White paper

5G versus Wi-Fi 6: Deployment considerations for enterprises

verizon

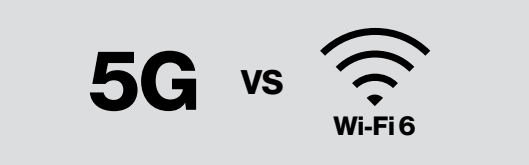
Catalysts for economic growth

The world's economy is at a pivotal moment, as artificial intelligence, the Internet of Things (IoT), augmented and virtual reality (AR and VR), and other long-awaited technologies are transitioning from buzzwords into offerings and capabilities. The catalyst: high-speed, high-capacity and low-latency wireless connectivity.[1]

Mainstream adoption of such bandwidth-hungry technologies will naturally result in a massive increase in wireless network traffic. It's predicted that by the end of 2024, global mobile traffic will reach 131 exabytes (EB) per month.[2]

Consumers as well as large industrial companies will benefit from the technological advancements delivered with the Fourth Industrial Revolution (4IR). As an example, Deloitte estimates predictive maintenance will increase uptime and availability by 10% to 20%.[3] New networks supporting massive machine-to-machine communication are needed in order to make this happen.

Cellular and Wi-Fi technologies are undergoing major technological advances to support emerging use cases and requirements. This paper addresses considerations for both technologies, while demonstrating how 5G will help smart enterprises with their current and emerging wireless needs.



Emerging use cases and requirements and the role of 5G

New and enhanced wireless service capabilities will be necessary to support heavy consumer, public sector and business use, including:

- Seamless user experience (e.g., access, coverage and quality of service)
- IoT support (e.g., cameras, sensors, smart cities, streaming)
- Critical services (e.g., public safety)

As an example, smart factories will need advanced remote industrial robotics. Operations will have to be controlled remotely and will typically require less energy consumption. Real-time digital "twins" that allow plant management to identify capacity, track production and optimize operations is an emerging use case.

The Verizon Eight Currencies of 5G define a common set of performance attributes that can be used to evaluate whether or not a network can deliver next-generation service capabilities. They are:

- Throughput
- Service deployment
- Mobility
- Connected devices
- Energy efficiency
- Data volume
- Latency
- Reliability

5G and Wi-Fi 6 have different characteristics for some of these currencies and, as a result, are not equally suited to support certain use cases.

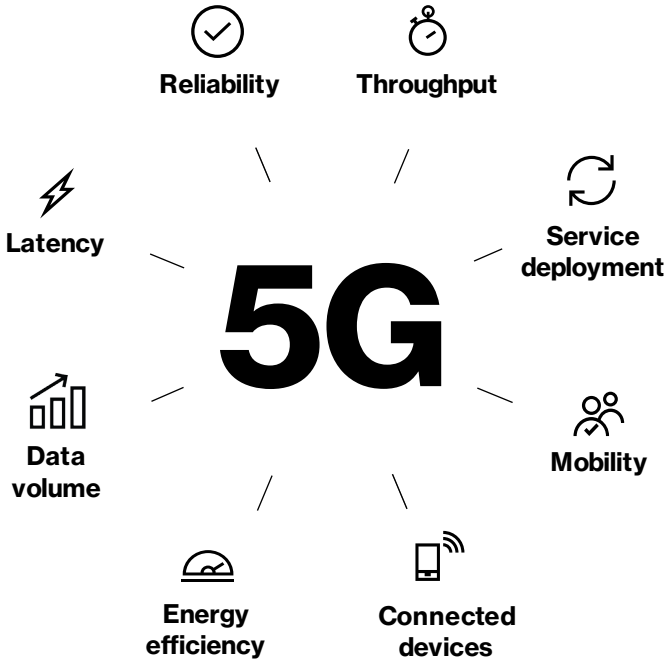


Figure 1: Verizon's Eight Currencies and the related service capabilities

As illustrated in Figure 1, Verizon 5G is very well positioned to serve most enterprise use cases, especially mission-critical use cases like Industrial IoT (IIoT), emerging use cases like time-sensitive networking over wireless, or bandwidth-hungry use cases such as connected video cameras and AR/VR. To achieve this, improved radio techniques are introduced, such as different symbol durations and carrier spacing, advanced beam-forming techniques, sleep modes, and improved spectral efficiency, among others. But there is more. There are other critical considerations for enterprises that are inherent to the way 5G is designed.

