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5G and Wi-Fi 6E -Friends or Foes?



Today's new generations of cellular and wireless LAN technologies, 5G and Wi-Fi 6E, leverage similar technical methodologies to provide high-end user experiences.

Two common approaches being used are orthogonal frequency-division multiplexing (OFDM), which is the most efficient way to pack data into a wireless signal, and multi-user multiple-input and multiple-output (MU-MIMO), which sends unique data streams simultaneously to multiple users. With these standard approaches, both networks are powering gigabit speeds and quicker response times for users. While there are purists that tout one technology over the other, what counts is the technology's ability to provide high-quality user experiences. Is one better than the other? Let's look at some of the primary considerations for choosing to use 5G, Wi-Fi 6E, or both.

5G & Wi-Fi 6E Offer Complementary Indoor Capabilities

5G and Wi-Fi 6E have the following valuable attributes that allow both to be used in indoor networks.

The Benefits of Wi-Fi 6E

Wi-Fi has more presence in various devices, including smartphones, and is easier to use, allowing it to become the dominant connectivity technology for homes and businesses. Being established in more ecosystems than 5G provides Wi-Fi 6E with a natural marketplace and the following advantages:

- The cost of Wi-Fi 6E modems is lower than 5G alternatives.
- Installation and deployment of Wi-Fi are typically easy for owners and businesses to accomplish without assistance.
- Some device operating systems establish Wi-Fi connectivity preference ahead of the cellular network, allowing it to select the Wi-Fi 6E network automatically.
- The spectrum used by Wi-Fi 6E is available to all, as Wi-Fi 6E operates in unlicensed spectrum, while 5G being deployed today, called 5G New Radio (5G NR), requires licensed spectrum.
- Usability, simplicity, and flexibility make Wi-Fi easier to deploy and support for system integrators and enterprises.
- Vendors that provide Wi-Fi devices have well-established relationships with integrators and enterprises.
- Users that have data-limited wireless packages are accustomed to offloading to Wi-Fi.

The Benefits of 5G

5G offers substantial advantages that make it a compelling technology for indoor connectivity.

- 5G operates in a wide range of spectrum bands, allowing an MNO or enterprise to balance coverage needs between low- and mid-band spectrum, and high-band spectrum when high capacity and low latency are critical to specific applications or use cases.
- Unlike Wi-Fi, 5G fulfills quality of service (QoS), to enable use cases like Industrial IoT, real-time computer-controlled robots, and other latency-sensitive applications.
- 5G networks offer a wide range of use cases that need low latency, high bandwidth, and superior reliability.
- 5G ecosystem has demanding and thorough interoperability testing and certification processes.
- The New Radio Unlicensed (NR U) can leverage unlicensed spectrum to provide additional spectrum capacity when needed by high-bandwidth applications.
- 5G seamlessly transitions users between wide-area and local networks for full mobility without delays or interruptions.
- 5G defines full-system, end-to-end specifications, including secure user access and traffic prioritization, while Wi-Fi only provides device-to-access-point physical connectivity.

Now that we've looked at the benefits of each from a high level, let's take a closer look at the benefits of each wireless technology in more detail.

An Effective Option for Enterprises & Service Providers

One of the primary strengths of Wi-Fi solutions is that Wi-Fi operates in unlicensed spectrum. For years, businesses and service providers have been leveraging wireless networks to provide services that allow employees and customers to get network connectivity without carrying and plugging in a cable. Wi-Fi 6E is the latest technology that operates in unlicensed spectrum bands, providing for lower-cost solutions to deploy, manage, and scale for indoor coverage areas. With several new technical capabilities, including OFDMA, MU-MIMO, and 1024 QAM, Wi-Fi 6E uses spectrum more efficiently, brings enterprise users gigabit speeds, and achieves higher user densities that prior Wi-Fi technologies could not reach. Wi-Fi 6E's target wake time feature enables the device to minimize communications with the access point until the appointed "wake-up time," which improves network efficiency and can extend device battery life.

Wi-Fi 6E Increases Speeds with Wider Channels in 6GHz Spectrum

Wi-Fi 6E devices can now reach multi-gigabit speeds using much larger spectrum swaths. Wi-Fi 6E devices function in wider 80 and 160 MHz channels, creating much larger pathways that help users reach multigigabit speeds. By getting these rates, enterprises can deploy Wi-Fi for their internal operations to meet real-time application needs. Users in this range also encounter less network interference because the latest devices do not compete with legacy Wi-Fi devices using the same spectrum.

