Evolution from LTE to 5G: Global Market Status

LTE and 5G report based on intelligence gathered as part of ongoing industry research and available in GSA’s Networks, Technologies and Spectrum (NTS) online database

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Introduction

LTE is a global success, connecting over one in three mobile users worldwide and it is the fastest developing mobile system technology ever. LTE is specified by 3GPP as a single global standard for paired and unpaired spectrum users. The vast majority of the standard is the same for FDD and TDD. LTE has evolved through various 3GPP technology releases covering the introduction of LTE-Advanced and then LTE-Advanced Pro innovations that have significantly improved the capabilities of LTE networks.

From 3GPP Release 15 onwards, the community has been defining 5G networks, starting with Non-Standalone 5G systems that will integrate with existing LTE networks, and then moving on to Standalone 5G systems with substantially different network configurations.

GSA's *Evolution from LTE to 5G* report provides an independent in-depth status view and analysis of the global 4G/LTE, LTE-Advanced and 5G markets, supported by facts, and confirms technology trends. Information is obtained, analysed and verified by GSA. The report is published quarterly and referenced by industry across the whole ecosystem.

Key market facts

There are:

- **865** operators investing in LTE, including pre-commitment trials.
- **681** commercially launched LTE or LTE-Advanced networks in **208** countries, including those using LTE for FWA services, as well as **114** LTE-TDD (TD-LTE) networks launched in **60** countries.
- **156** commercial VoLTE networks in **76** countries and **229** operators investing in VoLTE in **107** countries.
- **261** launched networks that are LTE-Advanced in **119** countries.
- **four** launched networks that are capable of supporting user equipment (UE) at Cat-18 DL speeds (within limited geographic areas).
- **690–700** anticipated commercially launched LTE networks by end-2018 (GSA forecast).
- **60** NB-IoT and **18** LTE-M/Cat-M1 networks commercially launched with **57** other operators investing in NB-IoT and **26** other operators investing in LTE-M/Cat-M1 in the form of tests, trials or planned deployments.
• **154** operators that have been engaged in, are engaged in, plan to engage in, or have been licensed to undertake 5G demos, tests or trials of one or more constituent technologies.

• **67** telecom operators in **39** countries have announced intentions of making 5G available to their customers between 2018 and 2022.

### LTE deployments

The drivers of LTE, LTE-Advanced, LTE-Advanced Pro and increasingly 5G for operators are more capacity, enhanced performance and improved efficiencies to lower delivery cost. Compared with 3G, LTE offers a big step up in the user experience, enhancing demanding apps such as interactive TV, video blogging, advanced gaming, and professional services.

Deployment of LTE-Advanced technologies – and particularly carrier aggregation – takes performance to a new level and is a major current focus of the industry. Interest in LTE-Advanced Pro is high too, bringing with it new, globally standardised LPWA solutions – LTE Cat-M1 (LTE-M, eMTC) and Cat-NB1 (NB-IoT) – and new business opportunities.

And while LTE-Advanced and LTE-Advanced Pro solutions have yet to be deployed by the majority of operators, vendors and network operators are already looking towards 5G and its potential to meet future capacity, connectivity and service requirements.

### LTE global status

The second quarter of 2018 saw the continued introduction of LTE to more markets and regions around the world. Although already very widely deployed, it is still being introduced in many countries and several have recently announced LTE services. By the end of July 2018 there were 681 public mobile or FWA LTE networks in service in 208 countries worldwide. GSA forecasts that 690–700 LTE networks will be commercial by the end of this year. In addition to those that have already built LTE networks, 168 operators worldwide have either announced plans to deploy, have started deployment of, or have been licensed to deploy LTE; a further 16 have been involved in pre-commitment trials.
Figure 1: Growth of LTE: networks launched each year, and cumulative (including mobile and FWA networks)

More Africa-based telecom operators have been investing in LTE in recent months. Rival telecoms operators Moov and Togocell in Togo made their LTE networks available to customers almost simultaneously. Africell in Sierra Leone, Airtel Kenya, Korea Telecom Rwanda, and Vodacom Democratic Republic of the Congo also started delivering LTE on a commercial basis. Another African operator, Azam Telecom Tanzania, announced plans to launch LTE, using the 700 MHz band.