Quality of service

5G is designed as a network with a radio access component, backhaul and core network, and it can deliver superior quality-of-service (QoS) mechanisms, including:

- Licensed frequency bands, which reduce interference issues from other wireless devices
- Network slicing, which is a powerful QoS mechanism. Extending it into the backhaul and core provides true end-to-end QoS for applications. This is enormously valuable, as illustrated in Figure 2. As an example, it will facilitate lines of business within enterprises in achieving individual business outcomes

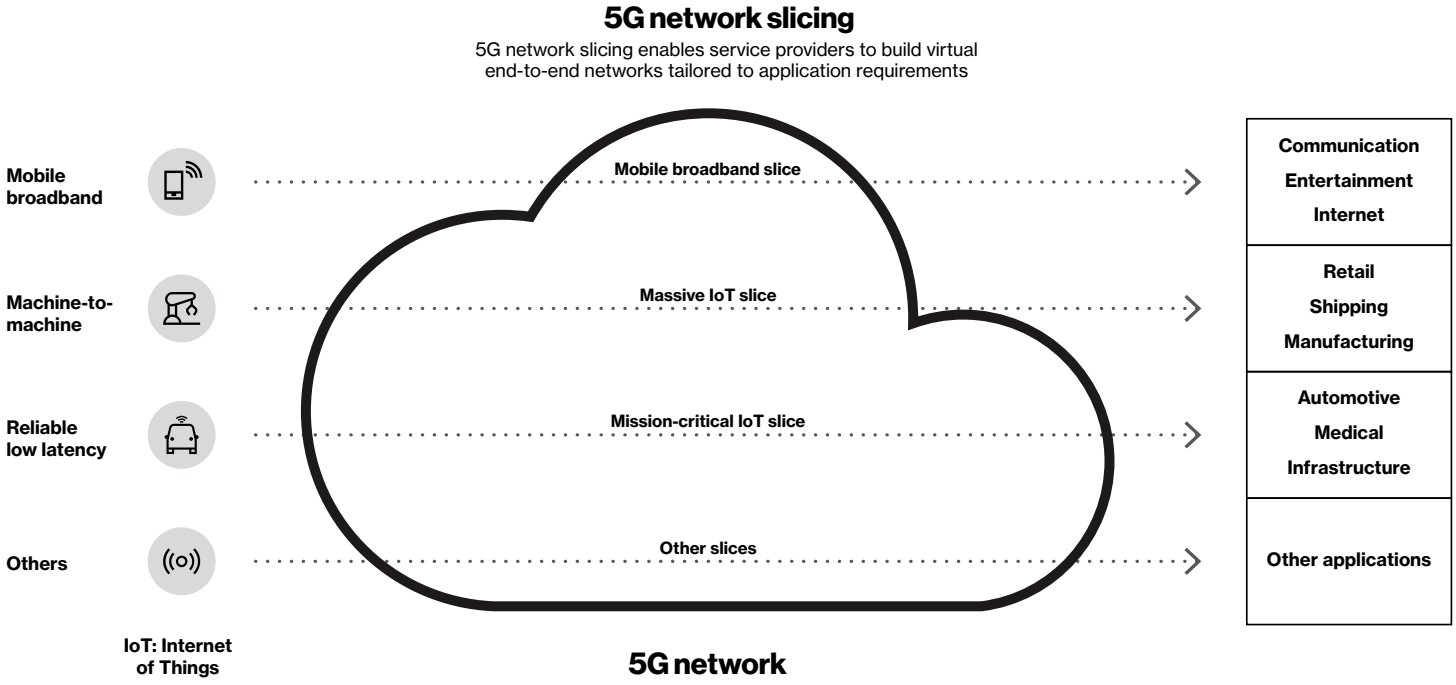


Figure 2: 5G network slicing (source: sdxcentral[4])

