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 GAMBoD online database

October 2019

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Introduction

LTE is a global success, with around 4.7 billion subscriptions and connecting over 53% of 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 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 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.

900 operators actively investing in LTE

777 operators are running LTE networks worldwide

311 operators are running LTE-Advanced networks

Key market facts

There are:

- **900** operators actively investing in LTE, including those evaluating/ testing and trialling LTE and those paying for suitable spectrum licences (excludes those using technology neutral licences exclusively for 2G or 3G services).
- **777** operators running LTE networks providing mobile and/or FWA services in 228 countries worldwide.
- **204** commercial VoLTE networks in **94** countries and a total of **268** operators investing in VoLTE in **120** countries.
- **311** launched LTE-Advanced networks in **136** countries. Overall, **341** operators are investing in LTE-Advanced technology in **143** countries.
- **Ten** launched networks that support user equipment (UE) at Cat-18 DL speeds within limited geographic areas, and **one** supporting Cat-19 (in a limited area).
- **233** operators with TDD licences and at least **165** operators with launched LTE-TDD networks.

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- **155** operators investing in NB-IoT in 72 countries; of these, **103** NB-IoT networks are deployed/launched in **55** countries. **Sixty-seven** operators are investing in LTE-M/Cat-M1 in **39** countries; of these, **42** LTE-M/Cat-M1 networks are deployed/commercially launched in 26 countries.
- **321** operators in **125** countries are investing in 5G mobile or 5G FWA/ home broadband networks.
- **62** operators in 34 countries have announced the deployment of 5G within their live network.
- **46** operators in 26 countries have announced 3GPP 5G service launches (or limited service launches).

321 operators in 125 countries are investing in 5G networks

62 operators in 34 countries have deployed 5G within their networks

46 operators in 26 countries have announced 3GPP-compatible 5G service launches

Note that all references to countries in this document can be read as also including territories, special administrative regions, disputed territories and dependencies.

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 offered 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.

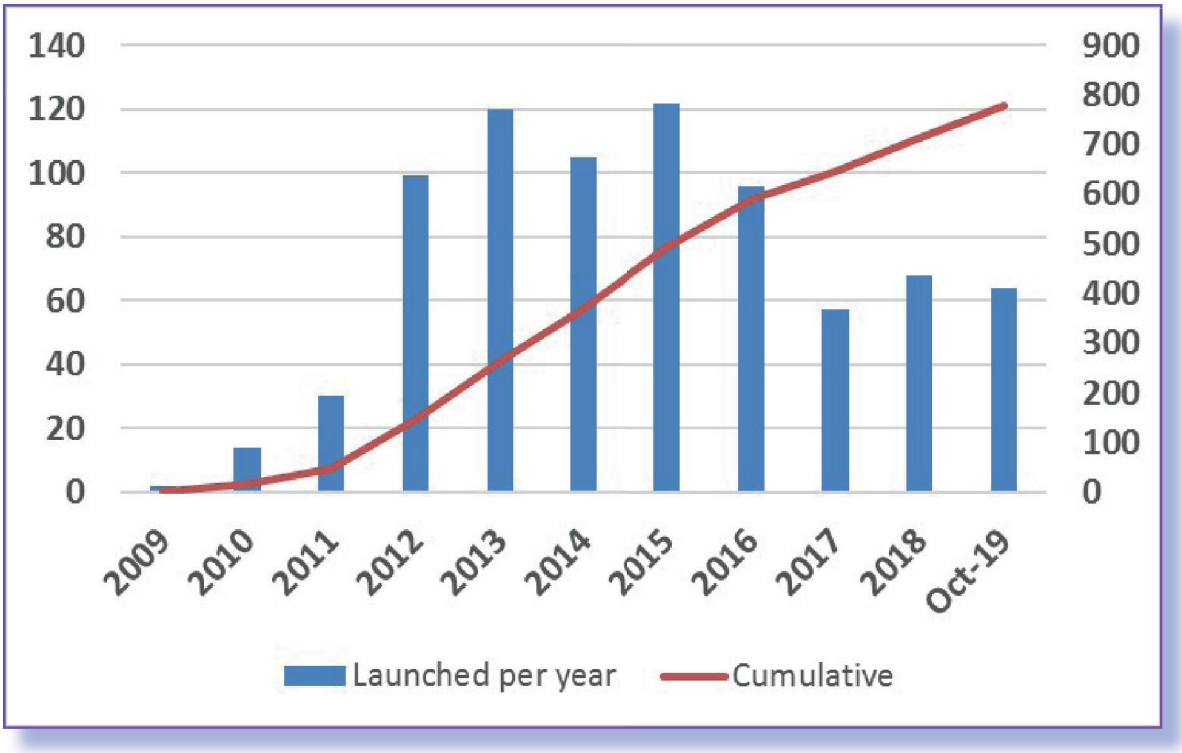
Interest in LTE-Advanced Pro is high too, bringing with it new, globally standardised LPWA solutions – LTE Cat-M1 (LTE-M, eMTC) and Cat-NB1 (NB-IoT) – and new business opportunities. And whilst LTE-Advanced and LTE-Advanced Pro solutions have yet to be deployed by the majority of operators, vendors and network operators are already looking towards 5G and its potential to meet future capacity, connectivity and service requirements.

LTE global status

In 2019, we see deployment of LTE reaching into almost every part of the world. By October 2019, GSA had identified 777 operators running LTE networks providing mobile and/or fixed wireless broadband services in 228 countries worldwide. GSA is aware of at least another 123 companies actively trialling, investing or that have stated plans to invest in LTE.