In April 2020, the FCC classified the 6GHz spectrum for unlicensed use, and the Wi-Fi Alliance coined "Wi-Fi 6E" for networks and devices that operate in this newly allocated spectrum.^{1, 2}

Wi-Fi 6E Offloading Improves User Experiences

MNOs and MSOs use Wi-Fi as a natural part of their network strategies. For MSOs, like cable operators that provide wireless services as an MVNO, Wi-Fi offload capability reduces the operational fees that the MVNO pays to the MNOs. MVNOs leverage Wi-Fi in home networks and public hotspots to transition the subscriber off the commercial wireless network when they reach Wi-Fi coverage. MNOs are also finding value in Wi-Fi offload by similarly transitioning cellular traffic to Wi-Fi in busy areas like subways, shopping districts, stadiums, and other large venues. By offloading some of the cellular traffic and sending it over the Wi-Fi infrastructure, the MNO improves the user experience for cellular customers in that area.

However, for offloading to be effective with 5G, the Wi-Fi network's user experience must be comparable to or better than 5G. Though the new features in Wi-Fi 6E provide the high bandwidth and improved reliability that new media services like AR and VR demand, a seamless experience between indoor and outdoor transition remains a challenge.

Wi-Fi Security Improves with WPA3

One of the significant concerns with legacy Wi-Fi solutions was the relative ease with which unscrupulous users could access a Wi-Fi network. The new security protocol that Wi-Fi 6E uses, Wi-Fi Protected Access 3 (WPA3), will help combat this concern. WPA3 adds new features that simplify overall Wi-Fi security, enable more robust user and device authentication, increase encryption strength, and ensure secure communications. First, Wi-Fi Protected Access (WPA) builds in defense against brute force attacks, like "dictionary" attacks, by delivering robust device protection even when a user chooses a password that does not meet typical complexity recommendations. Second, WPA uses 192-bit keys for encryption and aligns with the Commercial National Security Algorithm (CNSA) Suite. Third, WPA3 provides secure public Wi-Fi through a more secure handshake and by offering data encryption on open networks. These new abilities can provide the promise of better security for public Wi-Fi networks.

^{1. &}lt;u>https://docs.fcc.gov/public/attachments/DOC-363490A1.pdf</u>

^{2.} https://www.wi-fi.org/news-events/newsroom/wi-fi-alliance-brings-wi-fi-6-into-6-ghz

5G Meets Expanded Needs for Enterprise Indoor Networks

5G is a complete end-to-end solution that covers the access and core networks, which enables enhanced mobile broadband (eMBB) connectivity, ultra-reliable and low-latency communications (URLLC), and massive machine-type communications (mMTC). By providing the full network suite, 5G meets both the wide-area and indoor connectivity needs of consumers, enterprises, and government communications. From its early deployments, 5G has been providing high throughput and low latency, allowing users to reach gigabit speeds when used with millimeter wave spectrum. 5G is an integrated solution that offers excellent reliability, tight security, and seamless network transparency to efficiently serve businesses and users. The 5G NR radio network delivers a dramatic boost to cellular communications by leveraging a much wider range of frequencies (from sub-1 GHz up to 100 GHz) to create large bandwidth channels. 5G also allows the aggregation (logical addition) of carriers across multiple bands to create even greater bandwidth paths. 5G is also differentiated from Wi-Fi in its support of massive MIMO, which actively focuses the signals on many antenna elements to establish specific high-bandwidth links to improve user throughput and experience. 5G also offers automated end-to-end network slicing and a QoS framework that allows users to receive a guaranteed service level by reserving resources. These are some of the capabilities that make 5G NR an appealing technology for today's indoor connectivity requirements.

5G Offers Higher Reliability and Lower Latency

Industry 4.0's smart manufacturing sees facilities with high user densities that require accurate delivery of data packets on the first attempt, and 5G is built to deliver. Smart factories can depend on 5G's reliable indoor connectivity and low-latency connectivity to operate real-time services like automated manufacturing controls and AR/VR applications that can reduce downtime from maintenance activities on production equipment. The ability of 5G to exchange high-bandwidth data dependably in less than two milliseconds allows smart production facilities to minimize infrastructure costs by building agile production lines without copper

When it comes to reliability and latency, 5G stands out. The ultra-reliable factor offered in 5G can swing businesses to deploy 5G for indoor coverage.

wires as their connectivity infrastructure. Many of these automation systems use AI-based video for validating the quality of components during each step of production, and the reliable, low-latency connectivity provided by 5G delivers high-quality images to ensure quick and accurate analysis.

5G Builds in Security

Today's business world demands high security, and the 5G network integrates defense capabilities that keep data private and systems free from intruders. The 5G network uses sophisticated and efficient procedures like Authentication and Key Agreement (AKA) security protocol. Another enhancement in 5G is that the user equipment (UE) encrypts its identity (Subscription Permanent Identifier or SUPI) before sending it to the network, eliminating the ability to track the UE based on its long-term identity to prevent unauthorized device access to the 5G network. Security in cellular networks continues to advance, offering technologies that mitigate user data interception and protect the network's integrity by preventing unauthorized software loading from man-in-the-middle attacks, software viruses, and other malicious activities. 5G provides centralized management and automated upgrades that provide enhanced security practices over Wi-Fi deployments. Using these enhancements, 5G improves device authentication, traffic encryption, and privacy protection for devices that were impossible in 4G networks.

