

SAMSUNG

**3GPP Release 16 - Shifting
Gears to Increase 5G Speeds
on Multiple Network Highways**



For more than a quarter of a century, wireless technologies have been creating networks that allow people to communicate with each other and obtain fast access to information anywhere in the world from wherever they are.

From voice-only systems to data-oriented services, wireless network architectures continue to evolve, and innovations lead to new capabilities that provide more efficient use of resources while delivering unique capabilities to instantaneously access information.

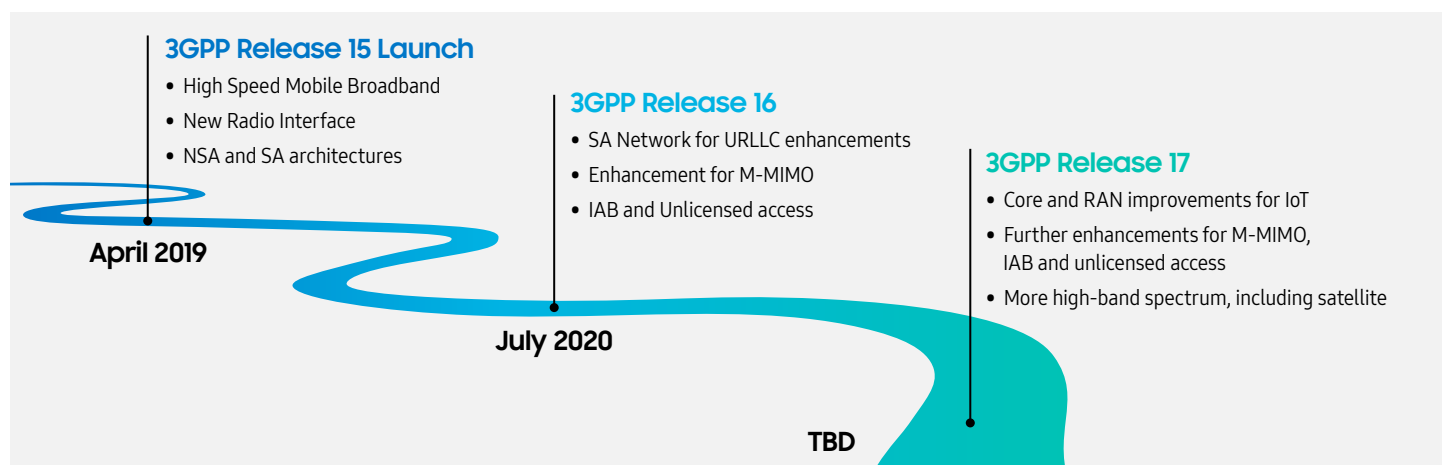
One of the primary challenges of wireless technologies is the need to define and publish product standards and specifications for equipment manufacturers to develop standards-based products for global network operators. 3GPP creates these rules and standards in a series of publications called “Releases,” which are used to develop new wireless

network capabilities for ITU standardization. 5G cellular technology, a revolutionary step in wireless networking, was introduced in Release 15. To ensure smooth deployments for network operators, 3GPP plans to evolve 5G in three phases:

Phase 1 – 3GPP Release 15 provided a new radio access network (RAN) and a new core network built on a service based-architecture to meet the high-throughput mandate leveraging automation and cloud techniques.

Phase 2 – 3GPP Release 16 extended capabilities in the RAN and core to drive down latency to support real-time sensitive services, providing support for more bands of spectrum.