Security

The use of licensed frequency bands and network slicing not only provide superior quality of service. They are also fundamental to ensure strong end-to-end security. Combined with SIM authentication, 5G natively secures the application across the network, including devices and radio.

The vSIM technology recently patented by Verizon should further increase security and enhance the user experience. The blockchain-based vSIM can be used by and transferred between different devices associated with the user account or temporarily assigned to other users.[5] This extends the capability of "virtualization" into the end-user device.

Service deployment flexibility

5G has been designed from its inception to be "cloud native," inheriting many of the technology solutions used in cloud computing and with virtualization at its core. This enables faster, more efficient service deployment. This is also another reason Verizon software-defined networking (SDN) and network function virtualization (NFV) solutions can make enterprise networks 5G ready now.

MEC support

The cloud-native approach also brings native mobile edge computing (MEC) support. Combined with a core network, a distributed MEC approach can enable cost-efficient support of a mix of services with, among other things, differing latency requirements. This will embed compute functionality within

the 5G network, which is needed for an enterprise to scale its 4IR operations efficiently. Verizon is the first to put this concept into practice by integrating its 5G network edge computing with Amazon's AWS® Wavelength. As Hans Vestberg, CEO and Chairman of Verizon, commented on this partnership: "Bringing together the full capabilities of Verizon's 5G Ultra Wideband and AWS, the world's leading cloud with the broadest and deepest services portfolio, we unlock the full potential of our 5G services for customers to create applications and solutions with the fastest speeds, improved security and ultralow latency."[6]

Ubiquitous access
Cellular networks are built to support easy, ubiquitous access through efficient end-user authentication, as well as mobility and roaming that provides seamless coverage far beyond the local area network. Cellular networks, by nature, have excellent outdoor coverage and can operate in various licensed and unlicensed frequencies, depending on the intended use case and environment (urban, suburban and rural).

Roadmap flexibility
Third Generation Partnership Project (3GPP) standards include the principle of separating the control plane and user plane. The importance of this cannot be underestimated. It allows Verizon to implement a flexible roadmap that enables enterprises to make a phased transition into new technologies and a gradual transition from 4G LTE into 5G on a network where LTE and 5G can coexist. Indeed, cellular roadmaps have a demonstrated history of controlled and gradual technology transitions.

WAN and LAN support
Cellular technology is by design a WAN technology. The upcoming 3GPP R16 standard includes LAN support. As such, 5G service deployments will be full network deployments, providing a distinct and important advantage for large enterprises with multiple sites, for indoor and outdoor facilities, and for mobile workforces that require both office and remote connectivity.

Other existing and emerging technologies considerations and 5G benefits

Other wireless technologies such as Wi-Fi are also undergoing major technological shifts to support emerging use cases and requirements.

As illustrated in Table 1, Wi-Fi 6 is the next-generation Wi-Fi to address high-bandwidth, low-latency applications and dense, highly congested wireless environments. Note that the radio techniques used to achieve the improvements are similar to those used in cellular technology (improved modulation, improved spectral efficiency, different symbol durations and carrier spacing, beam-forming techniques, and sleep modes).

