Wi-Fi 6: Expanding the role of Wi-Fi in the enterprise

Monica Paolini, Senza Fili

Wi-Fi 6: Expanding the role of Wi-Fi in the enterprise

Wi-Fi is ubiquitous in the enterprise. Can you think of an office building, a warehouse, a hospital, or a college campus an enterprise without Wi-Fi? With Wi-Fi 6, the next generation of Wi-Fi, Wi-Fi has become an even better fit for the enterprise, for voice and data connectivity, and for new IoT and industrial IoT (IIoT) use cases. As enterprise connectivity needs grow, Wi-Fi has stepped up to the challenge with higher capacity, greater reliability and security, and lower latency, alongside a new set of traffic management tools. Far from Wi-Fi being replaced by 5G, the two technologies continue to develop and be adopted in parallel, complementing each other in increasingly integrated enterprise wireless private networks.

Wi-Fi evolution has accelerated to meet our fundamental connectivity needs

Wi-Fi has been around for 20 years. Not only has adoption massively expanded – across networks and devices – but it has steadily evolved in terms of performance, features, security, and spectrum bands covered, all while maintaining its low-cost structure. With Wi-Fi 6, and its most recent expansion to 6 GHz with Wi-Fi 6E, we are seeing the biggest evolutionary step of the technology – one that specifically addresses the growing capacity and connectivity needs of the enterprise.

At home and at work, Wi-Fi is the primary access technology for many of us across the world. Cisco VNI has predicted Wi-Fi traffic accounting for 51% of all IP traffic and 72% of wireless traffic by 2022. During the COVID-19 pandemic, Wi-Fi was the access technology with the largest traffic increase for both voice and data. It provided the fundamental connectivity we needed for work, education, health care, social interaction, and entertainment while we were confined in our homes. During the pandemic, Comcast reported a 36% increase in Wi-Fi traffic and a 17% decrease in LTE traffic on Xfinity Mobile, and T-Mobile saw a 57% increase in Wi-Fi tethering.

What Wi-Fi 6 offers to the enterprise

- Increased data rate (up to 9.6 Gbps, compared to 3.5 Gbps in Wi-Fi 5) and capacity, to improve data and voice connectivity to employees, visitors and IoT terminals. Voice capacity may double from Wi-Fi 5, according to Cisco. This can eliminate congestion in existing Wi-Fi networks, enable support for new use cases, and connect a higher number of terminal devices.
- 75% lower latency than Wi-Fi 5, reduced jitter, more deterministic behavior, and higher reliability to improve support for IoT and industrial IoT (IIoT) applications that are highly time sensitive or are mission critical.
- With Wi-Fi 6E, more efficient use of spectrum and support for the 1200 MHz of newly available unlicensed spectrum in the 6 GHz band.
- Advanced traffic management to meet the requirements of enterprise applications and multiple sets of users and devices with different access priority.
- Lower power consumption, which is especially useful for some IoT terminals.
- Increased densification enabled in indoor and outdoor environments.
- Better support for IoT and IIoT, as well as enterprise-specific use cases, such as:
  - Virtual/augmented/extended reality applications – e.g., for remote control or assistance, training, customer services.
  - Video-based applications, such as surveillance and analytics.
  - Healthcare and education applications.
  - Customer services in retail and entertainment venues.
  - Industrial and supply chain automation.

Wi-Fi 6 technology highlights

- Based on IEEE 802.11ax and on the Wi-Fi Alliance Wi-Fi 6 certification program to provide interoperability and standards compliance.
- Wide channels, up to 160 MHz, with capacity up to 9.6 Gbps (compared to 3.5 Gbps in Wi-Fi 5).
- Support for the 6 GHz band in Wi-Fi 6E, in addition to the global 2.4 GHz and 5 GHz unlicensed bands.
- Better network efficiency, lower latency, increased range with orthogonal frequency division multiple access (OFDMA), multi-user multiple input, multiple output (MU-MIMO) for both uplink (UL) and downlink (DL), 1024-quadrature amplitude modulation (QAM) subcarrier modulation, and transmit beamforming. In dense environments, Qualcomm estimates a 4x increase in median throughputs with 8x8 MIMO in Wi-Fi 6 compared with 4x4 MIMO Wi-Fi 5.
- Improved spectrum efficiency and resource allocation, and better service level agreement (SLA) compliance with transmission scheduling.
- Spatial reuse and color coding to support high-density deployments.
- Target wake time (TWT) to improve network efficiency and to prolong device battery life.

