PRIVATE MOBILE NETWORKS:

November 2020

GSA

Private Mobile Networks

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Private Mobile Networks – – market status update –

End October 2020

Introduction

The demand for private mobile networks based on LTE (and increasingly 5G) technologies is being driven by the spiralling data, security, digitisation and enterprise mobility requirements of modern business and government entities. Organisations of all types are combining connected systems with big data and analytics to transform operations, increase automation and efficiency or to deliver new services to their users. Wireless networking with LTE or 5G enables these transformations to take place even in dynamic, remote or highly secure environments, while offering the scale benefits of a technology that has already been deployed worldwide.

The arrival of LTE-Advanced systems delivered a step change in network capacity and throughput, while 5G networks have brought improved density (support for larger numbers of users or devices), even greater capacity again, as well as dramatic improvements to latency that enable use of mobile technology for time-critical applications.

In addition to companies looking to develop their own private mobile networks for the first time, there is a large base of potential customers who currently operate LMR/PMR private networks based on technologies such as TETRA, P25 and DMR. These customers are demanding critical broadband services that are simply not available from alternative technologies and consequently, private mobile networks based on LTE and 5G have the potential to eventually replace much of this market.

The exact number of existing private mobile network deployments is hard to determine, as details are not often made public. Excluding the companies holding CBRS PAL licences in the USA (except those known to be undertaking private rather than public mobile network projects using the spectrum), available data shows that at least 330 companies have been or are investing in private mobile networks based in LTE or 5G, in the form of trials and pilot deployments, commercial network launches or investment in licences that would enable deployment of private LTE or 5G networks. This is likely to be a substantial underestimate of the overall global market.

GSA has identified 36 countries with LTE or 5G-suitable private network spectrum licences or private network deployments based on LTE or 5G.

In order to improve information about this market, GSA is now maintaining a database of private LTE and 5G networks and spectrum worldwide. The database catalogues specific information about 199 companies with (LTE or 5G-suitable) private mobile licences or known to be deploying LTE or 5G private mobile networks to enable analysis about the evolution of the market and is being added to on an ongoing basis. This report is the third in a series tracking the evolution of this sector of the industry and includes a data annex for GSA Members.

Spectrum for private networks

Whatever the approach to deployment, an organisation cannot operate a private LTE or 5G network without access to sufficient and appropriate spectrum. Private mobile networks based on LTE or 5G can be deployed in licensed, licensed (sub-leased), shared or unlicensed spectrum.

Licensed spectrum can be used where either a public operator provides a private network-as-a-service (NaaS) using the spectrum it has been allocated to run public networks or where it sub-leases its spectrum to the private network operator or, alternatively, where the national regulator has specifically allocated spectrum to be used for local private networks. In many countries, utilities and emergency services have historically been allocated dedicated slices of spectrum for their private networks (although many would argue they don't have enough spectrum to support future requirements and are considering hybrid models combining public services and private assets). With the arrival of 5G, regulators in many countries are considering allocating, or are already allocating, more spectrum to enable private network deployment, with the aim of enabling and encouraging digital industry development.

Shared spectrum solutions enable the use of the same spectrum range in a single geographic area by more than one organisation.

Unlicensed spectrum solutions enable the use of LTE or 5G to build a network using spectrum that is freely available for public use, such as the spectrum bands set aside globally at 2.4 GHz and 5 GHz that are already widely used for WiFi.

Both LTE and 5G have development paths that have or will encompass all three options. LTE was originally designed to work in licensed spectrum, but a variety of technology developments have enabled

support of unlicensed networking. LTE-U was developed as a pre-Release 13 technology pioneered in the USA and has been deployed in Thailand and trialled in a handful of other countries. It enables use of the 5 GHz unlicensed WiFi spectrum to augment the LTE network. Momentum in the market slowed after the emergence of the 3GPP standard for Licensed Assisted Access (LAA), which enables use of unlicensed spectrum alongside a licensed anchor band and which has now been deployed by operators in six countries. Other approaches include LTE WLAN Link Aggregation (LWA) and LTE WLAN radio level integration with IPSec tunnels (LWIP).

Multefire subsequently emerged enabling deployment of LTE networks in either shared spectrum environments or unlicensed spectrum (2.4 GHz and 5 GHz globally and 800/900 MHz and 1900 MHz regionally).

