

TELCOMA Global Whitepaper

A review of 3GPP releases from 4G to 5G



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Research workers and engineers toil unceasingly on the development of wireless telegraphy. Where this development can lead, we know not. However, with the results already achieved, telegraphy over wires has been extended by this invention in the most fortunate way. Independent of fixed conductor routes, and independent of space, we can produce connections between far-distant places, over far-reaching waters and deserts. This is the magnificent practical invention that has flowered upon one of the most brilliant scientific discoveries of our time!

– Guglielmo Marconi, December 1909

More than 100 years after Marconi received his Nobel Prize for Physics, the same unceasing toil of research workers and engineers from all around the world, under the 3rd Generation Partnership Project (3GPP), continues apace. Since the time when 3GPP release 8, the first 4G LTE standard, was frozen in Dec 2008, the dream of connecting everyone and everything in the world wirelessly everywhere has been becoming a reality. At the start of the 3rd decade in the 21st century when the NR 5G is under large-scale rollout, it is worthwhile to have a retrospect on how 4G LTE has reached the goal. That is the purpose of this short article.

Table [1] shows how the LTE has been evolving in the last decades. According to the 3GPP home page, LTE was first introduced for the very first time in 3GPP release 8 frozen in Dec 2008 and ended in 2009, March, 12. All the releases since then are enhancements that have greatly leveraged the technology. Release 10, also known as LTE-Advanced, is 3GPP's first ITU-R IMT-Advanced radio interface that is generally regarded as the first true 4G technology. Release 13 is always referred to as LTE-Advanced Pro, which can be used by other vertical sectors other than telecommunications. These vertical sectors include Critical Communication in Mission Critical Systems, the M2M or IoT industry. The LTE-Advanced Pro has been the basis for the 5G NR system, which starts its 1st phase in Release 14.

In summary, LTE, LTE-Advanced, and LTE-Advanced Pro have offered an increasing spectrum efficiency, higher data rate, and adoption of advanced signal processing techniques. Their emergence has laid down the solid foundation for the evolution to the next generations of mobile systems from Release 14 and onwards

The past 10 years have witnessed the accelerating evolution from 4G LTE basic technologies to the next generation wireless communication technologies, i.e., 5G NR. As in no doubt, in the next 10 years, such a fast evolution trend will continue.

The COVID-19 pandemic has also proved the critical role of the network infrastructure during the social crisis, and the demand for a ubiquitous global network to keep everyone connected and stay safe will never decline.

Table 1: A review of 3GPP releases

Release	Start/End date	Descriptions
8	2006-01-23 / 2009-03-12	<ul style="list-style-type: none"> - Up to 300Mbps in downlink and 75Mbps in uplink by using 4x4 MIMO in DL and 4RX diversity reception in UL with 20MHz bandwidth. - 1.4 MHz, 3MHz, 5MHz, 10MHz, 15MHz, 20MHz are supported. However, the experience in the later rollout of the LTE network has shown that only 10, 15, 20MHz are the most popular ones. - Shorter round trip time and lower latency - Both normal CP and extended CP are supported, though the latter one is seldomly deployed in commercial networks. - OFDMA in downlink and SC-FDMA in uplink - All-IP network - Both paired and unpaired spectrum operations, i.e., FDD vs. TDD, are supported
9	2008-03-06 / 2010-03-25	<ul style="list-style-type: none"> - MIMO beamforming extension from single layer to multiple layers, especially in the 8 TRX scenarios with cross-polarization antenna, where each layer is mapped to one polarization - Enhancement of the MBMS for higher data rate and capacity compared to Release 8 - LTE positioning methods including network-assisted GNSS, downlink positioning, and enhanced cell ID.
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**Table 1 A review of 3GPP releases
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Release	Start/End date	Descriptions
10	2009-01-20 / 2011-06-08	<ul style="list-style-type: none"> - The ITU IMT-Advanced requirement has been fulfilled since Release 10 - It can achieve 1Gbps DL and 500 Mbps UL throughput, by using MIMO 8x8 layers in downlink with DL CA features, and 4x4 MIMO in uplink with UL CA. - Carrier Aggregation (CA) was first introduced to allow operators to utilize their fragmented spectrum spread across different or same bands. Up to 100MHz can be aggregated, i.e., 5 carriers with each 20MHz. - eICIC solutions are first standardized in the frequency domain, time domain, or by power control
11	2010-01-22 / 2013-03-06	<ul style="list-style-type: none"> - CA enhancements such as multiple timing advancement in up-link, noncontiguous intraband carrier aggregation, and support of aggregation in TDD LTE - CoMP, short for Coordinated Multi-Point Operation for LTE, is one of the most important technical improvements coming with 3GPP Release 11. - ePDCCH as a new control channel for LTE-Advanced was first introduced, to increase the control channel capacity, beam-forming on control channels, and ICIC in the frequency domain. - Support for the uplink position was added by the use of the measured timing at multiple reception points of UE SRS signals. - Minimization of Drive Test (MDT) was introduced to provide complimentary enhancements to drive tests.
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Release	Start/End date	Descriptions
12	2011-06-26 / 2015-03-13	<ul style="list-style-type: none"> - Small cell enhancements in mobility robustness, reducing signaling load, and increasing per-user throughput by using 256QAM and dual connectivity for LTE - Device to Device Communication to realize reliable and resilient communication under adverse circumstances and to allow direct communication between terminals. It also enabled Mission Critical Push-To-Talk. - WLAN/3GPP Radio Interworking by leveraging the WLAN technology integrated into most of today's mobile phones. - LTE TDD-FDD joint operation including Carrier Aggregation when typically, FDD and TDD spectrum licenses are bundled - Inter-eNB CoMP for LTE by exchanging the load information, resource status in the X2 interface between eNBs. - Further downlink MIMO enhancements including an enhanced 4Tx codebook and a new aperiodic PUSCH feedback mode
13	2012-09-30 / 2016-03-11	<ul style="list-style-type: none"> - To promote efficient use of unlicensed frequency spectrum, Licensed-assisted access (LAA), frame structure type 3 was first added in release 13 - Carrier aggregation to support up to 32 component carriers - Dual connectivity enhancements - Full-Dimension MIMO (FD-MIMO) up to 16 antenna ports with two new categories, Non-precoded CSI-RS, and beam-formed CSI-RS

14	2014-09-17 / 2017-06-09	<ul style="list-style-type: none">- Enhanced LAA (eLLA) in the uplink direction accessing the 5GHz ISM band was adopted, along with a new uplink waveform, B-IFDMA, for eLLA.- eLWA, enhanced dual connectivity for LTE and WLAN, was extended in UE mobility.- MUST, short for multiuser superposition transmission, was standardized from the years of academic research on non-orthogonal multiple access (NOMA).- Enhanced FD-MIMO up to 32 antenna ports with overhead, hybrid CSI-RS, advanced CSI, DMRS-based OL MIMO
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