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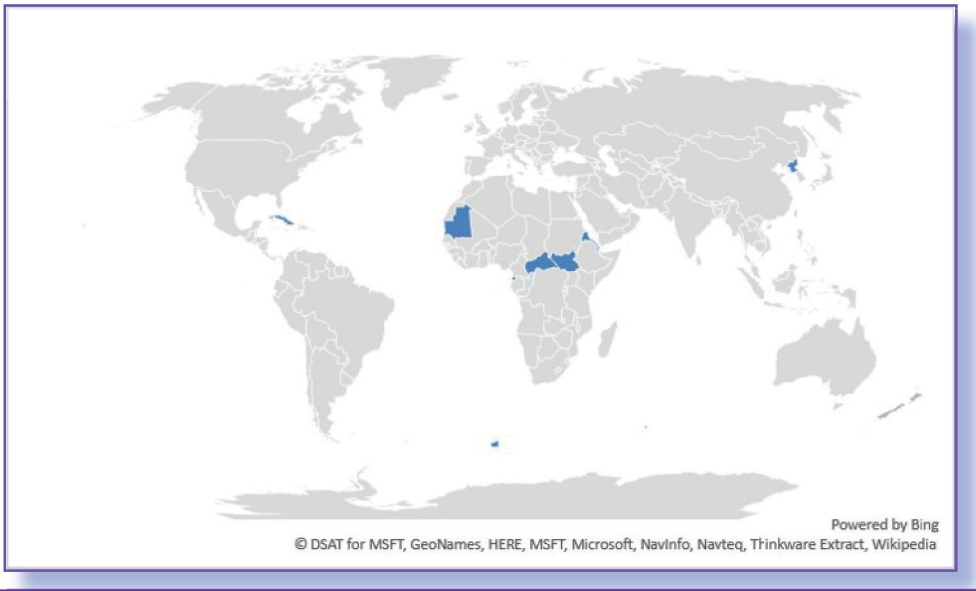
Figure 1: Growth of LTE: number of mobile operators launching LTE networks each year, and cumulative (including mobile and FWA networks)



LTE networks not-spots include Central African Republic, Cuba, Djibouti, Equatorial Guinea, Eritrea, Mauritania, North Korea, South Sudan, and Western Sahara

There are now relatively few LTE not-spots (i.e. countries with no launched LTE network of any kind – mobile or broadband fixed wireless) left in the world. Most remaining LTE not-spots are remote island territories and states or are countries in Africa: Central African Republic, Djibouti, Equatorial Guinea, Eritrea, Mauritania, South Sudan, and Western Sahara. Other notable LTE not-spots are Cuba, and North Korea.

Figure 2: Countries with no identified commercial LTE network for mobile or broadband fixed wireless services



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Of the bigger countries remaining, in Cuba, Etecsa is trialling LTE (and the government is making it easier for new networks to be established).

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 (FDD Band 7) as a major capacity band; and 700 MHz (with variations in spectrum allocated around the world) again for coverage improvement.

The now-completed LTE standards enable the possibility to extend the benefits of LTE-Advanced to unlicensed and shared spectrum. There are several options for deploying LTE in unlicensed spectrum. The GSA report *LTE in Unlicensed and Shared Spectrum: Trials, Deployments and Devices* gives details of market progress in the use of LAA, eLAA, LTE-U, LWA and activity in the CBRS band.

Many recent allocations/auctions of spectrum have focused on licensing unused spectrum – including pockets of spectrum in the 2 to 4 GHz range, but also at lower frequencies – for LTE and future 5G services. This spectrum is sometimes dedicated to LTE, sometimes to 5G and sometimes allocated on a technology-neutral basis.

There are 411 operators in 158 countries licensed to deploy LTE in Band 3

Band 3 (1800 MHz) global status

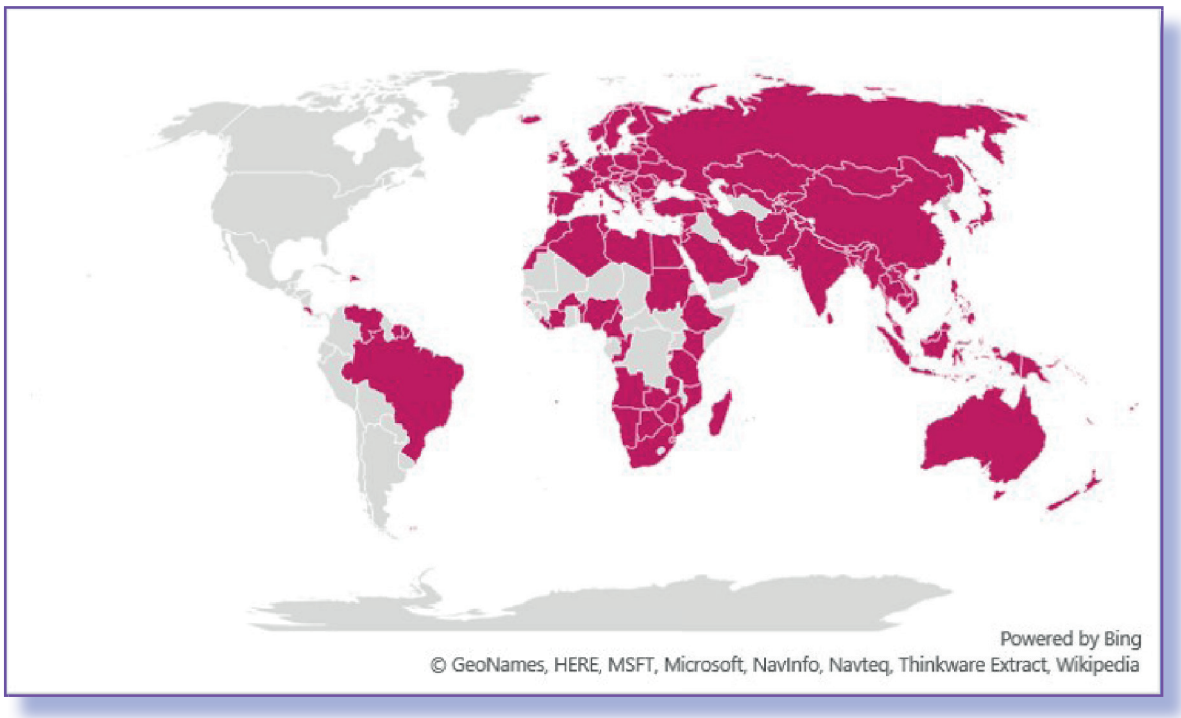
LTE network deployment in the 1800 MHz (Band 3) is now common throughout Europe, APAC, MEA, and regions of South America. In fact, usage of 1800 MHz is now almost universal on a national basis in Europe and Asia. There are 411 companies in 158 countries licensed to deploy LTE in Band 3 (excluding those with technology neutral licences that have used the spectrum for 2G or 3G networks). At least 377 operators (just under 50% of all LTE network operators) in 155 countries have launched LTE services using spectrum in Band 3.