Citizens Broadband Radio Service (CBRS) is a blended approach that has been developed in the USA. Access to the spectrum is prioritised for government/military users and after them, for Priority Access Licensed (PAL) users (organisations that have acquired one of the many regional ten-year licences in spectrum auctions) with everyone else (General Authorized Access [GAA] users) able to request access dynamically to use the spectrum via approved SAS (spectrum access server) operators.

3GPP Release 16 has introduced standards for use of unlicensed spectrum at 5 GHz and 6 GHz for 5G networks. It enables new modes of operation for 5G networks: anchored NR-U (licensed assisted access), using a licensed spectrum band as the anchor for an unlicensed spectrum band (with options to use either LTE or 5G anchors for the new radio using the unlicensed spectrum) and Standalone NR-U, using only unlicensed spectrum to carry the 5G service (with no LTE or 5G NR anchor).

While use of unlicensed spectrum offers benefits, it is the case that many organisations are concerned about the risk of not being able to achieve the required deterministic system behaviour, availability and performance using unlicensed or shared spectrum solutions, meaning that dedicated spectrum is required too.

National spectrum plans for local private mobile networks

As already mentioned, many countries have allocated dedicated frequency ranges for the operation of utility or emergency service networks (these are typically WANs covering regions or entire countries/territories). But with growing demand for networks to support IoT, smart city, mission critical, government and Industry 4.0 applications, regulators in some countries have decided to (or are exploring the possibility of) setting aside much more spectrum, either on a dedicated or shared basis, for local area private mobile networks (those covering individual sites or campus networks with multiple sites) or for wide area private mobile networks covering cities (for smart city applications).

Recent examples of spectrum initiatives to private mobile networking are outlined below (non-exhaustive list).

Australia: In August 2020, ACMA launched a consultation on plans for area-wide apparatus licences for wireless broadband in the 24.7–27.5 GHz frequency range of the 26 GHz band; wireless broadband and FSS in the 27.5–29.5 GHz range; and FSS in the 29.5–30 GHz range. It is envisaged these licences would support private network and local WISP use-cases. ACMA is making the spectrum at 24.7–25.1 GHz and 27.5–29.5 GHz available Australia-wide via an administrative process. Applications opened in November 2020 and licences are expected to be available from December 2020. Licences for spectrum from 25.1 GHz to 27.5 GHz will be available via administrative process only after the conclusion of an auction of spectrum in this range covering key metropolitan and regional areas scheduled for Q1 2021. That administrative process is scheduled to begin in May 2021 with licences issued by the end of June 2021.

Belgium: In December 2019, BIPT launched a consultation on a draft bill and three draft royal decrees concerning among other things, the possibility of authorising local private networks using 4G or 5G in the 3800–4200 MHz band.

Brazil: An auction is expected in H1 2021 covering various bands with spectrum set aside for private networks: 2390–2400 MHz, 3700–3800 MHz, 27.5–27.9 GHz.

Chile: In November 2019, Chile passed a resolution designating spectrum from 3750 MHz to 3800 MHz for private 5G networks.

Croatia: Croatia is planning an auction of multiple spectrum bands. Due to the impact of COVID-19, the auction has been delayed from 2020 to H1 2021. It intends to auction at least 300 MHz in the 3410–3800 MHz range on a national basis, with the remaining 90 MHz of spectrum potentially available for local or private networks.

Finland: Spectrum at 24.25–25.1 GHz is being reserved for the construction of local, private networks in the future.

France: At the end of March 2019, applications were closed for requests to run 5G trials at 26 GHz. The French regulator ARCEP accepted 11 schemes backed by public and private network operators. The various private network projects include inter alia deployment of a 5G network at the National Vélodrome in Saint-Quentin-en-Yvelines, a network at Lyon Part-Dieu station offering both public and private 5G services (the latter to enable station management and train telematics) and a network at The Grand Maritime Port of Le Havre for smart grid and logistics applications.

In May 2019, ARCEP opened up the possibility of wider private use of TDD spectrum at 2.6 GHz (2575–2615 MHz) for very-high-speed mobile networks (Air France KLM has already been trialling private LTE in this band for a number of years). Then in September, after a public consultation, it confirmed that it would be allocating the spectrum on a regional basis in order to improve broadband coverage for enterprises. Enterprises must express interest in using the spectrum, which will either be allocated (in the case of no competition for the spectrum) or ARCEP will determine a (possibly competitive) system of allocation. So far three applications have been accepted.