Adoption timeline

Cisco estimates that by 2022, over 56% of Wi-Fi devices will support Wi-Fi 6 – with the percentage being much higher in the enterprise, because the enterprise will be the first segment to upgrade to Wi-Fi 6. This is usually the case with new versions with upgrades linked to the refresh cycle or driven by the IT team to meet specific needs. Residential upgrades usually take longer, because they depend on individual users' retail purchase decisions or on ISPs' upgrades, which happen on a longer time scale. Equipment is already commercially available, with 295 Wi-Fi CERTIFIED 6 products, including 153 handsets. Initial deployments of Wi-Fi 6 will be driven by enterprises that:

- Have greenfield locations.
- Want to roll out enterprise services or IoT/IIoT applications that require Wi-Fi 6 capabilities.
- Need additional capacity and want to upgrade or densify their existing networks.

Enterprises with legacy networks that still meet most of their current needs have less urgency to update, so we will see a gradual adoption of Wi-Fi 6 in this segment. This is in line with prior generations of Wi-Fi. The technology's backward compatibility makes it possible for users to continue to use existing networks and enterprises, so they have the flexibility to upgrade as part of their planned refresh cycles.

The Wi-Fi Alliance plans to start the certification of Wi-Fi 6E in early 2021 and expects commercial availability of Wi-Fi 6E to follow soon after, with a forecast of 300 million devices in the market in 2021.

The enduring appeal of Wi-Fi to the enterprise

With Wi-Fi 6, Wi-Fi will retain its role as the most widely used wireless technology in the enterprise. Cisco estimates that 35% of Wi-Fi traffic goes over enterprise-owned networks. Much of the growth in enterprise wireless connectivity that we expect from digital transformation and the fourth industrial revolution (Industry 4.0) in the enterprise is going to be delivered by Wi-Fi 6.

Wi-Fi has given enterprises the flexibility to deploy wireless networks where they need to, at prices they could afford. Wi-Fi has also been able to provide levels of indoor coverage and capacity that cellular networks have not. In turn, this has made it possible to eliminate much of the wireline access, to the point that now many laptops do not even have Ethernet connectivity, but they invariably have Wi-Fi.

With Wi-Fi 6, Wi-Fi will retain this role and expand it in new directions.

Enterprise private networks are the bright spot for growth in wireless today. But enterprise Wi-Fi networks are already, and will continue to be, private networks, run by or on behalf of the enterprise. As they evolve to include other access technologies, enterprise private networks will continue to have Wi-Fi at the core as they evolve to include Wi-Fi 6.

Integrating Wi-Fi 6 and other wireless technologies

It is not by chance that Wi-Fi 6 and 5G have emerged and are being deployed at approximately the same time. They both address a much more pervasive need for people and things to be connected – reliably and securely regardless of where they are – and for this connection to be wireless. As wireless connectivity becomes more crucial not just to keeping people in touch, but to running many enterprise operations, there is no single wireless technology that can do it all.

Wi-Fi 6 and 5G are complementary technologies that are learning from each other. There is some technological convergence – e.g., both 3GPP and IEEE use OFDMA, MU-MIMO and beamforming – but at the same time the two technologies have retained fundamentally different characteristics, with Wi-Fi

IoT and IIoT

Wi-Fi supports many of the IoT and IIoT applications deployed today that do not require wide-area mobility. With Wi-Fi 6, the range of applications supported will expand beyond the surveillance and other video-based applications, sensor applications, and retail applications that are most used today.

The lower latency, combined with higher reliability, determinism and throughput, makes Wi-Fi 6 better suited than previous generations of Wi-Fi to supporting more demanding IIoT applications, such as industrial automation, smart manufacturing, remote control, building and goods management, supply chain and operational applications.

The availability of Wi-Fi in 6 GHz will greatly increase the opportunity for enterprises to deploy IoT and IIoT applications that require high bandwidth and/or high reliability because of the large swath of unused spectrum that enterprises can use exclusively if they have control over the location.

New capabilities such as environmental sensing will accelerate the adoption of applications that track movement of unconnected objects within the coverage area, or detect the presence of threats, or monitor changes in the environment.

dominating in home and office environments, and 5G solidly anchored in use cases that require wide-area deployments. Wi-Fi makes it possible to reuse spectrum more intensively and have higher traffic density; 5G is better suited for applications with strict quality of service and performance requirements.