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The importance of spectrum at 1800 MHz continues to grow steadily with regulators looking at unlicensed or underused spectrum at 1800 MHz and forming plans to allocate or award it for LTE usage. Since our last report, regulator events related to Band 3 include the following:

- Slovakia launched a public consultation on methods for auctions of spectrum at various bands, including unallocated spectrum at 1800 MHz.
- Applications closed in the Taiwan auction of various bands including 20 MHz of spectrum at 1800 MHz.

Figure 3: Deployed/launched LTE Band 3 networks per country (including fully mobile and FWA networks)



There are nearly 200 operators using Band 20 in their commercial networks

Band 20 (800 MHz) global status

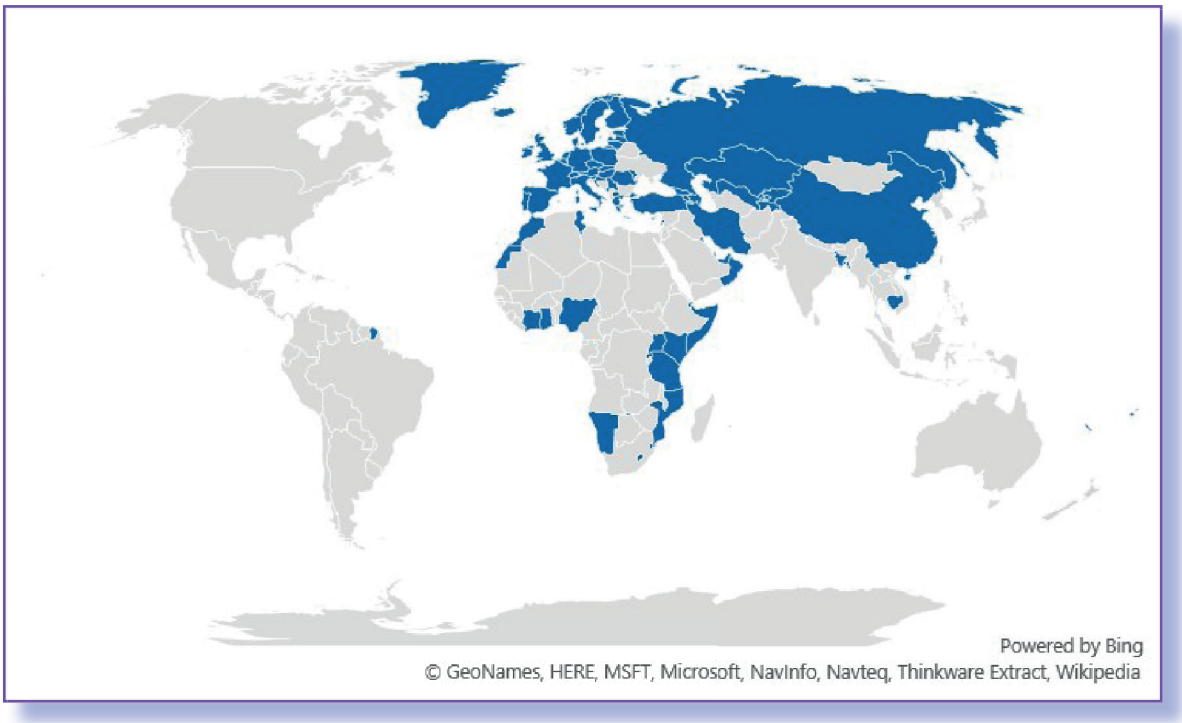
The 800 MHz band (Band 20) is firmly established as a mainstream band for LTE. There are 224 companies in 100 countries licensed to deploy LTE in Band 20 (excluding those with technology-neutral licences that have used the spectrum for 2G or 3G networks). It is used in at least 199 commercial networks in 91 countries.

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Regulatory activity related to spectrum at 800 MHz includes the following:

- Romania launched a consultation about a multi-band auction (including 2x5 MHz of spectrum at 800 MHz) scheduled to start in October 2019.
- Slovakia launched a public consultation on methods for auctions of spectrum at various bands, including unallocated spectrum at 800 MHz.
- Telekom Albania was awarded spectrum at 800 MHz in September 2019.

Figure 4: Countries with launched Band 20 networks



191 commercial LTE networks have been launched using Band 7

Band 7 (2.6 GHz) global status

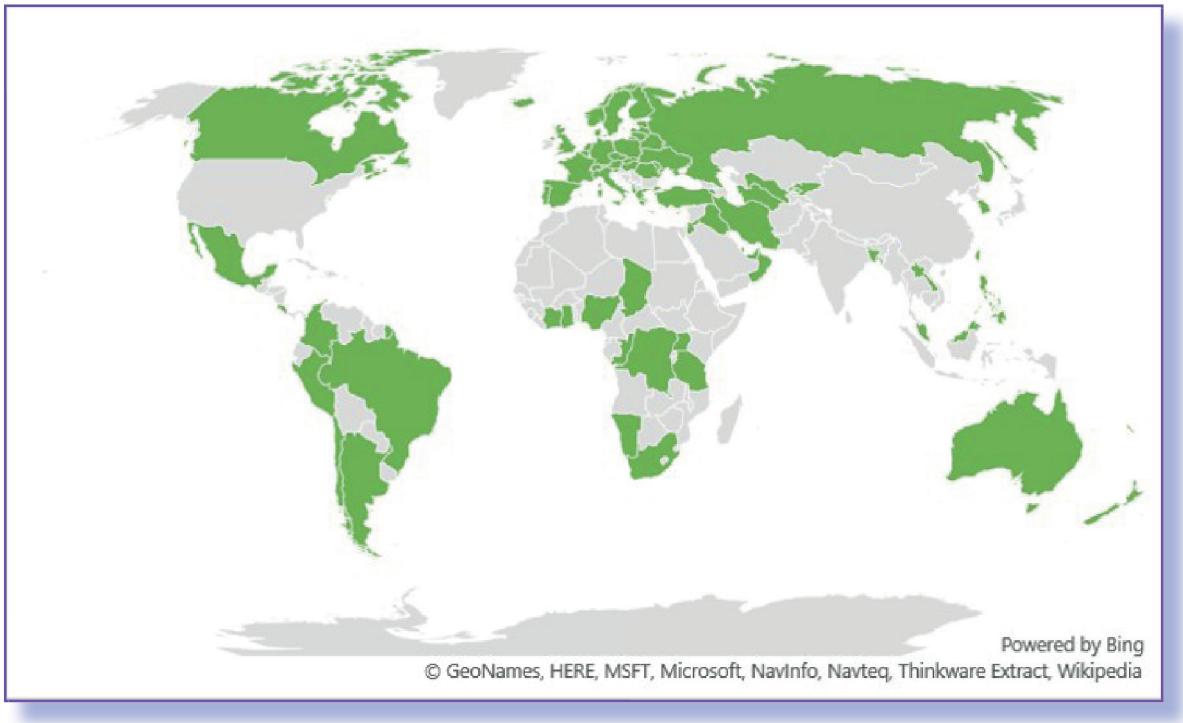
The 2.6 GHz band (Band 7) is also very widely licensed and deployed. There are 232 companies in 92 countries licensed to deploy LTE in Band 20 (excluding those with technology-neutral licences that have used the spectrum for 2G or 3G networks). It is used in at least 191 commercial networks in 86 countries.