ARCEP has also opened the possibility of private network deployment in C-Band spectrum. In order to ensure organisations can get access to mobile services with sufficient coverage and performance, the terms of the licences for C-Band spectrum awarded in September 2020 included commitments to respond to reasonable requests from enterprise and public sector organisations for the supply of services, either through the supply of services on its own network or through sub-licensing of the frequency on a geographically limited basis.

Germany: In November 2019, Germany's regulator, Bundesnetzagentur, opened up applications for use of the 3700–3800 MHz band for local and regional 5G networks. Stating that it wants Germany to be a pioneer in Industry 4.0, in addition to industrial users, the regulator anticipates the spectrum being leased by organisations in the agricultural and forestry sectors. Frequencies can be used immediately after allocation. The right to apply for spectrum derives from ownership or from another legal right to use the associated land and fees are related to size of the geographic area covered by the licence, the amount of spectrum allocated and the duration.

The regulator has also been preparing a framework for the assignment of spectrum at 24.25–27.5 GHz for local applications. After consultation it is proposed the entire range be assigned on a technology- and service-neutral basis (starting with spectrum at 26.5–27.5 GHz). The new plans were opened up to a consultation which ended in August 2020. No limit is proposed for the geographical size of a local frequency assignment, although the licensee must have a plan for service availability throughout that area within a year. The results have not yet been published.

Hong Kong: In July 2019, the regulator OFCA announced that it would be making 400 MHz in the 27.95–28.35 GHz range available for Localised Wireless Broadband Licences (using 5G or other advanced mobile technologies) on a geographic-sharing basis. It opened up applications for assignment of the shared spectrum later the same month. GSA is aware of one active licence.

OFCA has also stated plans to assign spectrum at 617–698 MHz and 703–803 MHz for indoor mobile services, with the spectrum available from 2021 at the earliest.

Japan: In December 2019, the Ministry of Internal Affairs and Communications began accepting applications for local 5G licences. The spectrum available spans 28.2–28.3 GHz and can be used within the applicant's own building or on its own land to provide broadband fixed wireless services. National carriers are not eligible to apply, as the spectrum is not intended to supplement national carriers' existing holdings. MIC also stated it would consider allocation of spectrum at 4.6–4.9 GHz and 28.2–29.1 GHz for local private services in the future.

(In 2017, Japan also made the 1.9 GHz band, Band 39, previously used for PHS and DECT available for private LTE networks as a shared band.)

Malaysia: In January 2020, the MCMC stated that spectrum at 26–28 GHz will be assigned in two parts. Spectrum at 24.9–26.5 GHz will be tendered (beauty contest) to licensees on a national basis. Spectrum at 26.5–28.1 GHz will be assigned on a first-come, first-served basis for the deployment of local/private networks 'for industrial and enterprise services and applications for, but not limited to, healthcare, ports, transportation, manufacturing, agriculture, public safety and smart city projects'. Proceedings have been delayed, however.

Netherlands: Spectrum at 3.5 GHz is already widely used for local and private network applications, although the government is reorganising the spectrum. It intends to make spectrum at 3500–3700 MHz available nationally from September 2022. Spectrum at 3400–3450 MHz and 3750–3800 MHz is then intended to be made available for local use from 2026. Spectrum at 3450–3500 MHz and 3700–3750 MHz is already used and currently protected for national security reasons. Netherlands' Digital Connectivity Action Plan foresees the use of spectrum at 26 GHz either for a very large number of local permits or for shared use.

New Zealand: Spectrum at 2.5 GHz (2575–2620 MHz) is available in New Zealand for local or regional Managed Spectrum Park (private) licences (often for regional wireless broadband services). Eighty licences were awarded in 2009 after an initial round of applications. Subsequent licences have been made available on a first-come, first-served basis. Licences last for six years. There are limits on geographic coverage of licences held by any single organisation.

Norway: The Norwegian regulator Nkom is considering a joint assignment of various spectrum bands in 2021, two of which – the 2300–2400 MHz band and 3600 MHz – are under consideration for use for allocation to local/regional permits. In June 2020, it launched a consultation on plans to offer local/regional permits at 2300 GHz and 26 GHz.

Russia: In December 2019, Russia's Deputy Minister of Digital Development, Telecommunications and Mass Communications stated that the government was preparing an auction of mmWave spectrum at 25.25–27.5 GHz (with six lots, four federal lots of 400 MHz and two regional lots of 250 and 400 MHz). Then in March 2020, SRCF published its decision that it would open up spectrum use at 24.25–24.65 GHz for an unlimited number of users for the purpose of creating private networks.