Enterprises need both 5G and Wi-Fi 6 – and already use other technologies as well, such as Low Power Wide Area Network (LPWAN) technologies for some IoT applications or microwave links for point-to-point transmissions. Depending on the services and applications they use, enterprises will choose different mixes of Wi-Fi 6, 5G and other wireless technologies.

What is crucial for the coexistence of multiple wireless access interfaces is the ability to integrate them within the wireless private network. The growing adoption of distributed network architectures that combine elements of centralized cloud with elements of edge computing is going to be a fundamental enabler of the integration of multiple wireless technologies in the enterprise. Again, this is an area of convergence between the two technologies: traditionally, Wi-Fi uses a distributed network model, with networks deployed within the enterprise location, while cellular networks use a centralized network model, necessary to provide wide-area coverage.

Beyond the enterprise: Wi-Fi 6 at home

Initial adoption of Wi-Fi 6 infrastructure will be driven primarily by the enterprise, but it will quickly spread to devices such as smartphones and laptops. As penetration among user devices goes up, Wi-Fi 6 will become the default choice for residential APs.

Increased throughput and lower latency will improve the user experience at home, especially if the Wi-Fi network is shared by several heavy users and many connected devices. The improved battery life and increased uptake of smart devices in the home network will also further accelerate the adoption of IoT devices and services, which in turn will increase the performance requirements and drive the adoption of both Wi-Fi 6 and Wi-Fi 6E.

The large increase in throughput and capacity in Wi-Fi 6 can benefit Wi-Fi 6E devices where the 6 GHz band is available. Wi-Fi 6E may also lead to expanded use and improved performance of Wi-Fi for broadband connectivity in multi-dwelling buildings.

Wi-Fi 6E in the new 6 GHz band

In April 2020, the FCC opened 1,200 MHz of spectrum in the 6 GHz band (5.925–7.125 GHz) to unlicensed access, and Wi-Fi 6E will be the only version of Wi-Fi available in the new band. Wi-Fi 6E extends all the features of Wi-Fi 6 to 6 GHz. Because earlier Wi-Fi versions are not supported in this band, there will be no overhead to manage legacy devices, so Wi-Fi performance will be further improved. The European Conference of Postal and Telecommunications Administrations (CEPT) and many countries are exploring the opening of the 6 GHz band to unlicensed access, with the UK, Brazil, Canada and South Korea expected to be among the first to open the 6 GHz band to Wi-Fi.

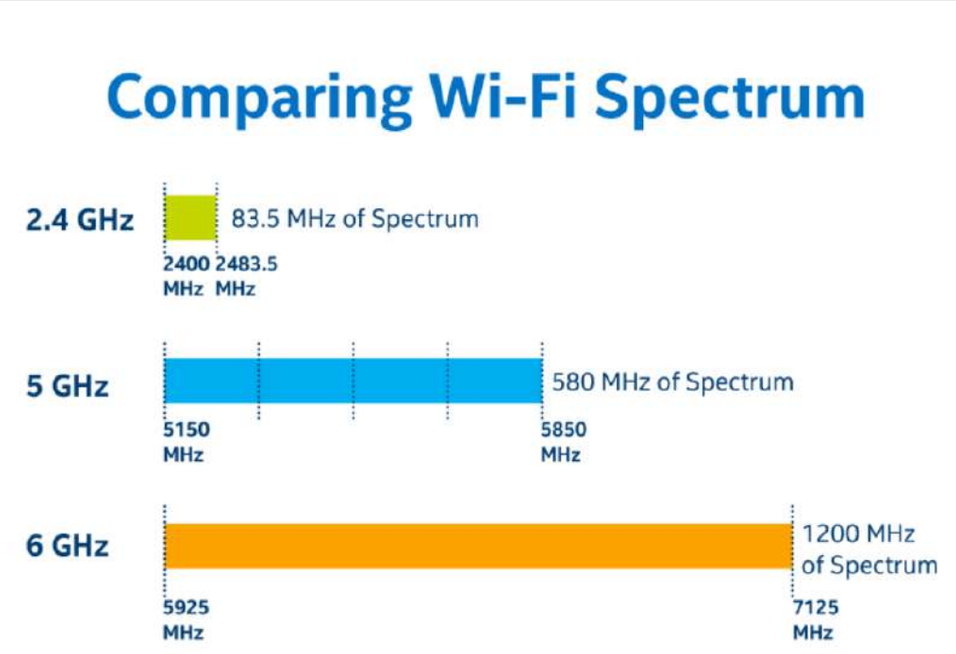

Figure 1. Source: Intel Corporation, 2020

One cannot overestimate the impact of the 6 GHz spectrum designation on unlicensed use: the new spectrum band has almost twice the bandwidth of the 2.4 GHz and 5 GHz bands combined. Wi-Fi 6E will massively increase the capacity of Wi-Fi, and some enterprises may need Wi-Fi 6E simply to address congestion at 2.4 and 5 GHz, where traffic levels continue to rise.

