and support low-latency collaborative applications or other key services over Wi-Fi, rather than costlier and less flexible wired Ethernet solutions.

Application-Specific Deployments: The clean 6 GHz band could allow specific applications to be leveraged on the 6 GHz band. AR and Virtual Reality (VR) applications could be transferred to 6 GHz Wi-Fi 6E to ensure reliability and performance. Likewise, backhaul could shift to 6 GHz for higher throughput. For industrial applications, mission-critical machinery and equipment could leverage this band for guaranteed performance and low-latency services. Chipset vendors like Broadcom have already unveiled client Wi-Fi 6E chipsets capable of supporting over 2 Gbps leveraging the 6 GHz band.

Low-Latency, High-Throughput Non-Line-of-Sight Performance: Applications like VR/AR headsets require increasing amounts of throughput, while maintaining extremely low latency. 6 GHz could potentially enable non-line- of-sight AR/VR applications. It could also provide better casting performance than 5 GHz Wi-Fi, potentially allowing low-latency display sharing or screen mirroring from mobile devices or game consoles with greater flexibility than 60 GHz.

THE 6 GHz TIMELINE

In December 2018, the FCC released its Notice of Proposed Rulemaking (NPRM) that provided a set of guidelines for 6 GHz Wi-Fi. In this notice, the FCC proposed that because the 5.925 GHz to 6.425 GHz and 6.525 GHz to 6.875 GHz sub-bands of the 6 GHz band (totaling 850 MHz) are currently heavily used by point-to-point microwave links, including critical links that must maintain a high level of availability, in these parts of the band, only "standard-power APs" using power levels permitted for unlicensed use in the U-NII-1 and U-NII-3 bands will be able to operate only on frequencies determined by an Automated Frequency Control (AFC) system. As setting up a 6 GHz link today requires coordination with existing license holders, this AFC system is designed to automate this coordination by leveraging the FCC's Universal Licensing System (ULS) to scale this effectively to the Wi-Fi ecosystem and determine if access can be granted.

Alongside this, other portions of the 6 GHz band, specifically the 6.425 GHz to 6.525 GHz and 6.875 GHz to 7.125 GHz sub-bands (totaling 350 MHz), are to be used by mobile stations where the locations of the incumbent receivers are not necessarily known or cannot be easily determined from existing databases. Because the lack of location information on mobile stations makes an AFC approach impractical, the FCC has proposed allowing only indoor "low-power access point" operation in these sub-bands to protect incumbents.

In February 2019, the Wi-Fi industry sent its comments on the FCC's NPRM and argued that low-power indoor operations should be enabled across the entire 6 GHz band without the need for AFC. The Wi-Fi industry views band-wide authorization of Low-Power Indoor (LPI) operations to be of special importance to ensure the rapid availability of spectrum to consumers while permitting the use of larger channel sizes. Without doing so, the Wi-Fi industry believes that investment in the 6 GHz band would be hindered, and that LPI devices will be prevented from accessing wider 160 MHz channel sizes, resulting in lower throughput. The industry also believes that requiring AFC registration for all unlicensed devices or the need for professional installation would make the process too complex and result in a considerable delay to 6 GHz rollout. In contrast, LPI unlicensed equipment without AFC could be available to consumers within 12 to 18 months, following FCC approval of the spectrum.

On April 23rd, 2020, the FCC voted to make 1.2 GHz of additional spectrum in the 6 GHz band available for Wi-Fi, and proposed that AFC will only apply to the standard power access points (APs), meaning that indoor, low-power APs and client devices will be able to take advantage of the full 1.2 GHz of additional spectrum. The Wi-Fi industry is therefore extremely optimistic on much more rapid deployment of Wi-Fi 6E-enabled devices throughout the next few years thanks to less stringent regulations. ABI Research anticipates significant uptake of 6 GHz capable Wi-Fi products from 2021 onwards.

Ahead of CES 2020, the Wi-Fi Alliance introduced Wi-Fi 6E as the terminology that will be leveraged to distinguish Wi-Fi 6-capable devices that can operate in the 6 GHz band. At CES 2020, a number of vendors introduced 6E-capable chipsets. Broadcom introduced a comprehensive enterprise and residential portfolio of Wi-Fi 6E chipsets and showcased them at the show. These include a combination of dual and tri-band 4x4, 3x3 and 2x2 solutions with a combination of 80 MHz and 160 MHz support. Alongside this, Celeno announced that it was adding Wi-Fi 6E support to its CL8000 series of chips, with the entire family capable of supporting the entire 6 GHz spectrum under regulatory evaluation (5925-7125 MHz) with 160 MHz support. Its 6E products will sample in 2Q 2020. In February 2020, Broadcom announced its BCM4389 Wi-Fi 6E client chipset, with support for more than 2 Gbps throughput in devices like smartphones. Qualcomm is also developing its Wi-Fi 6E portfolio, while ON Semiconductor has also unveiled its QCS-AX2 series for Wi-Fi 6E infrastructure applications.

While much still needs to be done from a global regulatory perspective, the year 2020 will be a hugely important one in bringing 6E technology to the forefront. Following the show, Ofcom in the United Kingdom announced that it is proposing that 500 MHz of the 6 GHz spectrum should be made available for Wi-Fi. To date, the FCC has led the charge on 6 GHz Wi-Fi by making 1.2 GHz available for Wi-Fi in the United States.