5G Seamlessly Transitions Connections Between Indoor and Outdoor Coverage

A consumer or business executive's ability to transition their applications between indoor and outdoor coverage has long plagued Wi-Fi. With many of today's business applications residing in the cloud, the user's ability to maintain connectivity as they change environments can be critical. When 5G provides indoor coverage, the network can seamlessly transition voice or video sessions or exchange data between computationally intensive real-time applications from the indoor to macro networks without interruption. While 3GPP Releases 15 and 16 enable the 5G core to maintain connections that move users to and from non-3GPP access networks, like Wi-Fi, applications can experience disrupted communications. For real-time applications, 5G is more reliable than Wi-Fi in addressing hand-offs between radios, whether it's transitioning inside or maintaining a seamless connection between indoor and outdoor coverage.

5G Private Networks Offer Enterprises Control

The ability of 5G to bring high-speed, low latency connectivity indoors creates deployment options for enterprises. With security being a top concern, enterprises can choose to manage the indoor network themselves to ensure that they have full control. Alternatively, they can partner with an MNO for indoor coverage. While the best choice often is for the company to arrange for the MNO to manage their private network and indoor coverage, another option is to leverage an independent service provider, or neutral host, to deploy and operate the indoor private system. The agreement with the managed service provider allows the provider to tailor the network to the business's unique indoor requirements without impacting existing macro network operations.

Meeting Business Needs with Both Solutions

As businesses have leveraged multiple technologies in the past, Samsung believes that the industry will use both 5G and Wi-Fi 6E in much the same way. These new higher frequency deployment options will require more radios and access points to cover the same areas, as the higher frequency signals do not provide the same coverage as lower frequency equipment.

Wi-Fi 6E is a cost-effective solution for networks and provides high bandwidth connectivity, but it does not guarantee the first-time-successful-delivery of data. Wi-Fi 6E is a good option for high-bandwidth networks that can endure some latency caused by retransmitting packets through the network.

For networks that require high reliability, 5G includes mechanisms in the protocols to establish connections that deliver accurate data the first time. And since 5G defines connectivity across the radio and core networks, it optimizes end-to-end data session control to improve application performance. 5G NR's higher user densities and QoS management offer service providers the ability to deliver new revenue-generating services to enhance their investment returns.

While Wi-Fi 6E is undoubtedly an excellent indoor option for use cases that need best-effort connectivity, many of today's applications have strict latency requirements that demand tightly managed quality of service levels available only with 5G. When proven device interoperability is essential, the 5G ecosystem that uses proven interoperability procedures before deployment is the right choice.

Samsung Products Deliver the Indoor 5G Experience

Samsung provides new, innovative indoor 5G products that network providers can use to extend high-speed, ultra-reliable 5G service to stadiums, arenas, concert halls, manufacturing sites, hotels and other settings.



Samsung Link Cell: The Samsung Link Cell is an innovative compact indoor small cell that integrates antenna, radio, and baseband functions in a sleek form factor to offer robust in-building 5G coverage with throughputs approaching 1.8Gbps using mmWave spectrum (the first commercially available Link Cell supports 28GHz). This 5G product is among the first commercially available solutions that can connect indoor users to their data and applications using mmWave spectrum. Since the same 5G network supports indoor and macro coverage, users can seamlessly transition between the zones without missing a beat.



Samsung Link HubPro: The Samsung Link HubPro extends 5G and 4G capabilities indoors efficiently and cost-effectively. The solution includes small units with antennas and radio capabilities for operating in 700MHz, 850MHz, AWS, PCS, and CBRS spectrums. These small units connect to a hub unit for power and network connectivity. Network operators can join multiple Link HubPros to act as a single cell that extends coverage in buildings and transit locations like subways and airports.



Samsung Link Hub: The Samsung Link Hub is an innovative radio solution that provides 4G and 5G services through passive antennas, like the Distributed Antenna System (DAS). The solution efficiently expands 4G coverage or cost-effectively upgrades a location to 5G capabilities using 700 MHz, 850 MHz, AWS, PCS, and CBRS spectrum bands by reusing existing cables, saving both time and cost.

The Samsung Link portfolio of indoor solutions is another example of Samsung's pioneering efforts to successfully deliver 5G end-to-end solutions. These indoor 5G services ensure the smooth and continuous high-quality user experiences inside buildings that 5G users expect.

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