The availability of many wide channels (14 channels of 80 MHz or 7 channels of 160 MHz) further enhances the ability of the enterprise to roll out services that have tight reliability, capacity, and latency requirements.

The more limited range in the 6 GHz band enables enterprises to protect their outdoor and indoor locations from interference from adjacent networks using the same band (Wi-Fi 6E, but in the future potentially 5G NR-U) and to have better control over spectrum use in various applications.

At the same time, enterprises need to keep in mind that the 6 GHz band is shared with incumbents for microwave links, mobile auxiliary services, and cable TV relay connections. While low-power indoor operation is allowed in the entire 1200 MHz band, the FCC has introduced Automated Frequency Coordination (AFC) to ensure that incumbents retain priority access to their outdoor links for protection against interference from outdoor access points. Because of the limited propagation of 6 GHz spectrum and the large bandwidth, spectrum availability is not expected to be an issue in most locations, but enterprises will verify whether this is the case when they build out their Wi-Fi 6E networks if they need outdoor coverage.

Adding to Wi-Fi 6: OpenRoaming

While not part of Wi-Fi 6, OpenRoaming promises to be a major component of the evolution of Wi-Fi in enabling seamless onboarding and roaming across Wi-Fi networks. This is critical for enterprise users.

Signing up in a Wi-Fi network has become much easier, but it is still challenging for an enterprise managing a Wi-Fi network to provide seamless and secure authentication to visitors, and to know whether enterprise users connect to trusted networks when they leave the premises.

OpenRoaming uses Wi-Fi Alliance's Passpoint for automatic network discovery, selection and signup, and seamless access and roaming.

On top of Passpoint, OpenRoaming establishes a roaming federation, in which the Wireless Broadband Alliance (WBA) acts as the ecosystem policy authority. The federation includes both Wi-Fi network operators, which include enterprises and venues, and identity providers – trusted entities that manage users' credentials. An enterprise may be an identity provider for its users, or it may collaborate with an identity provider to give access to its users outside its network. By participating in the federation, the enterprise can seamlessly provide access to visitors or customers within its Wi-Fi footprint, according to its access policy.

The federation leverages many of the strengths of Passpoint that are valuable to the enterprise, but that have not been extensively used until now because Passpoint was largely deployed by mobile operators using SIM-based authentication, which is not the preferred authentication method in enterprise Wi-Fi networks.

The wide range of identity providers – ranging from mobile and cable operators to social media providers, equipment vendors and enterprises – creates a much wider ecosystem where everybody can participate, and that uses global policies, identifiers and provisioning mechanisms. The federation establishes a trusted cloud of entities that work across authentication methods without the need to have bilateral agreements in place.

Until now, this has made it difficult for enterprises, especially small and medium ones, to securely and effortlessly manage visitor access to their networks and user access to other networks. Often the solution is to create separate guest Wi-Fi access and temporary credentials for visitors and to leave users to manually connect to external Wi-Fi networks. Upon joining the OpenRoaming federation, the enterprise becomes part of the ecosystem and can manage trusted Wi-Fi access for both its users and its visitors.