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Recent 2.6 GHz spectrum activity relevant to LTE includes:

- Romania launched a consultation about a multi-band auction (including 2x40 MHz of spectrum at 2600 MHz) scheduled to start in October 2019.
- Bidders were shortlisted in the Hungarian multi-band auction, including the sale of 2600 MHz spectrum, which is expected to be completed before the of the autumn 2019.
- Colombia published the processes for a multi-band auction including 80 MHz of Band 7 spectrum due in December 2019.

Figure 5: Countries with launched Band 7 LTE networks (including fully mobile and FWA networks)



After the 2.6 GHz band, the next most widely licensed FDD bands are in the 700 MHz spectrum range with 198 operators investing in LTE across the various 700 MHz bands.

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

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a single technology. 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.

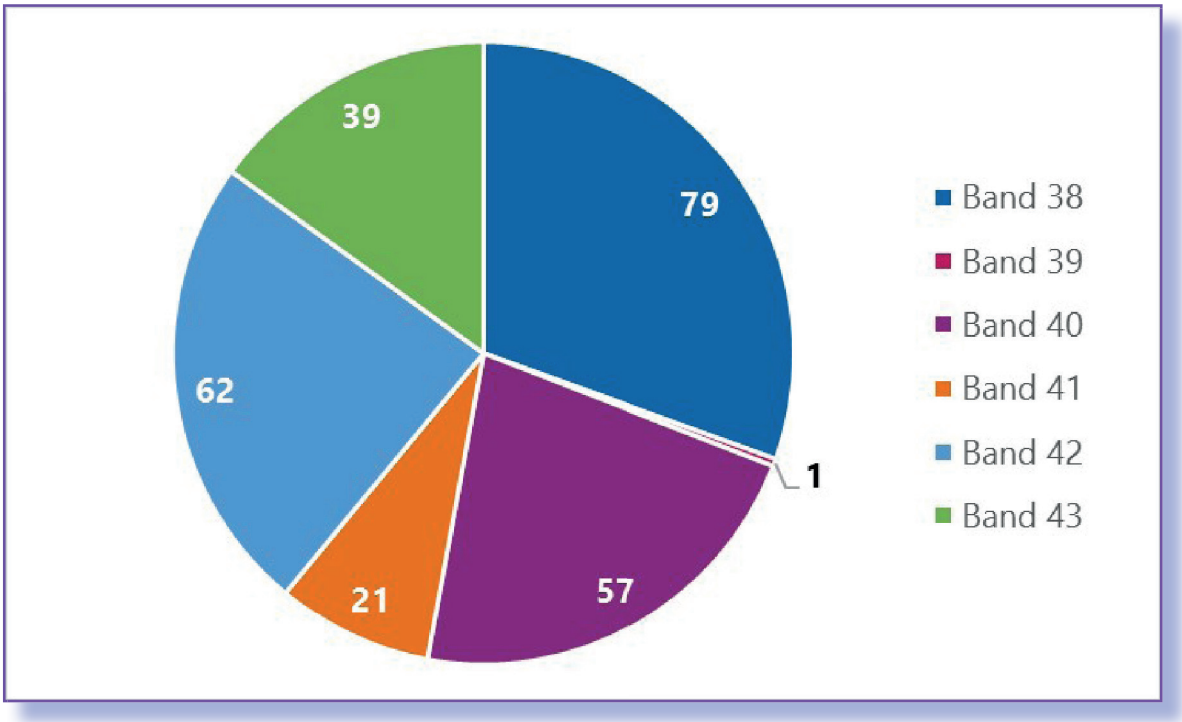
Most LTE deployments use paired spectrum (FDD). The LTE TDD mode is complementary and the perfect choice for providing high-speed mobile broadband access in unpaired spectrum. Many operators have deployed both FDD and TDD modes in their networks. LTE-TDD is an integral part of the 3GPP standard, implementing a maximum of commonalities with LTE-FDD and offering comparable performance and similar high spectral efficiency.

GSA has identified 233 operators that hold spectrum licences enabling them to launch LTE-TDD services. Of those, 165 operators are deploying or have launched TD-LTE networks.

233 operators hold licences to to deploy LTE using TDD

Spectrum in Band 38 (79 licenses) is the most commonly licensed for LTE, followed by spectrum in Bands 42 (62 licences) and 40 (57 licences).

Figure 6 Distribution of spectrum licences for TD-LTE (includes regional and national licences, mobile or broadband FWA networks, spectrum not necessarily in active use)



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The importance of TDD will grow. TDD bands are of clear interest for future 4G and 5G deployments.

For a full analysis of recent activity related to licensing of spectrum (including key TDD bands) see GSA's report: *Spectrum for Terrestrial 5G Networks: Licensing Developments Worldwide*, published September 2019.