Russia SRFC is also reportedly planning to allocate chunks of spectrum at 400 MHz for private LTE networks.

Slovenia: In August 2020, Slovenia announced draft terms and conditions on plans for a multi-band spectrum covering various bands. A portion of the spectrum at 2300 MHz (2300–2320 MHz and 2390–2400 MHz) and at 3600 MHz (3400–3420 MHz) is expected to be set aside for local use (including for private use).

The latest timetable envisages the completion of the auction before the end of 2020.

Sweden: PTS intends to enable local permits for the use of spectrum in the 3720–3800 MHz range. These will be awarded and managed through an administrative process.

PTS initiated consultations on the demand for 5G frequencies in the 24.25–27.5 GHz bands and in December 2019, stated that it intended – as soon as possible – to allocate parts of the spectrum range for both local and large-scale 5G use. In its consultation, launched in April 2020, it proposed before the end of 2021 authorising the use of spectrum at 24.25–25.1 GHz for local 5G services, with licences valid to end 2025 and limited to indoor use.

UK: Following consultations, in July 2019, Ofcom announced plans to initiate spectrum sharing with localised licensing of key spectrum bands. Its aim is to open up use of the spectrum to private network operators such as enterprises and utilities. The spectrum that will be available through local licences includes:

- 3800–4200 MHz
- 1781.7–1785 MHz/1876.7–1880 MHz) (called 1800 MHz shared spectrum by Ofcom)
- 2390–2400 MHz (called 2300 MHz shared spectrum).

The spectrum is available on a coordinated first-come, first-served basis. Ofcom indicated that localised licenses can be applied for immediately.

Ofcom has also decided to enable localised access to spectrum in the 26 GHz band (24.25–26.5 GHz) available on a shared-spectrum basis, but only for indoor use. (Spectrum in the 26.5–27.5 GHz range is used by the military. Ofcom will continue to review possible ways of making this spectrum available in the future.)

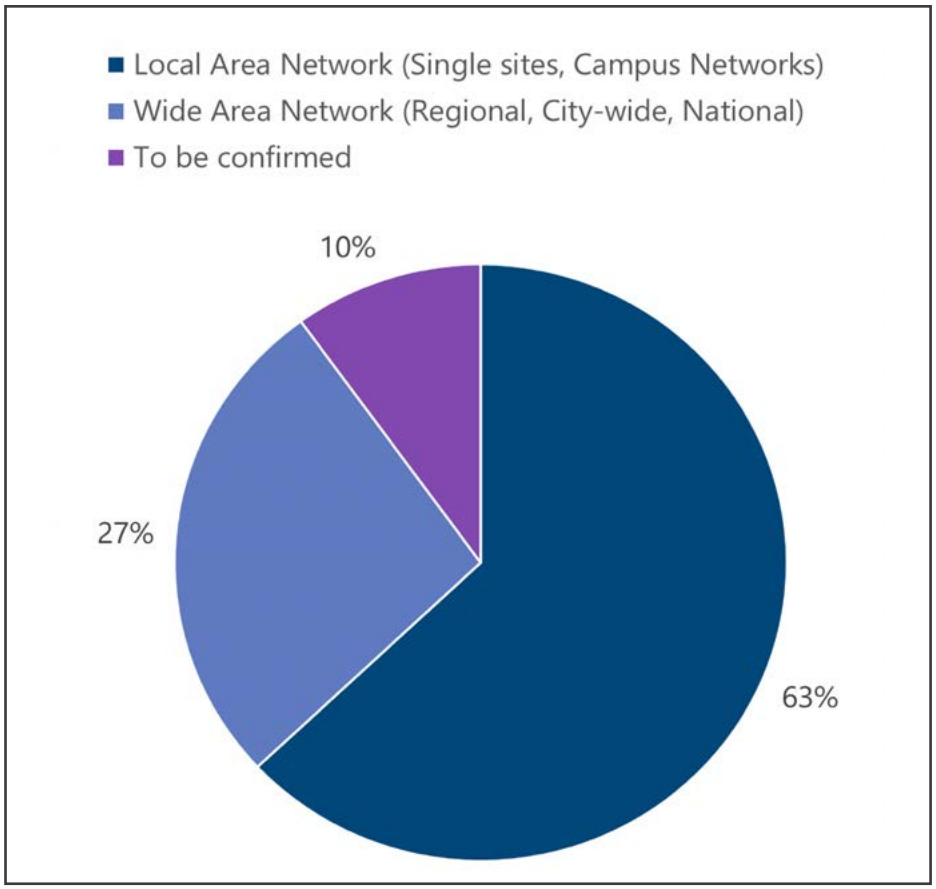
USA: There are more than 200 organisations holding PAL spectrum licences for CBRS deployments in the USA, including for private enterprise purposes, and more organisations intending to use General Authorized Access (GAA) spectrum. Initial commercial deployments of CBRS were given the go-ahead in September 2019. Full-blown commercial deployments were authorised in January 2020, initially only using General Authorized Access (GAA) spectrum. The auction of Priority Access CBRS spectrum at 3.5 GHz was completed in August 2020 enabling launch across all relevant spectrum ranges. The CBRS bands is expected to be used extensively for private mobile network deployments in the USA.