TTC Tuvalu is the only Oceania-based telecom to have launched the technology since April 2018. Another Oceania-based company, MTN in the Marshall Islands announced plans to build an LTE network. Digicel T&T Trinidad and Tobago and Digicel Anguilla are two telecoms operators in Latin America and the Caribbean region to have recently announced LTE availability to their customers.

In Asia, Bangladeshi operators Robi Axiata-Airtel and Qubee started offering LTE services in July. Sazz in Azerbaijan also launched the technology the same month.

Cuban state-owned telecom Etecsa announced LTE trials and revealed plans for commercial LTE service introduction in 2019.

Figure 2 shows where LTE has been launched since April 2018.
Most places without LTE are either in Africa, or are islands in the Pacific or Atlantic Oceans. Notable exceptions are Bosnia (where networks are planned) and North Korea. Not-spots that have been filled recently include Mali, Senegal and Ukraine.

**LTE-TDD global status**

LTE is an open standard developed by 3GPP. The advanced technological performance of LTE came with in-built flexibility to operate in either paired (FDD, or Frequency Division Duplexing, mode) or unpaired (TDD, or Time Division Duplexing mode) spectrum and various channel bandwidths – all with a single technology. Companies from around the globe contributed to the LTE standard and its evolution.

The emphasis was always to leverage synergies between the two duplex modes to the largest extent possible. This allows operators to best utilise their current network assets, spectrum allocations and various bandwidth needs, while securing support, choice and economies of scale from the global vendor ecosystem and to limit potential market fragmentation.

The result is major commonality of the LTE specifications for the FDD and TDD modes – in fact the vast majority of the LTE standard is identical for both modes – and the huge global success of LTE.
Most LTE deployments use paired spectrum (FDD). The LTE TDD mode is complementary and the perfect choice for providing high-speed mobile broadband access in unpaired spectrum. Many operators have deployed both FDD and TDD modes in their networks. LTE-TDD also provides a future-proof evolutionary path for TD-SCDMA, another 3GPP standard. LTE-TDD is an integral part of the 3GPP standard, implementing a maximum of commonalities with LTE-FDD and offering comparable performance and similar high spectral efficiency.

There are 114 LTE-TDD (TD-LTE) systems commercially launched in 60 countries. Sazz Azerbaijan and Dtac Thailand are the two operators that have launched TD-LTE since our last report in April. Both their systems became commercially active in June 2018. Dtac deployed its network in Band 40, and Sazz uses Bands 42 Band 43. TOT, TeleAssets and Dtac TriNet in Thailand announced plans to launch a shared LTE-TDD network, deploying 60 MHz of bandwidth in Band 40. A further 77 companies have received spectrum licences enabling them to operate LTE in TDD bands, are trialling TD-LTE, planning TD-LTE networks, or actively deploying them.

Figure 3 shows the different spectrum bands in use in the commercially launched networks. Band 40 is the most frequently used TDD band.

*Figure 3: Distribution of commercial TDD networks by band*
Spectrum for LTE deployments

Pressure for spectrum is high and operators need to deploy the most efficient technologies available. LTE, LTE-Advanced and LTE-Advanced Pro services can be deployed in dozens of spectrum bands starting at 450 MHz and rising to nearly 6 GHz.

The most used bands in commercial LTE networks are 1800 MHz (band 3), which is a mainstream choice for LTE in most regions; 800 MHz (band 20 and regional variations) for extending coverage and improving in-building services; 2.6 GHz (band 7) as a major capacity band; and 700 MHz (with variations in spectrum allocated around the world) again for coverage improvement.