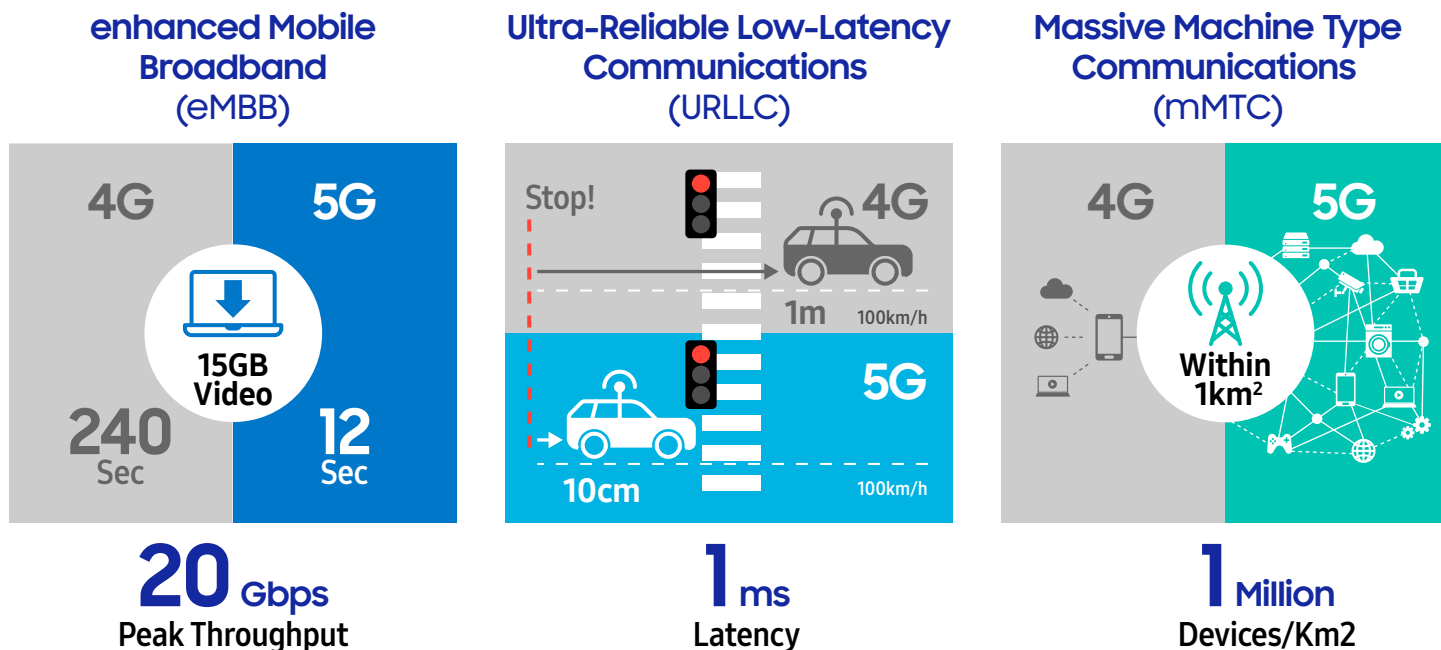
Phase 3 – 3GPP Release 17 will define more frequency ranges and implementation of non-terrestrial/satellite networks, as well as an architecture called NR-Light that reduces network complexities to meet low-cost, high-performance requirements.



This paper highlights several Release 16 benefits that enhance user experiences and improve network operator deployment options. Many believe these new capabilities are paving the path for 5G to open new vertical markets and become a multi-trillion-dollar contributor to the world economy.

5G Rolled Down the Highway with 3GPP Release 15

3GPP Release 15 was the first phase of the fifth generation of cellular technology, whose goal was to meet ITU's IMT-2020 performance requirements while also providing a variety of value-focused user services:



To support these goals, 3GPP targeted the following 5G performance requirements: 20 Gbps peak data rate, 1 ms radio network latency, 10 Mbps/m² area throughput, and 1 million IoT devices per square kilometer. 3GPP Release 15 defined for 5G a New Radio (NR) air interface, new radio and core network architectures, the requirement to use virtualization and automation technologies, and unique device types. One primary capability that enables existing mobile network operators to deploy 5G is the ability to connect and control the 5G NR RAN with their current 4G core, which is called non-standalone (NSA). Taking this approach allows network operators to transition their networks without needing a complete replacement or overlay of their existing investment.

Mobile network operators are deploying 5G NR solutions with 4G networks around the world. Depending on the spectrum they are using, users are experiencing throughputs ranging from 50 Mbps up to 2 Gbps. 3GPP Release 15 hit the mobile broadband mark – even 5G operating on the lower-frequency 600 MHz networks is exceeding 4G LTE speeds.