Private mobile networks – players and market statistics

The private mobile networks market is home to a wide range of service providers, including equipment/technology vendors, mobile network operators, systems integrators and the private network end users (who sometimes take responsibility for installing or operating their own infrastructure). GSA has counted 26 equipment vendors that have been involved in the supply of equipment for private mobile networks based on LTE or 5G. In addition, it has identified 41 public mobile network operators involved in the projects, so it is clear end users are not all breaking ties with existing mobile services providers.

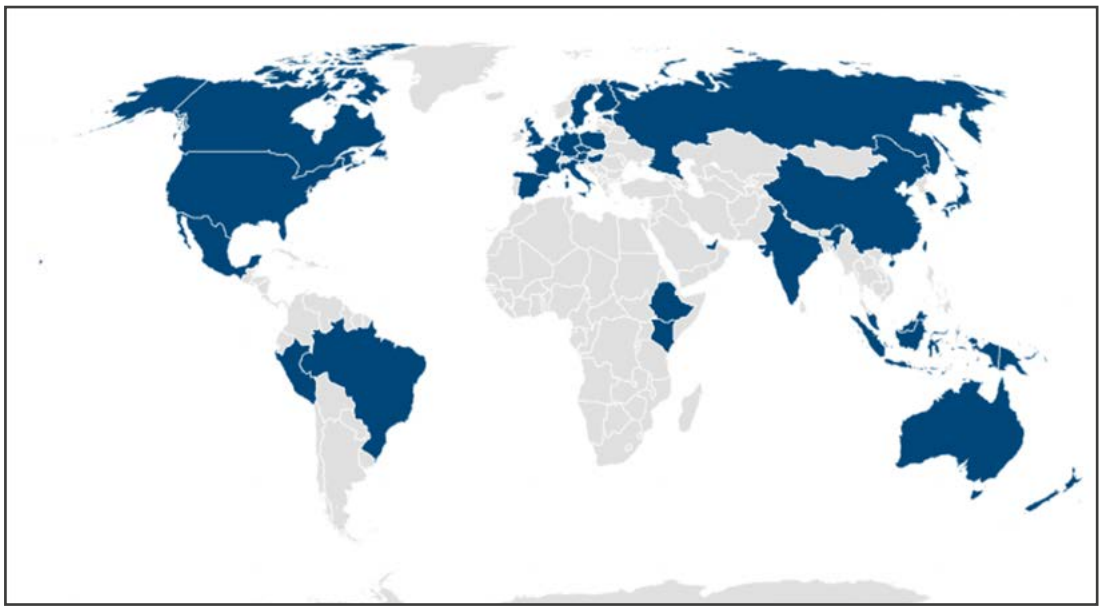
GSA has been able to categorise 199 private mobile network deployments, which as Figure 1 shows, are being deployed all around the world.

Figure 2: Private mobile network deployments by type, LAN vs WAN (base 199 networks)



As might be expected, LAN deployments outnumber WAN deployments and we would expect this disparity to continue as there are many more potential users of smaller local networks than large regional or nationwide ones.

Figure 1: Countries with identified private network deployments (pilot and commercial)



LTE is used in 81% of the catalogued private mobile network deployments for which GSA has data. Perhaps surprisingly, 5G is also being deployed (or planned for deployment) in over a quarter of those networks.