Evolutions of LTE standards now completed enable the possibility to extend the benefits of LTE-Advanced to unlicensed spectrum. There are several options for deploying LTE in unlicensed spectrum. The GSA report *LTE in Unlicensed Spectrum: Trials, Deployments and Devices* gives details of market progress in the use of LAA, LTE-U, and LWA. Momentum is building steadily and a few LAA and LTE-U networks have now been deployed/launched around the world.

Many recent allocations/auctions of spectrum have focused on licensing unused spectrum – especially in pockets of spectrum in the 2 to 4 GHz range – for LTE and future 5G services. This spectrum is sometimes dedicated to LTE, sometimes to 5G and sometimes allocated on a technology-neutral basis.
Figure 4: The most used spectrum bands for LTE and LTE-Advanced services (count of networks using each spectrum band to deliver commercial services)

LTE 1800 global status

LTE network deployment in the 1800 MHz (Band 3) is now common throughout Europe, APAC, MEA, and regions of South America. Band 3 has been established as the core band for LTE deployments. There are 323 networks in 137 countries/territories that either use it as a single band or as part of a multi-band deployment.

Band 3 is used globally in 47% of all launched LTE networks and it has greatly assisted international roaming for mobile broadband services. Ukrainian telecom companies Kyivstar and Vodafone launched commercial services in Band 3 (1800 MHz) on 1 July 2018, after being awarded spectrum in that band in March the same year. More LTE 1800 deployments are in progress – Band 3 spectrum licences have been awarded to 357 operators. Further licences will be issued soon. Thailand’s National Broadcasting and Telecommunications Commission (NBTC) is expected to announce the winners in the Band 3 auction on 18 and 19 August 2018. In July 2018, Mozambican National Communications Institute
(MNCI) revealed intentions of holding a 4G auction for Band 3 spectrum by the end of the year. Belgian Institute for Postal Services and Telecommunications (BIPT) also announced plans to hold an auction in Band 3 for LTE in 2019.

Figure 5: Number of commercial LTE 1800 deployments per country (including fully mobile and FWA networks)

Band 20 (800 MHz) global status

Band 20 (800 MHz) is firmly established as a mainstream band for LTE. It is used in 176 commercial networks in 79 countries. Recent activities in that band include Airtel Kenya’s LTE launch in May 2018 and BSNL India’s announcement of plans to launch LTE services later in 2018. Elsewhere, Zain, Saudi Arabia was awarded a licence to deploy LTE in Band 20 (expected in 2019). In July 2018, the Mozambican National Communications Institute (MNCI) revealed intentions of holding a 4G auction in Band 20 by the end of the year.
Band 7 (2.6 GHz) global status

Band 7 (2.6 GHz) is the third most-used band, with networks deployed in Band 7 in 161 deployed/launched networks in 75 countries and is more extensively used in the Americas than Bands 3 and 20. Ukrainian operators Kyivstar, Vodafone and Astelit (Lifecell) announced commercial LTE launches in Band 7 in July 2018. They were joined by Bitel Peru and Asia Pacific Telecom Taiwan. Vodafone Malta and Canadian telecom operators Freedom Mobile, Cogeco, Xplornet and Ecotel were all licensed to use that band.

There have been recent licence awards in Ukraine.
VoLTE global status

In total 229 operators are investing in VoLTE in 107 countries including 156 operators with deployed/launched VoLTE voice services in 76 countries, up from 145 in 70 countries in April 2018. In the last three months GSA has identified new VoLTE services from operators in Austria, Barbados, Belgium, Bulgaria, Chile, Ecuador, Kuwait, Luxembourg, Poland, Sri Lanka. We have been able to identify Austria as the only country with two launches between April and July 2018 – those of 3 Austria and T Mobile.

Figure 8: Countries with launched VoLTE networks

Figure 9: Number of launched VoLTE networks by country
GSA is aware of 57 other operators that either plan to deploy or are deploying VoLTE services. Sixteen additional operators have been identified that are involved in tests/trials.