But to deliver to high-speed throughput with low latency to everyone, the industry is going to need more spectrum, more efficiency, and better latency, and these new capabilities require 3GPP's continued efforts including the next 3GPP release being delivered now.



3GPP Release 16 Puts Us in the Fast Lane

3GPP's Release 16 is an evolution of 5G that offers a revolution in business opportunities. With these new capabilities, networks will be faster, with lower latencies; provide new ways of connecting devices; and establish architectures that facilitate new business prospects. Each of these abilities creates stepwise improvements that can help network operators reduce operating costs through automation and spectral efficiency while increasing network capacity.

Gaining High Speeds Over Non-Toll Roads

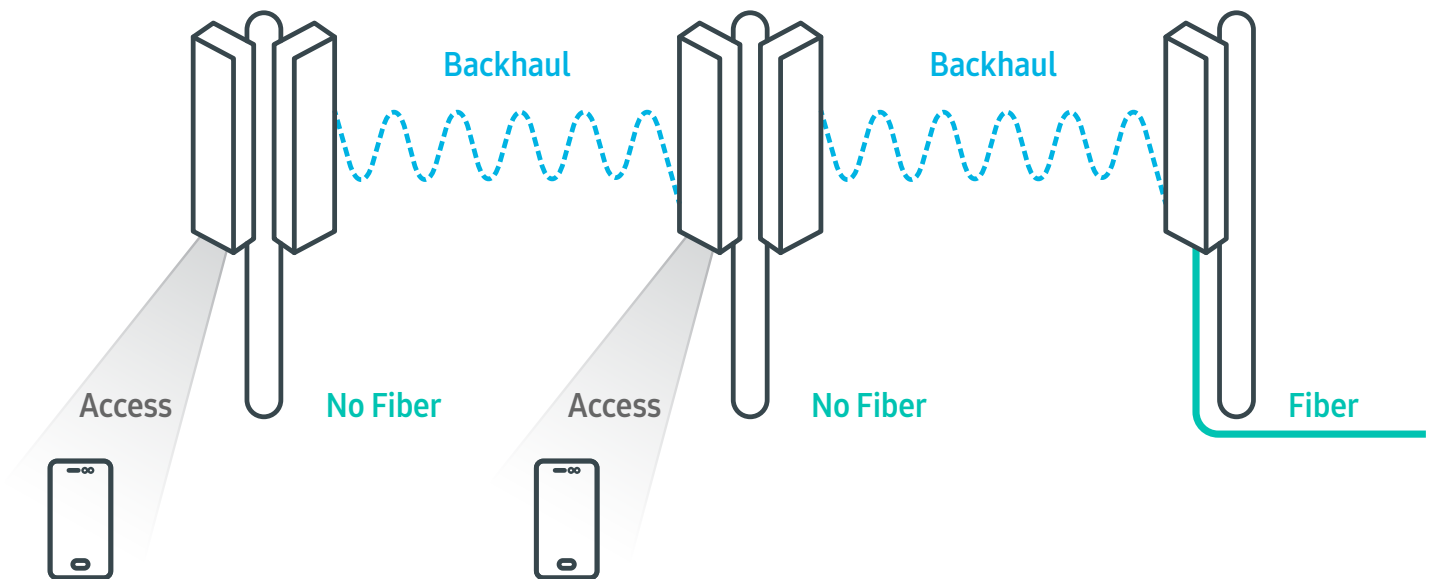
Spectrum is a scarce resource that provides the foundational connection for users, and mobile network operators require access to as much of the frequencies as possible. A variety of spectrum ranges allows operators to deploy networks that best support service for their users. Release 16 is increasing the availability of mid-band and millimeter wave channels for use by 5G. It is also establishing how 5G NR RANs can allow network operators to use the unlicensed spectrum to increase RAN capacity without the huge costs associated with licensed spectrum.