It is not always evident whether a private mobile network deployment is intended as a pilot project only or whether a full production network is being deployed, as the end users/contracted vendors do not always make that information available. What GSA's data suggests however, is that LTE deployments are much more likely to be commercial and 5G deployments are more likely to be pilot projects. (Note: some private mobile network projects involve both LTE and 5G.)

GSA's data suggests that manufacturing is an early adopter of local area private mobile networks with 40 companies holding suitable licences or involved in known pilots or deployments. Mining follow second, with ports and academic organisations also actively trialling/deploying local area private mobile networks. Meanwhile the data suggests that utilities, police/security/public safety, and rail are the biggest users of wide area private mobile networks. Companies in the communications/IT sector are also key investors in private mobile networks, though data is not available to determine whether their activities encompass local or wide area applications.

Figure 3: Private network deployments by technology (base with identified private network deployments, pilot and commercial (base 156 networks)

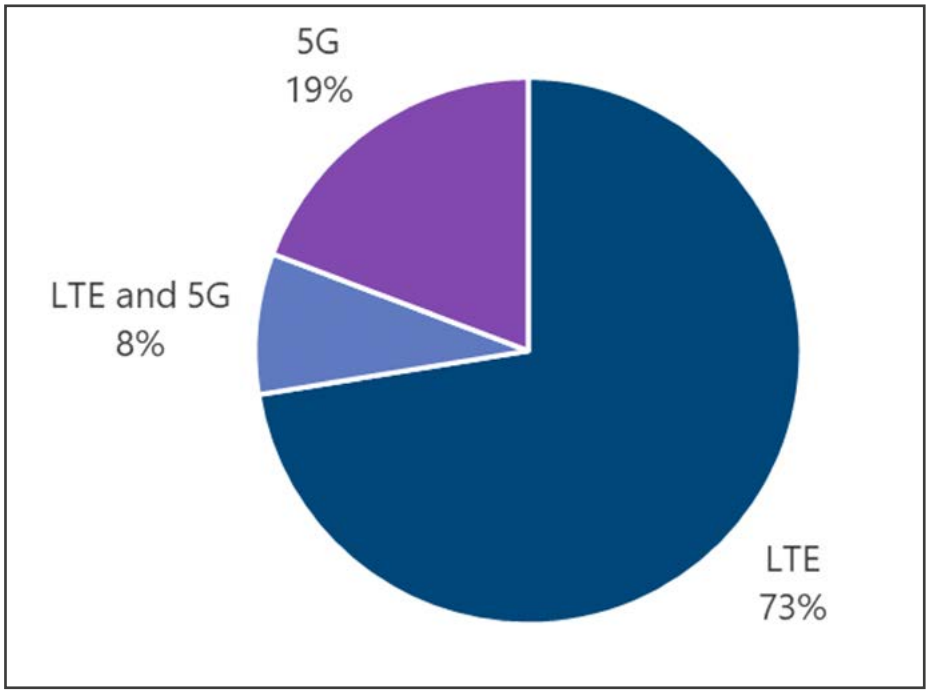
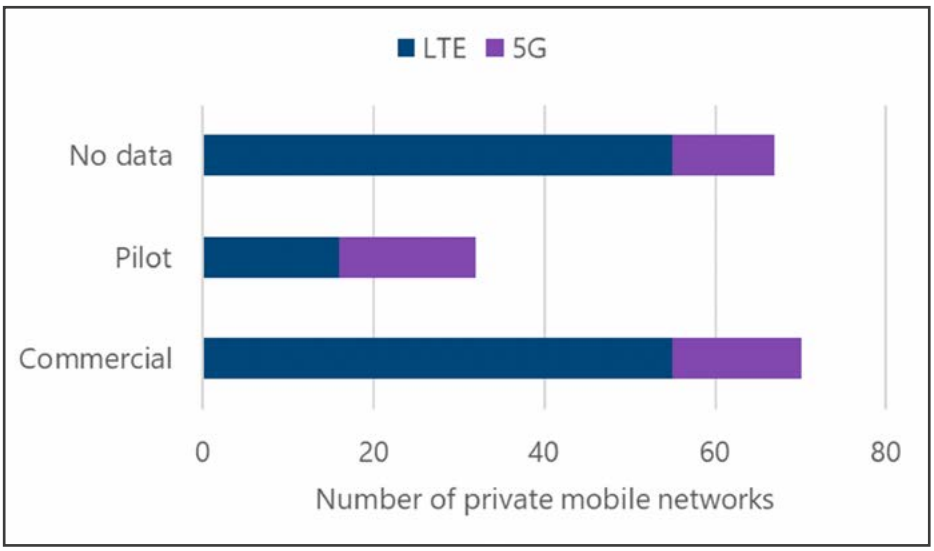