Regional Variations in 6 GHZ

While the United States is leading the charge, Europe is also anticipated to have around 500 MHz between the 5925 MHz and 6725 MHz bands, and some initial technical studies are currently responding to a mandate from the European technical commission. In Asia-Pacific and other regions, there is still limited visibility on the availability or timeline, however, these are likely to follow suit given the likelihood of availability and traction in the United States and Europe. The industry is confident that these two regions will help drive wider adoption and interest, and ABI Research believes that 6 GHz has the potential to become so important to Wi-Fi over the next decade that it will be virtually impossible for any region to ignore.

6 GHz Wi-Fi CHALLENGES AND STRATEGIC RECOMMENDATIONS

Regulatory Challenges: Perhaps the largest current barrier to 6 GHz adoption is still the need to iron out various regulatory challenges and obstacles across different regions. A number of other key stake- holders, other than the Wi-Fi industry, have responded to the FCC's NPRM, many of which are calling for more stringent requirements to protect incum-bents and for more evidence that 6 GHz Wi-Fi will not interfere with other essential services. Some have gone further and opposed any sharing of the band at all. Others are arguing that AFC must be strictly adopted, while others have argued that AFC does not go far enough. The UWB Alliance has also raised concerns about interference and suggested some amendments to avoid this. Several stake-holders have also proposed leveraging a portion of the 6 GHz band for licensed operations. While the FCC is pressing ahead, other regions may find these challenges harder to solve. Staggered availability of spectrum across the globe may also slow down incentives for adoption in the near term.

Lack of Awareness and Education: Some chipset vendors have expressed that the wider industry is still very much in the early learning cycle of 6 GHz and most requests do not include a 6 GHz requirement. It may, therefore, take more time for awareness to grow and devices to come to market. However, with recent momentum, FCC approval, and the 6E announcement, ABI Research anticipates that service providers, Original Equipment Manufacturers (OEMs), and the wireless industry more broadly will quickly digest the benefits of Wi-Fi 6E.

Cost: There will be a cost increase to supporting Wi-Fi 6E, and the 6 GHz band. Vendors will have to think carefully about how soon they will support the technology and it may not always be a simple upgrade. While 6 GHz may gain some initial support in the ultra-high end, it will likely take some time to transition down as other components become more widely available on both the infrastructure and client sides. However, this is expected to diminish over time.

Transition to New Band: Historically, moving to a new band takes time; 5 GHz Wi-Fi took time to go mainstream, and 60 GHz WiGig and sub-1 GHz Wi-Fi HaLow are still trying to find success. On a more positive note, some in the industry believe it could take a similar time frame as 802.11ac, which was ratified at the end of 2013, and by 2016, the technology had already reached 1 billion chipset shipments. If 6 GHz does indeed ratify by the end of 2020, some expect similar volumes during the 2023 to 2024 time frame due to the huge advantages it can offer. However, much will depend on regional availability of spectrum, infrastructure rollout, and mainstream device support in order to build a comprehensive 6 GHz ecosystem.

Chipset Availability: While several vendors are committed to bringing 6 GHz chipsets to the market early on, as with any new standard, it will take time before these are well established with numerous vendors, helping to drive down costs and build scale.

Proximity to ax Rollout and Deployment: Though Wi-Fi 6 is still in its relative infancy, over the next 12 to 18 months upgrades are likely to gain considerable traction. Those who have just invested in Wi-Fi 6 infrastructure may not immediately be able to afford the expense of upgrading once more to the 6 GHz band. This could also apply to OEMs and the wider ecosystem. However, some vendors such as ON Semiconductor are future-proofing their Wi-Fi infrastructure chipsets to accommodate this, enabling flexible deployments that allow the network to operate in 5 GHz or 6 GHz depending on the available client devices, maximizing performance and utilization of each band.

However, ABI Research anticipates that most of these challenges will be overcome and that opening up the 6 GHz band for Wi-Fi will help the technology address many of the challenges it is facing today. In today's environments, even when leveraging 80 MHz or 160 MHz channels, it is very challenging to guarantee QoS in the 5 GHz band. 6 GHz not only brings about additional spectrum and higher throughputs, but essentially guarantees access to channels with no legacy, resulting in a corresponding improvement in latency and simplifying channel access. Wi-Fi 6E can, therefore, open up new opportunities for Wi-Fi to better support 5G-class services reliant on high multi-gigabit throughput, low latency, high efficiency, broader coverage, and better mobility. ABI Research will be incorporating Wi-Fi 6E forecasts into upcoming iterations of its Wireless Connectivity Technology Segmentation and Addressable Markets (MD-WCMT) quarterly market dataset.

A COMPLETE PICTURE OF THE CONNECTIVITY LANDSCAPE

ABI Research's Wi-Fi, Bluetooth & Wireless Connectivity Research Service market intelligence uncovers and identifies key synergies between new connectivity solutions and standards long before they gain competitive traction.

Our research encompasses data, trend, and forecast reports, and examines major forthcoming innovations and disruptions across various Internet of Things (IoT) platforms, application layers, and consortiums that have the potential to affect companies across the supply chain. ABI Research provides technology implementers with unparalleled insight into commercial and industrial applications, as well as emerging opportunities in the smart city, environmental sensing, and nascent IoT markets.

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249 South Street

Oyster Bay, New York 11771 USA

Tel: +1 516-624-2500

www.abiresearch.com

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