### LTE-Advanced global status

Investment in LTE-Advanced networks is growing very rapidly. At the end of July 2018 there were 261 commercially launched LTE-Advanced networks in 119 countries. In the past three months alone 20 LTE-Advanced network launches have taken place. Overall, 305 operators are investing in LTE-Advanced (in the form of tests, trials, deployments or commercial service provision) in 127 countries.

*Figure 10: Countries with deployed/launched LTE-Advanced networks*

Many operators with LTE-Advanced networks are looking to extend their capabilities by adding 3GPP Release 13 or Release 14 LTE-Advanced Pro features, e.g. those making use of carrier aggregation of large numbers of channels, or carriers across TDD and FDD modes, LAA, massive MIMO, Mission-Critical Push-to-Talk, LTE Cat-NB1/NB-IoT or LTE-M/Cat-M1. Overall GSA has identified 141 operators investing in one or more LTE-Advanced Pro technology. GSA also tracks trials and deployments of a number of these specific 3GPP Release 13 and 14 features.

The GSA report *LTE in Unlicensed Spectrum* tracks progress of LAA/eLAA: by the end of July 2018, there were 23 operators investing in LAA, 11 operators investing in LTE-U and two investing in LWA (launch plus planned deployment).
There are three deployed/launched LTE-U networks; and four launched/deploidy LAA networks with other operators near to commercialisation. Recently, some early LTE-U pioneers have announced plans to refocus on LAA in 2018. The number of NB-IoT and LTE-M networks are reported elsewhere in this document.

We also track reported fastest downlink speeds in commercially launched LTE-Advanced networks. There is a wide variation, as shown in Figure 11.

Recent months have seen the introduction of services (in restricted geographical locations within a few networks) capable of delivering peak theoretical download speeds of between 1.1 Gbps and 1.2 Gbps. Combined with the availability of Cat-18 handsets, this means unprecedented downlink speeds for mobile services users. GSA has identified four commercial networks capable of delivering Cat-18 DL speeds in selected areas. The wide variation in downlink speeds is unsurprising, as operators around the world have different amounts of spectrum (numbers of carriers and bandwidth of those carriers) that they can aggregate to increase maximum throughput. They also vary in terms of their deployment of additional features such as the use of 256QAM modulation and 4x4 MIMO. Note also that some operators report theoretical downlink
speeds; others report live-network tested speeds. GSA carries out a detailed analysis of the development of Gigabit LTE in its paper *Progress to Gigabit LTE Networks*, available on the GSA website.

Figure 12 shows the proportion of LTE-Advanced networks (for which we have data) supporting the various UE categories. Note that where we have no confirmed speed data, we assume that the network is capable of supporting UE Cat-4.

*Figure 12: Distribution of LTE-Advanced networks by UE Category*

Carrier aggregation has been the dominant feature of LTE-Advanced networks. Varying numbers of carriers and varying amounts of total bandwidth have been aggregated in trials and demos, but in commercial networks, the greatest number of carriers aggregated (where we have data) is five. Some trials and demos have also aggregated up to 10 carriers (for instance SK Telecom’s trial in South Korea).

**IoT global status**

The second quarter of 2018 saw momentum continue to build behind cellular IoT networks based on NB-IoT and LTE-M. Most activity involved NB-IoT. Activity worldwide is indicated in Figure 13.

At the end of July 2018 there were 117 operators investing in NB-IoT in 58 countries, including 60 deployed/launched NB-IoT networks in 38 countries.
Countries in Europe and the Far East have been most active in adopting NB-IoT in the past three months. They are expected to be joined by AT&T Mobility USA and AT&T Mexico whose launch plans are focused on 2019. Spring US, TIM Brasil and TeliaSonera Denmark have also revealed planned commercial introductions. NB-IoT launches since early April 2018 include Slovak Telecom, Telekom Slovenije, Hrvatski Telekom, T-Mobile and Vodafone in Netherlands, TeliaSonera Sweden, Belgacom and Base in Belgium, T Mobile Austria, Asia Pacific Telecom Taiwan, Smartone Hong Kong and Reliance Jio India. Telenor Denmark has deployed its NB-IoT network. India’s Bharti Airtel announced plans to launch the technology within the next 18-24 months. Vimpelcom Russia and 3 Sweden announced they have been testing the technology.