Built on the learnings from LTE's Licensed Assisted Access (LAA), Release 16 supports 5G's ability to access the unlicensed spectrum when it is available. Network operators will be able to deploy 5G NR RANs in the unlicensed spectrum ranges for on-demand capacity including:

- Carrier Aggregation (CA,) where the RAN can create larger channels on demand using the unlicensed spectrum as incremental carriers for either downlink traffic or both downlink and uplink traffic to increase user throughput
- Standalone 5G NR in unlicensed spectrum, which allows network operators to deploy service in venues where licensed spectrum is not available
- 5G NR base stations using Dual Connectivity, where the cell site uses licensed spectrum for the primary cell and unlicensed spectrum for the secondary cell.

New Ways to Use the Highways

In addition to the new spectrum, Release 16 is creating ways to use the spectrum more efficiently. While prior technologies used licensed airwaves only for connecting the user devices to the cell sites, Release 16 expands the role of the spectrum with Integrated Access and Backhaul (IAB). The primary objective of IAB is to facilitate increasing cell density and expand coverage of cells in either a non-standalone (NSA) or standalone (SA) architecture, particularly into areas that do not have sufficient fiber resources. Instead of using fiber-based connectivity, IAB uses the licensed spectrum to connect the cell to the core network via another cell site. Without the need to wait for fiber resources, IAB can speed cell site deployment velocity for network operators by reducing the need for fiber resources at the cell site, which are often a barrier to cell site turn-up.



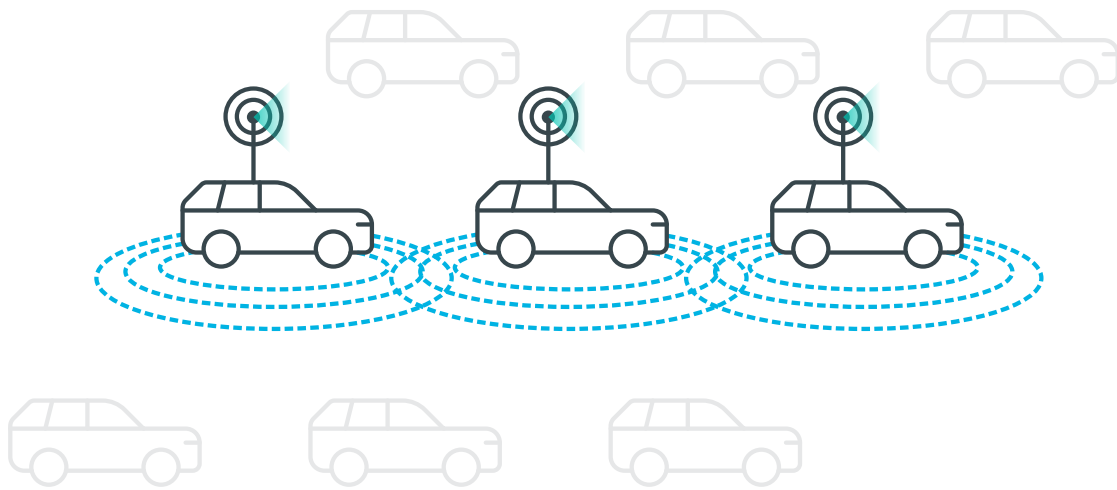
These additional cell sites can enable operators to more easily deploy cells to resolve coverage gaps and improve indoor coverage to 5G devices. Release 16 increases the range of coverage and locations that can use IAB by allowing multiple wireless cell hops using the sub-6 GHz spectrum and mmWave spectrum to help network operators expedite new cell deployments.

Quicker & Smoother 5G Roads Pave the Way for New Opportunities

The 5G tenet that promises to foster new enterprise applications is that of reliable, low-latency connections. While Release 15 created baseline capabilities to support low latency and reliable communications, Release 16 extends the base 5G NR capabilities to reduce latency between the user device and the radio to near 1 ms. The goal is to reach stable, consistent transmissions without error 99.999% of the time. Reliability and latency go hand-in-hand, as a connection with errors increases latency in the link due to the additional transfers needed to fix the mistakes.