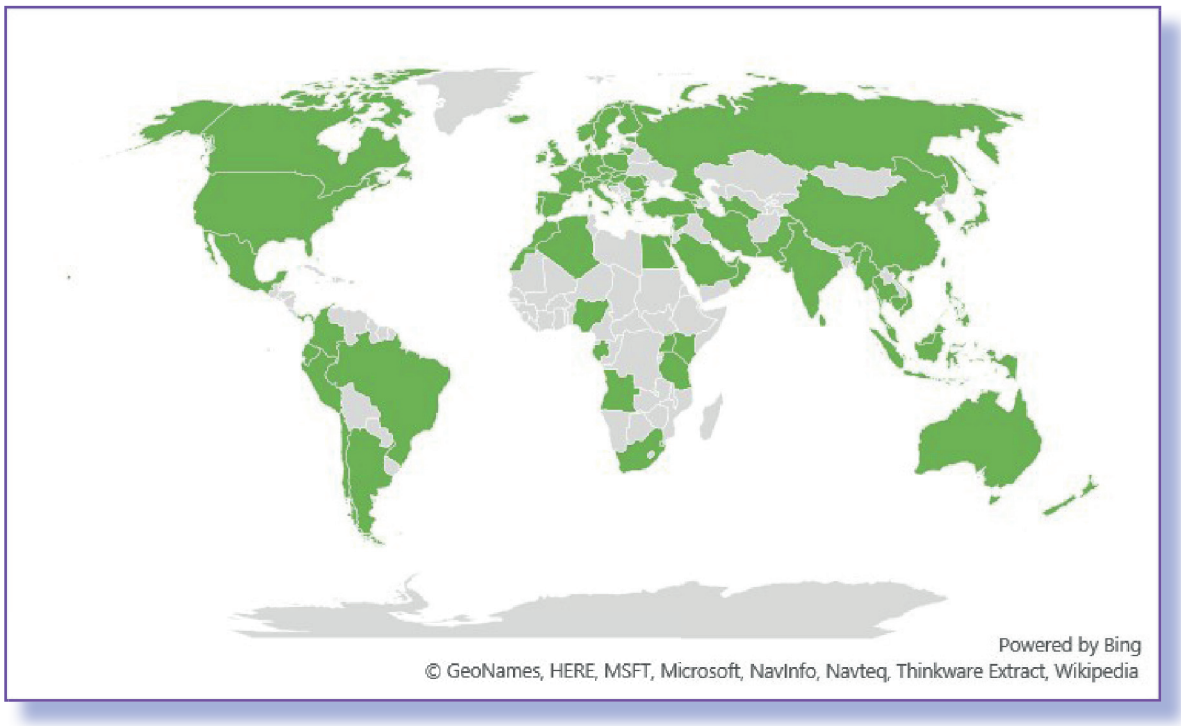
VoLTE global status

In total GSA has identified 268 operators investing in VoLTE in 120 countries, including 204 operators that have launched VoLTE voice services in 94 countries.

204 operators in 94 countries have launched VoLTE voice services

There have been recent launches in Guam, India, Hungary, Iran, Maldives, Northern Marianas Islands, Kenya, Mexico, Pakistan, Philippines, Tuvalu, Ireland, New Zealand, Niue and Spain.

Figure 7: Countries with launched VoLTE networks



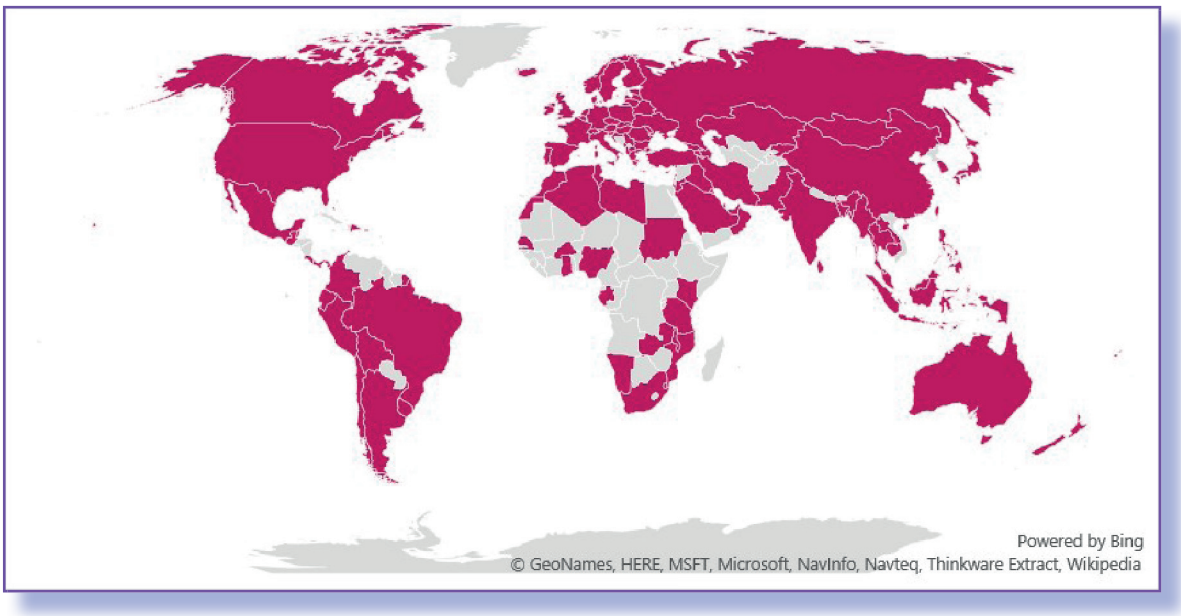
GSA is aware of at least 28 other operators deploying VoLTE and 36 other operators planning VoLTE or are testing/trialling the technology.

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LTE-Advanced global status

Investment in LTE-Advanced networks continues to grow. By October 2019, there were 311 commercially launched LTE-Advanced networks in 136 countries. Overall, 341 operators are investing in LTE-Advanced (in the form of tests, trials, deployments or commercial service provision) in 143 countries.

Figure 8: Countries with launched LTE-Advanced networks



341 operators in 143 countries are investing in LTE-Advanced

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.