Figure 4: Private network deployments by status: pilot project or production deployment (base 156 networks)



Looking a bit more closely at **Germany**, where the regulator makes the data about some of its C-Band local network licensees available, and where GSA has complemented this with wider research, GSA has identified 68 companies deploying private mobile networks or with licences enabling deployments. (Note: Identities of other licensees are not all published by the regulator due to requests for commercial confidentiality.) GSA has also been able to classify licensees/those deploying networks by sector.

Again, manufacturing leads, which is perhaps no surprise given the strength of Germany's manufacturing sector and the strong potential benefits of deploying advanced LTE or 5G in factory environments for monitoring, and automation.

There has been a high number of licences in the communications/IT sector suggesting a strong base of suppliers emerging to support organisations wanting to deploy private networks but without the skills needed in-house to launch or run them.

Summary

A wide range of market participants is actively engaged in developing and delivering solutions for private mobile networks. With so much opportunity and so many regulators planning initiatives to make spectrum available for LTE and 5G private usage, we can expect significant market evolution in the next couple of years. This is the second GSA paper tracking this sector. More will follow during 2020. Data about private network deployments in the Netherlands will be added in the next update.

Annex 1. A full list of all the Private Mobile Networks that GSA is tracking can be found in the Annex in the GSA Members and Associates version of this report.

Figure 5: Number of identified private mobile network deployments by sector: commercial or trial; deploying and deployed (base 199 networks)

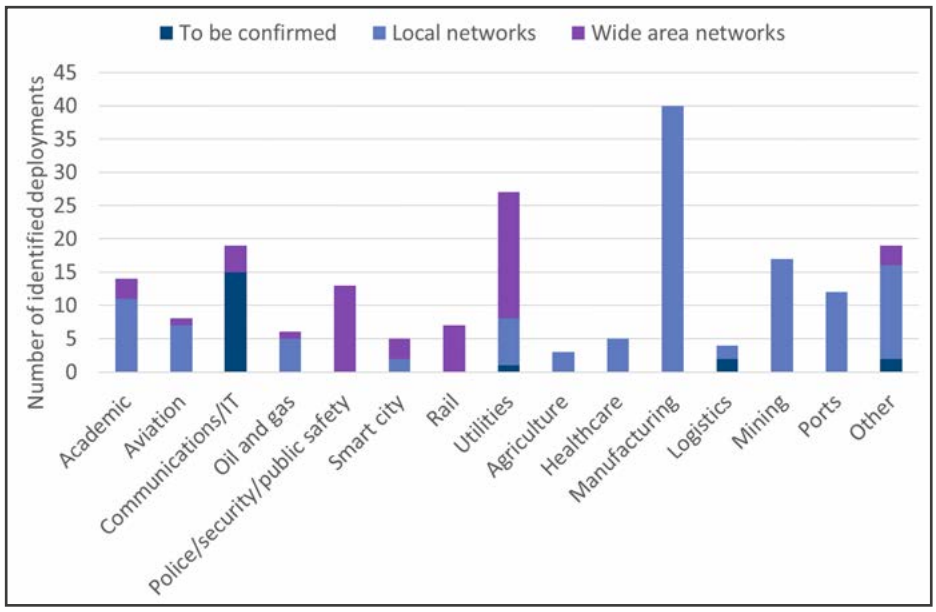
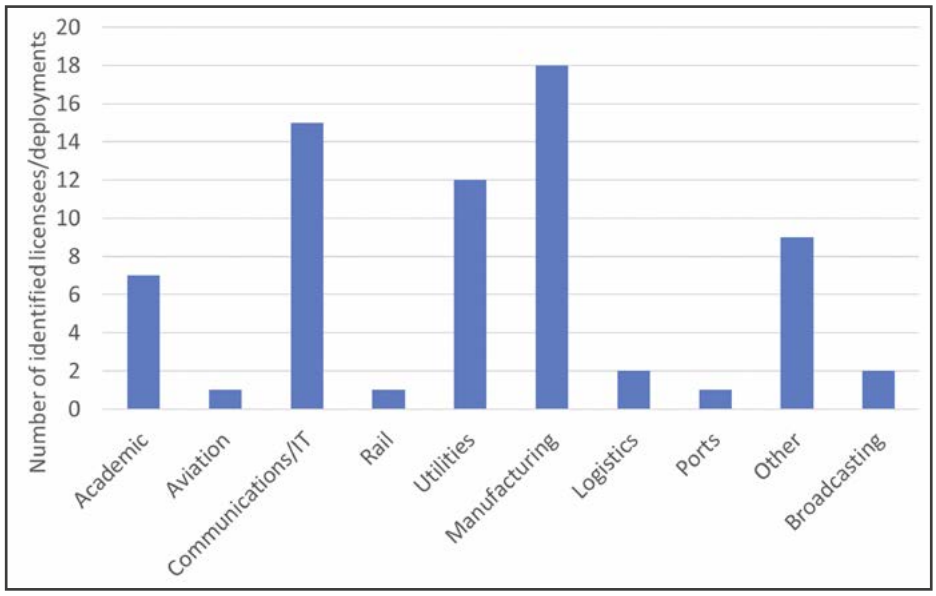
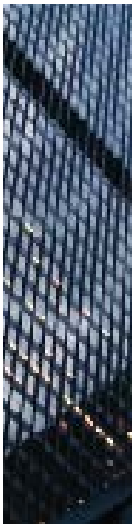