Why are low latency and reliable connections important? In addition to the benefit of more efficient use of that critical resource called spectrum, low latency and ultra-reliable wireless communications offer clear paths to new revenue-generating services and easier operations for network operators by providing network agility using machine control and automation. The Physical and MAC enhancements that Release 16 introduces provide the ability to repeat critical information within a series of frames to reliably transmit accurate information. Prior wireless technologies relied on human users to adapt to errors or delays that occasionally occurred in these legacy networks. However, machines are not able to accurately interpret missing or erroneous information, so 3GPP is using Release 16 to enhance reliability and significantly reduce latency. With this type of reliability and low latency, 5G becomes poised to provide a high-quality QoS-enabled alternative to costly and inflexible copper-based LAN connections.

These new changes will help network operators provide the reliable connectivity needed for tomorrow's IoT applications like automated driving and cyber-controlled interfaces for robotics in manufacturing. To support vehicular control, Release 16 optimizes the lower layers of radio communication to reduce latency and improve reliability.



Industrial IoT applications in manufacturing sites require these low-latency and accurate communications to provide better control of production processes than available with legacy wireless communications like Wi-Fi. Release 16 also establishes the new sidelink communications path, which enables devices to exchange vital information directly with nearby devices without incurring the latency of sending critical communications through the 5G radio. This new sidelink capability can be used in V2X applications to increase safety and reduce accidents by allowing vehicles to communicate directly with nearby vehicles.

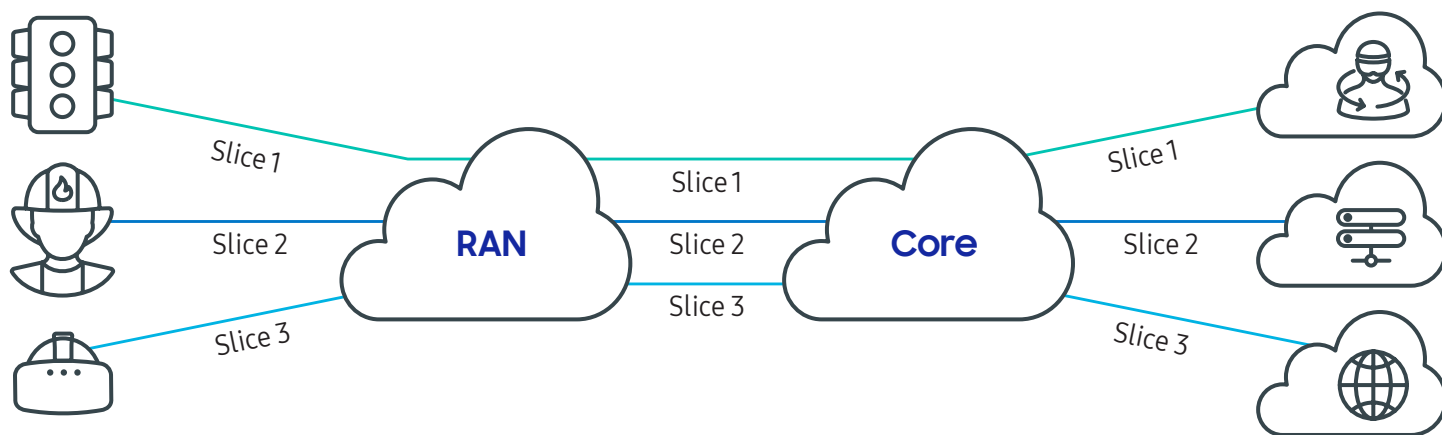
While not as critical as autonomous driving or robot-controlled production, video production teams are already testing 5G for creating real-time audio/video communications. The latency improvements in Release 16 can help video production teams provide the real-time experience expected when broadcasting live sporting events and breaking news stories with easier-to-use broadcast equipment.

Creating Dedicated Lanes for Optimal Experiences

One of the ways that network operators will be able to reduce latency is through dedicated, end-to-end traffic management. LTE provided approaches to establishing secure, dedicated paths by directing a subscriber's traffic to specific service networks based on the user's access point name. Release 16 significantly improves the experience by defining Network Slicing, which creates dedicated end-to-end traffic lanes across the RAN, Core, and transport resources of 5G SA networks. These dedicated lanes ensure high-quality data transmission for time-sensitive or mission-critical services, like connected cars and industrial production sites. While automotive use cases, like V2X, are prominent for 5G, network slicing provides the foundation for several more key services that have distinct service requirements.