Parameter	5G	Wi-Fi 6
Peak data rate	Up to 10 Gbps (LTE-A: 1 Gbps)	Up to 10 Gbps (Wi-Fi 5: < 100 Mbps) Theoretical value, no reliable test data available.
Reliability	Ultimate goal is 99.999% (LTE: 99.99%)*	Better than Wi-Fi 5. No specification available.**
Density	1 M devices/sq km (LTE: 1,000)	4x density of Wi-Fi 5
Energy efficiency	10% of current consumption	32% of current consumption
Latency	< 10 ms (LTE: 30–50 ms)	< 10 ms (75% lower latency)***

* % of 20-byte packets delivered by 1 ms

** Service subject to interference due to the use of unlicensed spectrum

*** Degrading over distance due to fading and unpredictable due to "Listen before Talk" constraint

Table 1: 5G and Wi-Fi evolution

Wi-Fi 6 differs from 5G in a number of areas:

- **Spectrum:** Wi-Fi 6 exclusively works in the unlicensed spectrum frequency bands and is subject to difficult-to-control interference in "noisy" environments
- **Current adoption:** Wi-Fi has a high adoption rate, mainly in home and office LAN environments. This is reflected in the Wi-Fi device ecosystem support for those environments
- **Current use cases:** Current Wi-Fi use cases are mainly indoor; cellular is suitable for mobile, fixed, nomadic, indoor and outdoor use

It is expected that Wi-Fi will continue to play an important role in consumer and office LAN environments. In addition, due to better performance compared to Wi-Fi 5 for peak data rate, latency, density and energy efficiency, Wi-Fi 6 will be used for other basic enterprise use cases. Verizon manages Wi-Fi solutions at scale for customers today and expects to do so in the future, supporting enterprise customers' needs wherever they are on their digital journey.

Future vision enabled by 5G

5G is not about building networks. It is about a platform for communication that can ultimately serve all enterprise use cases. Over the next decade, continued improvements will likely be made to enable this purpose. Areas where near-term (further) development for 5G is expected include:

- Coverage (both geographical and indoor coverage capabilities)
- Increased spectrum capabilities (such as the use of Citizens Broadband Radio Service [CBRS] and unlicensed spectrum)
- MEC
- Network slicing
- Expanded device ecosystem

These developments and many others should bring further improvements, such as:

- Increasing support of vertical industries and use cases, for example, vehicle communication
- Ultrareliable and low-latency communication (URLLC) enhancements
- Improved network densification
- Improved indoor coverage and LAN support
- Multiuser, multiple input, multiple output (MU-MIMO) enhancements[7]
- Location and positioning enhancements
- Integration of satellite in 5G systems

A roadmap for standardization of the features supporting the above developments has been laid out in great detail by 3GPP and can be used by various industries for forward use case planning.

Conclusion

Cellular technology and Wi-Fi come from different backgrounds and have traditionally sought to address different use cases and needs. Wi-Fi has been designed to answer wireless LAN and indoor needs; cellular has been designed to address WAN, mobility and nomadic use cases. It is to be expected that both technologies will coexist for some time to come, and Verizon will continue to manage both, providing enterprises with the optimal solution based on their individual use cases and needs and meeting SLAs as needed. It is not one or the other, rather one and the other.

However, to make Industry 4.0 work, a convergence of the needs in LAN, WAN, indoor and outdoor applications starts to occur. The continued improvements as laid out in the 3GPP standardization roadmap for 5G pave the way for a technology that supports this convergence.

As enterprises look to support their current and emerging use cases, they should consider how Verizon 5G can address them. Additionally, because 5G runs in a highly virtualized architecture, enterprises are able to make their network 5G ready today with SDN/NFV solutions. 5G offers an infrastructure that will have the capability of integrating device, LAN and WAN into one seamless, flexible and secure stack, eliminating unnecessary costs and increasing performance—all with the key attribute of mobility. Verizon, recognized as a leader in the market, offers solutions to address mission-critical use cases such as industry automation, autonomous vehicles, remote surgery and emerging use cases like Time-Sensitive Networking (TSN), while still providing the flexibility of a wireless infrastructure. Indeed, cellular technology has the advantage that it works everywhere: indoors; outdoors; and in fixed, nomadic and mobile applications.

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