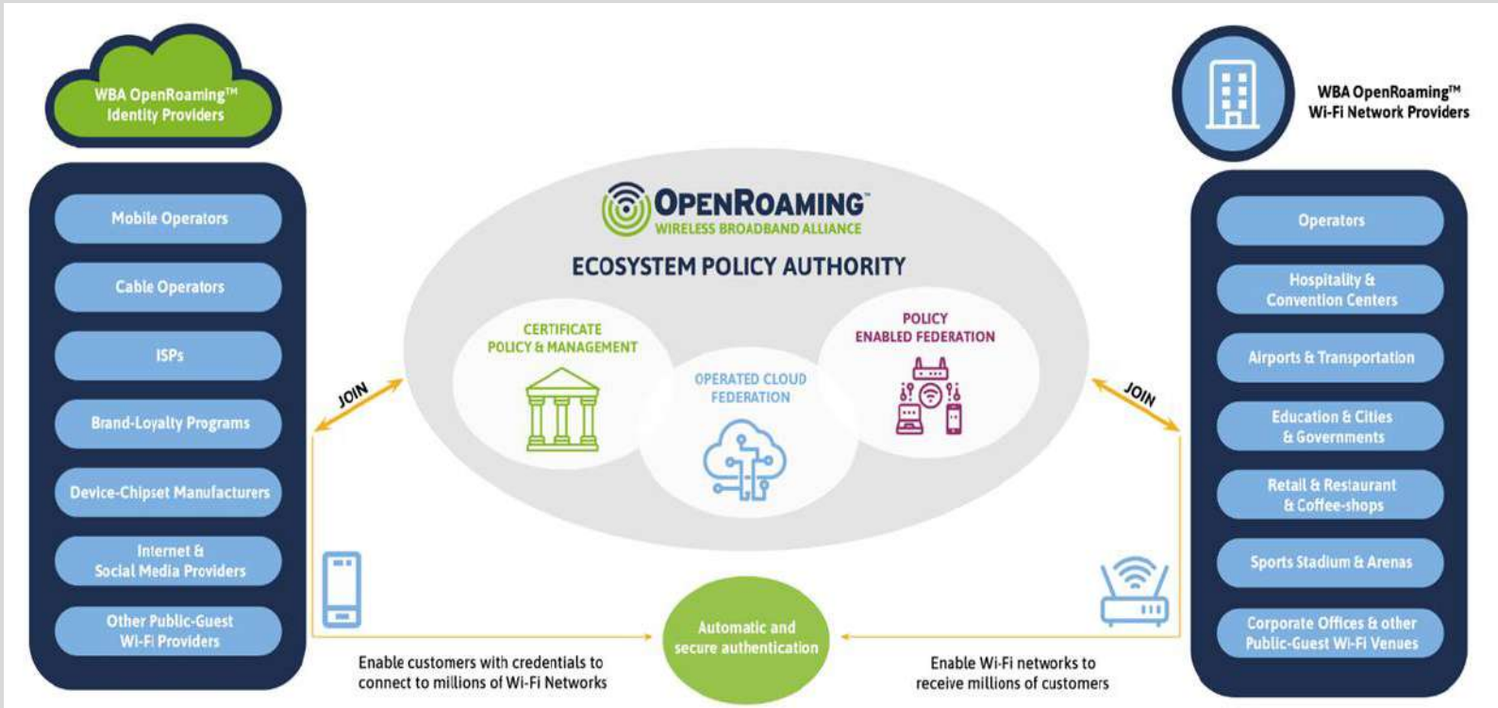

Figure 2. Source: Wireless Broadband Alliance, 2020

About Intel

Intel is an industry leader, creating world-changing technology that enables global progress and enriches lives. Inspired by Moore's Law, we continuously work to advance the design and manufacturing of semiconductors to help address our customers' greatest challenges. By embedding intelligence in the cloud, network, edge and every kind of computing device, we unleash the potential of data to transform business and society for the better. To learn more about Intel's innovations, go to newsroom.intel.com and intel.com.

About Senza Fili

Senza Fili provides advisory support on wireless technologies and services. At Senza Fili we have in-depth expertise in financial modeling, market forecasts and research, strategy, business plan support, and due diligence. Our client base is international and spans the entire value chain: clients include wireline, fixed wireless, and mobile operators, enterprises and other vertical players, vendors, system integrators, investors, regulators, and industry associations. We provide a bridge between technologies and services, helping our clients assess established and emerging technologies, use these technologies to support new or existing services, and build solid, profitable business models. Independent advice, a strong quantitative orientation, and an international perspective are the hallmarks of our work. For additional information, visit www.senzafili.com.

About Monica Paolini

Monica Paolini, PhD, founded Senza Fili in 2003. She is an expert in wireless technologies and has helped clients worldwide to understand technology and customer requirements, evaluate business plan opportunities, market their services and products, and estimate the market size and revenue opportunity of new and established wireless technologies. She frequently gives presentations at conferences, and she has written many reports and articles on wireless technologies and services. She has a PhD in cognitive science from the University of California, San Diego (US), an MBA from the University of Oxford (UK), and a BA/MA in philosophy from the University of Bologna (Italy).