Augmented reality (AR) and virtual reality (VR) are rising to similar prominence as V2X. AR creates engaging and interactive experiences for applications from education to high-tech field support guidance. AR applications superimpose diagrams, images, and text on the user's field of vision in real-time, so low latency is critical to the experience. While performing maintenance on a mechanical assembly on the manufacturing floor, a technician sees images that comprise the equipment, along with a checklist of tasks to confirm that the system is operating correctly. Virtual reality goes beyond pictures and words by providing full immersion for visual, audio, and tactile experiences. Virtual reality leverages high bandwidth and low latency to provide immersive education and training applications that are more engaging than simple screen video, as the user can experience the impact of actions they take during the training. With network slicing, network operators create multiple slices for handling different aspects of the application.

While first responders and public safety services have high bandwidth needs, the time they need the bandwidth is never known until an emergency arises. Not only can network slicing provide the necessary bandwidth for video and voice communications on demand, but the slices can ensure that the interactions between the public safety team members remain secure. First responder leaders also need access to accurate asset location information in real-time to deploy resources to the best locations. Network slicing is a critical technology that allows network operators to provide first responders with the necessary capacity, performance, and security when and where they need it.



Internet of Things and smart services have significantly different quality experiences that make them excellent services to leverage network slicing capabilities. Utility services, streetlight management, and vehicular traffic management are distinct services that do not have the same high-bandwidth characteristics of V2X, AR/VR, or public safety. However, they use many more devices that may need network access without warning. Network operators will have the ability to create slices that control standard vehicular traffic management and also deliver on-demand first responder needs in an emergency.

Network slicing can also establish the necessary resources in areas where capacity demands exceed the regular traffic load for that area. For example, short-term resources can be deployed close to such events, and traffic can be routed to these temporary resources during the events. Network operators can leverage the automated orchestration of end-to-end network slicing near these venues and roadways to ensure that the network can adapt when needed to the increased traffic demand.

Network operators can also use network slicing to set up private 5G networks for enterprises and business users. An enterprise can leverage the network operator's end-to-end network slicing to ensure their network meets their needs. The network operator can use network slicing to both limit access to the network and provide the resources that balance latency and throughput required by the applications used by that enterprise. This approach fits well in venues like manufacturing plants where the facility has different needs that range from ultra-low-latency connectivity for controlling production lines, to high-bandwidth security applications and sensor-based low-bandwidth lighting controls.

Looking Forward to 2021 and Beyond

The new capabilities introduced by Release 16 offer many benefits to network operators. From automating cell site management and accessing new mid-band spectrum to allowing devices to communicate with each other directly, the innovations delivered in Release 16 are continuing to improve the high-speed, low-latency networks that will bring new services to the market.

What's Next?

With 3GPP Release 16 finalized, research activities and discussions continue to make progress on the target items that 3GPP confirmed for inclusion in Release 17. The finalization of Release 17 was originally slated for 2021, but timing is in flux due to the pandemic. Release 17 intends to support 5G in more frequency bands in the mmWave range, including 57-66 GHz, and 66-72 GHz. In addition, the standards are providing enhancements to MIMO, IAB, and unlicensed access, along with optimizations to the RAN and core to support use cases for IoT for low-data, high-density “wearables.”

Release 16

- C5G System - Phase 2
- V2X for platooning, automated, and remote driving
- URLLC Enhancements and Network Slicing
- 5G NR Access to Unlicensed spectrum
- 5G Efficiency – SON, eMIMO, Interference Mitigation, Mobility Enhancements, eDual Connectivity

Samsung Leadership in 5G Technology

5G promises a lot, and the standards groups recognize that to deliver on these promises, strong leadership and experience are necessary to successfully develop 5G technological principles.

Samsung understands the real commitments of 5G and the genuine challenges that network providers must overcome to be successful when operating these new networks. While providing leadership and guidance during the standards-creation processes, Samsung continues to help define innovative solutions that both benefit network operators and offer valuable services to their customers. Samsung is proud to continue innovating technology that the industry recognizes and includes in these standards to help mobile network operators deliver the 5G capabilities that will drive benefits to business and all of society.

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