At the end of July 2018 there were 44 operators investing in LTE-M networks in 28 countries including 18 deployed/launched LTE-M networks in 13 countries.

GSA has been able to identify the following LTE-M launches since our last report: KT Corporation South Korea, AT&T Mobility USA and AT&T Mexico. Telenor Denmark and Vodafone Netherlands have deployed their LTE-M networks. Three more operators – T-Mobile Netherlands, Sprint USA and BASE Belgium – announced plans to launch the technology in the future.

Figure 13: Launched IoT networks by type
5G global status

GSA has identified 154 operators in 66 countries that have demonstrated, are testing or trialling, or have been licensed to conduct, field trials of 5G-enabling and candidate technologies (up from 134 operators in April 2018). The spread of global activity is shown in Figure 14.

*Figure 14: Geographic spread of operator 5G investments*

Detailed analysis of speeds and spectrum used for 5G trials to date is available in the report *Global Progress to 5G – Trials, Deployments and Launches*, on the GSA website. Operators continue to provide clarity about their intentions in terms of launch timetables for 5G, or pre-standards 5G.

GSA is aware of 67 telecom operators in 39 countries that have announced intentions of making 5G available to their customers between 2018 and 2022. Figure 15 shows the countries and current planned dates for the earliest 5G launches in those countries. We have only included countries where operators have announced their plans, not countries where governments have made general statements of intent.
Beyond those already claiming limited scale launches, we have been able to identify ten launches in nine countries planned to take place by the end of 2018. GSA will be tracking this progress.

**About this report**

This report is the latest update in a series of studies published by GSA tracking the development of mobile technology markets worldwide.

We summarise network trials, deployments, and the availability of services across a variety of technology innovations and spectrum bands. GSA welcomes additions to the database of information. The database also contains information about spectrum bands and bandwidth used, where available. If you have additional information, please contact research@gsacom.com

The data set for this release was frozen on 6 April 2018. We make no guarantees that the information is complete, but reasonable efforts have been made to ensure it is comprehensive and accurate. The next update of this report will be in July 2018.
About GAMBoD and NTS

GAMBoD, the GSA Analyser for Mobile Broadband Data, is a unique search and analysis tool that has been developed by GSA to enable searches of mobile broadband devices. It now includes new global data on Mobile Broadband Networks, Technologies and Spectrum (NTS).

The devices database can be searched by supplier, form factor, features, peak downlink and uplink speeds, and operating frequency. The NTS database can be searched by mobile broadband technology, feature, UE category, downlink speed, and spectrum bands used, and can be segmented by region. Results are presented as a list or in charts. Charts may be inserted into documents or presentations, subject to accreditation of GSA as the source.

Access to the LTE Devices and NTS databases are GSA Member benefits. Mobile operators also have access to the LTE Devices Database. Any company can subscribe to the GAMBoD databases to gain access to its unique data.

Please contact GSA for more information: info@gsacom.com
About GSA

GSA (the Global mobile Suppliers Association) is a not-for-profit industry organisation representing companies across the worldwide mobile ecosystem engaged in the supply of infrastructure, semiconductors, test equipment, devices, applications and mobile support services.

GSA actively promotes the 3GPP technology road-map – 3G, 4G, 5G – and is a single source of information resource for industry reports and market intelligence. GSA Members drive the GSA agenda and define the communications and development strategy for the Association.

Membership of GSA is open to any supplier of products; systems or services related to the mobile industry and brings many benefits including access to the GAMBoD and NTS database. The range of benefits includes enhanced discussion, networking and influencing opportunities on the key industry topics, and unique promotional/visibility opportunities for your company name, capabilities, positioning and messages. More details can be found at https://gsacom.com/gsa-membership/

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NOTE: Errors and omission excepted