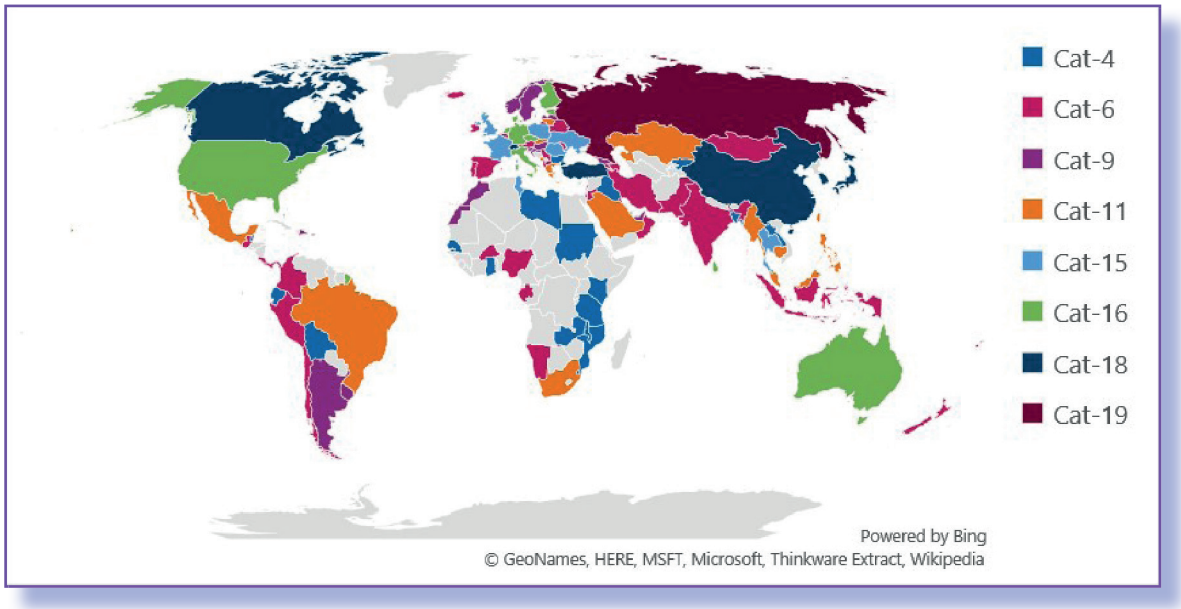
The GSA report *LTE in Unlicensed and Shared Spectrum: Trials, Deployments and Devices* tracks the progress of LAA/eLAA, LWA and LTE-U. By October 2019, there were 38 operators investing in LAA (including eight deployed/launched networks), 11 operators investing in LTE-U (including three launched/deployed networks) and three investing in LWA (including one launched network). One operator had undertaken trials of eLAA.

The figures for 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 9.

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Figure 9: Fastest commercial LTE-Advanced networks per country, expressed in terms of DL UE Category supported



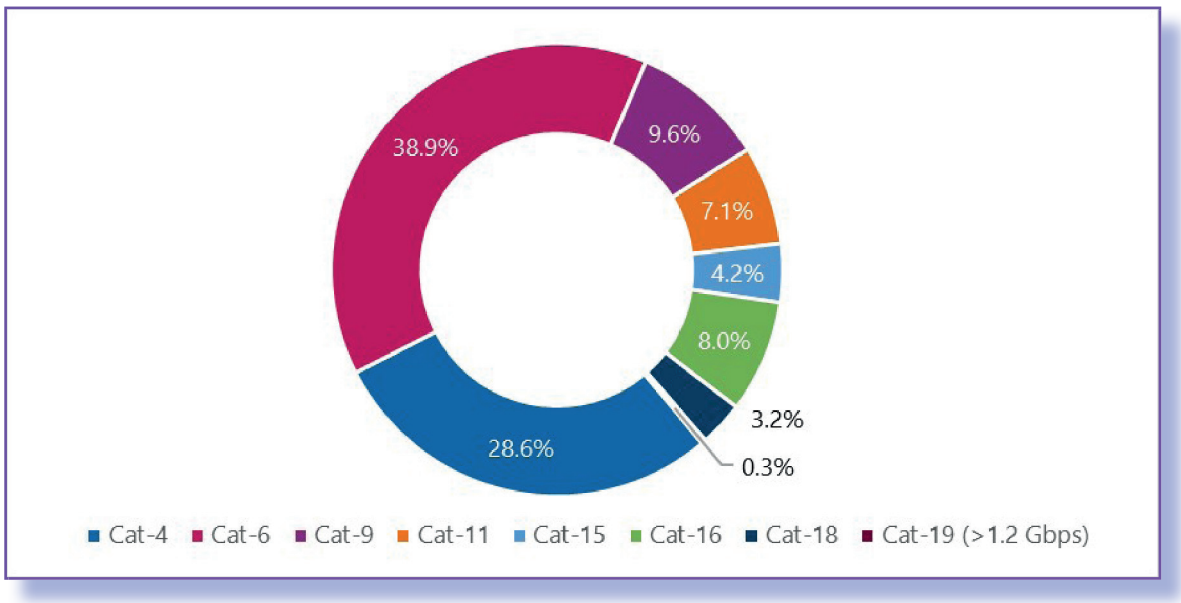
GSA has identified ten Cat-18 networks and one Cat-19 capable network

The number of commercial networks capable of delivering peak theoretical DL throughout equivalent to Cat-18 DL speeds in selected areas stands at ten, and one network is capable of delivering download speeds in one location equivalent to device category 19 (Megafon in Russia). 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 and in their use of unlicensed spectrum. Note also that some operators report theoretical downlink speeds, others report live-network tested speeds. GSA carried out a detailed analysis of the development of Gigabit LTE in its paper *Progress to Gigabit LTE Networks*, available on the GSA website.

Figure 10 shows the percentage of LTE-Advanced networks (for which we have data) that support each UE category. Note that where we have no confirmed speed data, we assume that the network is at least UE Cat 4 and is categorised as such below.

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Figure 10: UE Categories supported by LTE Advanced networks shown as percentages



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 ten carriers, for instance SK Telecom's trial in South Korea.

There are 155 operators in 72 countries investing in NB-IoT

IoT global status

The start of 2019 has continued to see strong growth in the number of cellular IoT networks based on NB-IoT and LTE-M. By October 2019, there were 155 operators investing in NB IoT in 72 countries, up from 148 operators in 71 countries in May 2019.