Figure 6: Number of identified private mobile network deployments/licences in Germany by sector: commercial or trial, licensed, deploying and deployed (base 68 networks)





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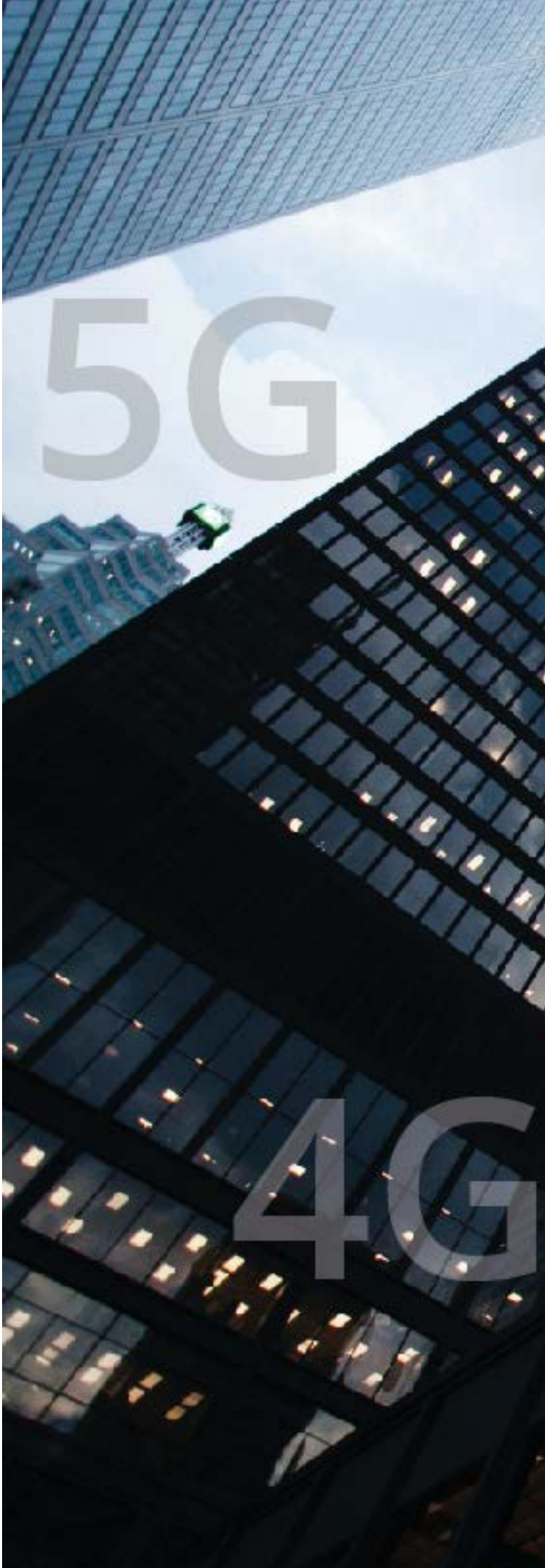

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