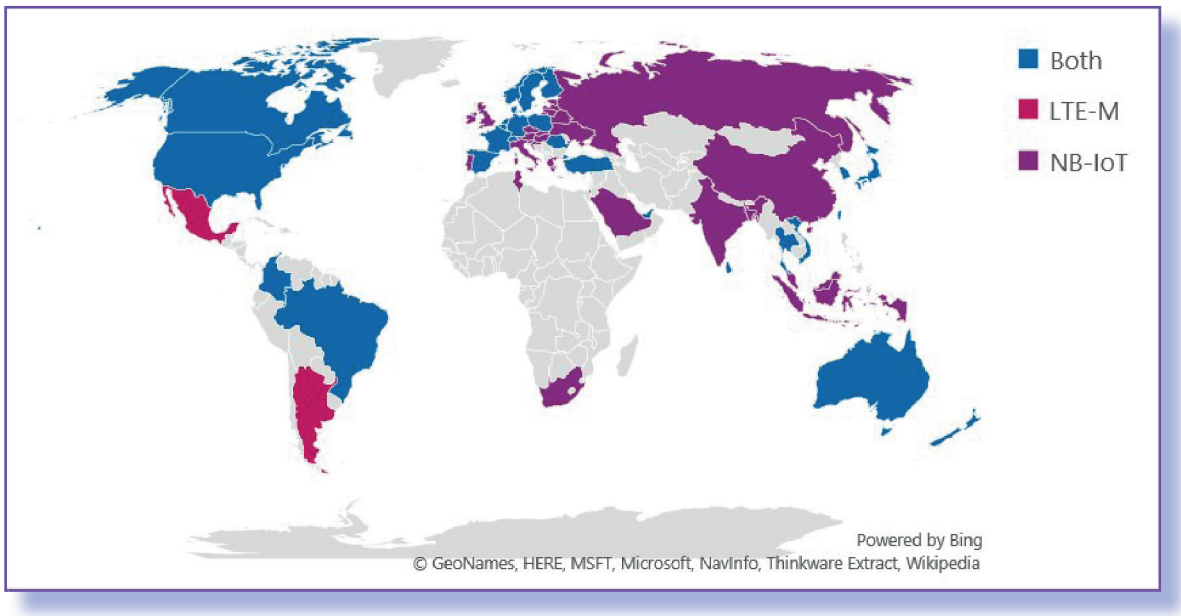
The number of deployed/launched NB-IoT networks was 103 in 55 countries, up from 78 operators in 45 countries in January 2019.

There are 67 operators investing in LTE-M networks in 39 countries, up from 57 operators in 34 countries in January 2019. Forty-two operators have deployed/launched LTE-M networks in 30 countries, up from 30 operators in January 2019.

Altogether 57 countries now have at least either a launched NB-IoT network or a launched LTE-M network and 27 of those countries have both network types.

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Figure 11: Launched cellular IoT networks by type

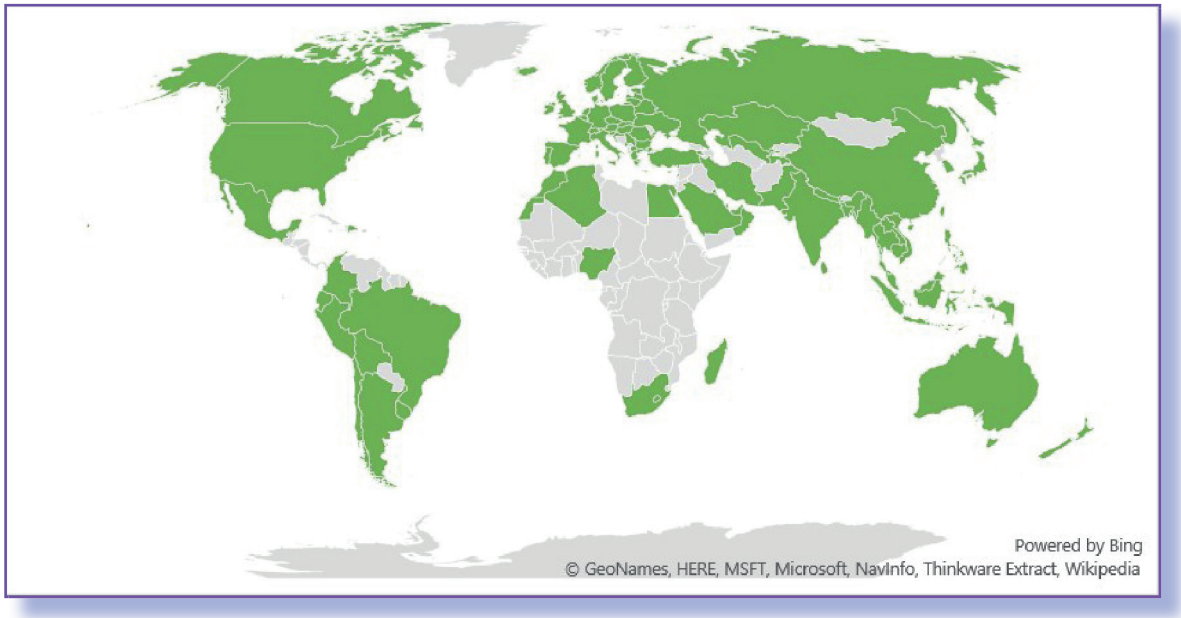


5G global status

GSA has identified 321 operators in 105 countries that have launched (limited availability or non-3GPP networks), demonstrated, are testing or trialling, or have been licensed to conduct field trials of 5G-enabling and candidate technologies (up from 235 operators in May 2019). The spread of global activity is shown in Figure 12.

Figure 12: Countries with operators known to be investing in 5G

62 operators in 34 countries have stated that they have activated one or more 5G sites within their live commercial networks



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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.

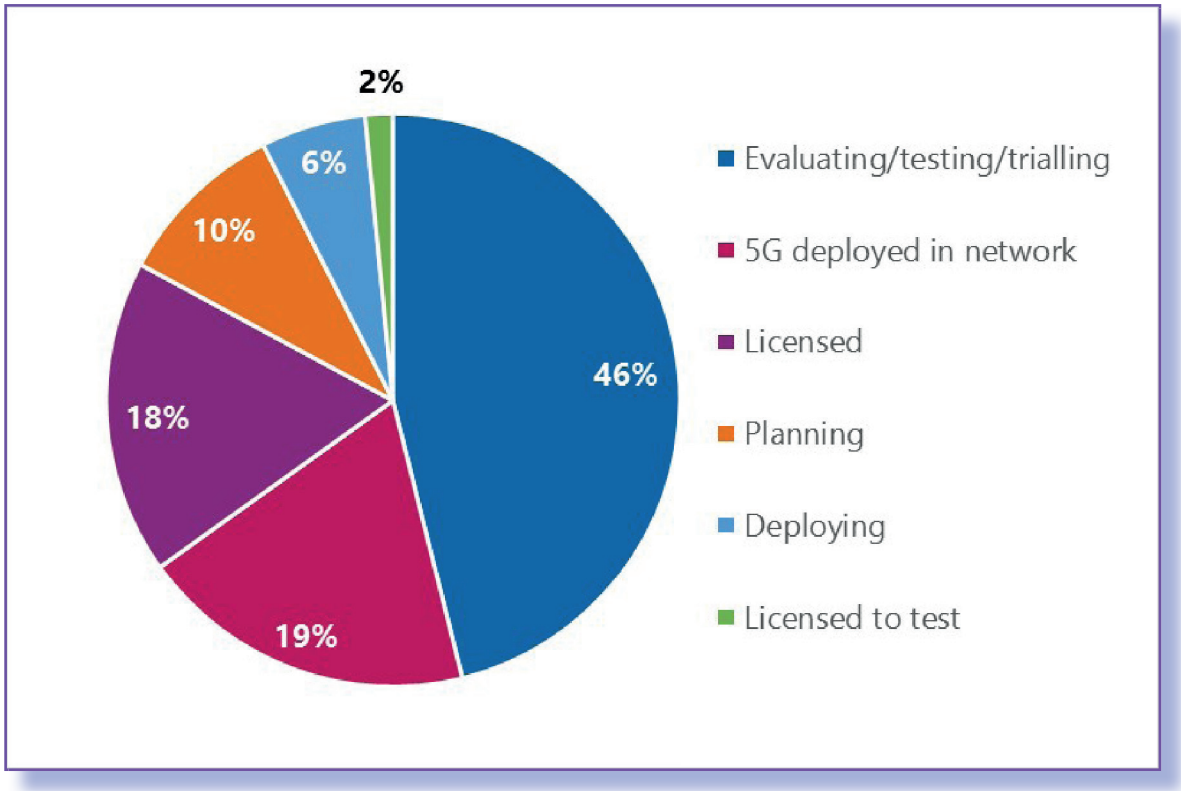
GSA has identified 62 operators in 34 countries that have stated that they have activated one or more 5G sites within their live commercial network (excludes those that have only deployed test sites). The number that have announced the launch of commercial services remains much lower however, as operators have had to await the availability of 5G devices. These have now started to appear, removing the market blockage.

46 operators in 26 countries have launched 5G services in 3GPP-compliant networks

GSA has identified 172 announced devices (including regional variants, but not prototypes) and at least 38 of these are now available for customers to buy and use. See GSA's report *5G Device Ecosystem*, published monthly, for more details.

GSA knows of 46 operators in 26 countries who have (as of 15 October 2019) announced 3GPP-compatible 5G service launches (either mobile or FWA, some with limited availability): we understand there are ten operators with FWA/home broadband-only services, 18 with mobile-only services, and 16 with both mobile and FWA/home broadband services.

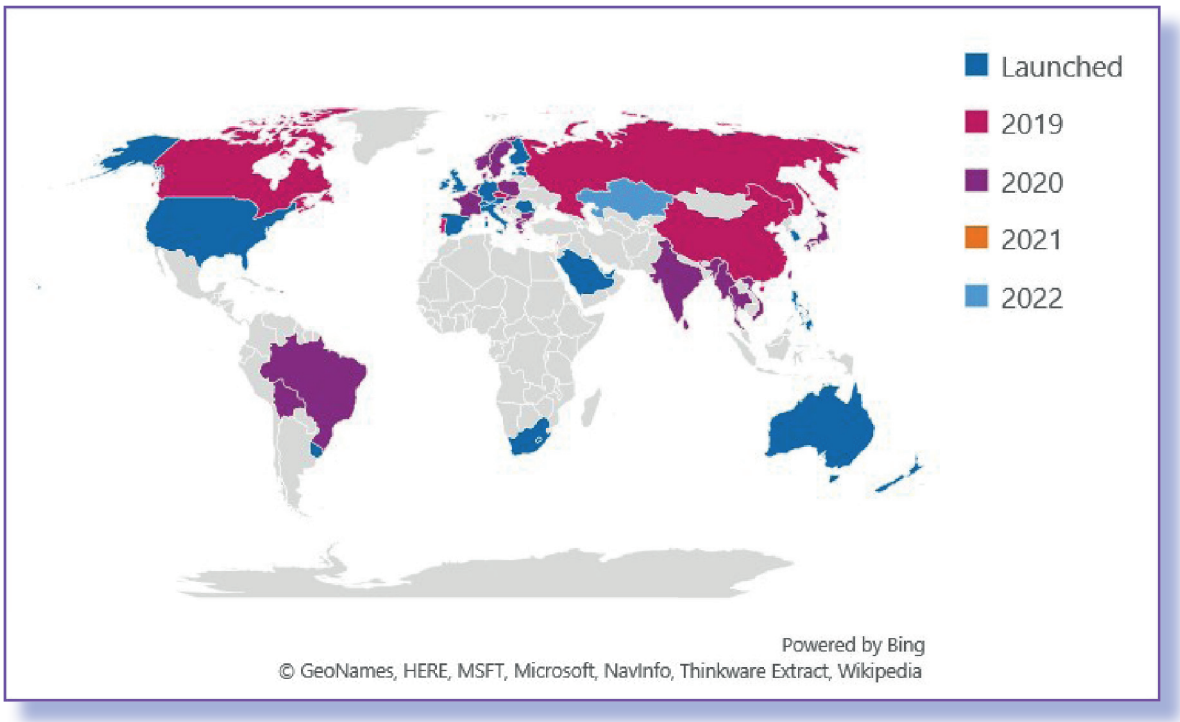
Figure 13: Operators' 5G network investments by status



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Figure 14 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.

Figure 14: Earliest expected 5G commercial launch dates (includes mobile or FWA, includes limited availability launches)



GSA will continue tracking the progress of 5G deployments worldwide.

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About GSA

GSA reports are compiled from data stored in the GSA Analyser for Mobile Broadband Devices/Data (GAMBoD) database, which is a GSA Member and Associate benefit. For more information on accessing the GSA GAMBoD database please contact GSA at info@gsacom.com

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