Research Report

State of the Private 4G/5G Market

A global view of market drivers, key industries, growth to date, forecast & quantifiable benefits

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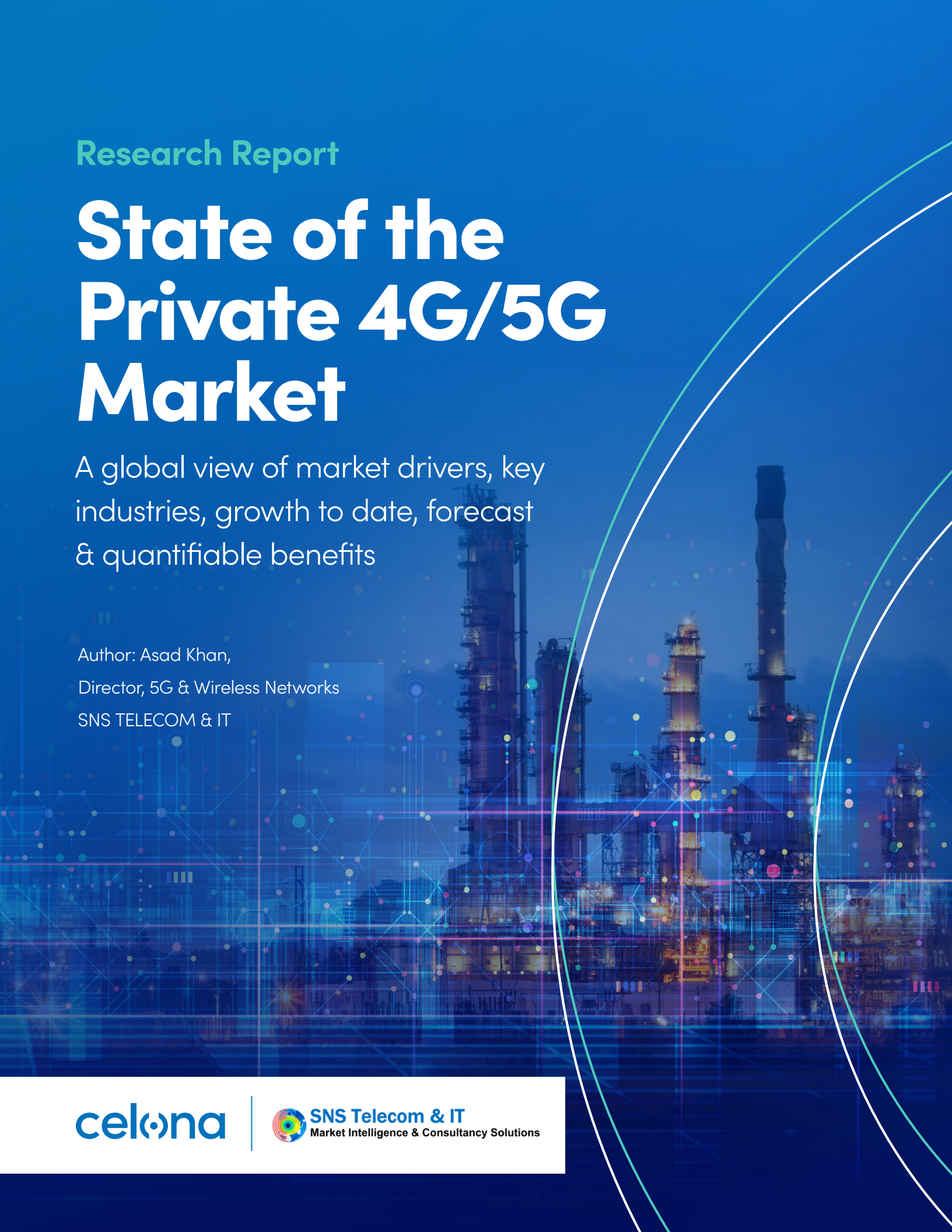

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Market Drivers

The key factors that are driving the continued expansion of the private 4G/5G market include, but are by no means restricted to the availability of shared and local area licensed spectrum for private networks, lack of reliable wireless connectivity in indoor, industrial and remote environments, Industry 4.0 revolution, critical communications broadband evolution and enterprise transformation initiatives.

Global Spectrum Liberalization Initiatives

National regulators across the globe have released or are in the process of granting access to shared and local area licensed spectrum suitable for private 4G/5G networks. Examples include the three-tiered CBRS spectrum sharing scheme in the United States, Germany's 3.7-3.8 GHz and 28 GHz licenses for 5G campus networks, United Kingdom's shared and local access licensing model, France's vertical spectrum allocation, Netherlands' 3.5 GHz licenses for plot-based networks, Finland's 2.3 GHz and 26 GHz licenses for local 4G/5G networks, Sweden's 3.7 GHz and 26 GHz permits, Poland's spectrum assignment for local government units and enterprises, Japan's 4.6-4.9 GHz and 28 GHz local 5G network licenses, South Korea's e-Um 5G allocations in the 4.7 GHz and 28 GHz bands, Taiwan's provision of 4.8-4.9 GHz spectrum for private 5G networks, Australia's apparatus licensing approach and Brazil's SLP licenses. The table below summarizes existing and planned allocations.

Country	Spectrum Band/License Scheme Name	Access Framework	Status
United States	3.5 GHz (CBRS – Citizens Broadband Radio Service)	Three-Tiered Sharing	Available
Canada	3.9 GHz (NCLL – Non-Competitive Local Licensing)	Local Area Licensing	Available
Germany	3.7-3.8 GHz & 26 GHz (5G Campus Networks)	Local Area Licensing	Available
United Kingdom	1.8 GHz, 2.3 GHz, 3.8-4.2 GHz & 26 GHz (Shared Access)	Local Area Licensing	Available
Ireland	3.9 GHz (Local Area WBB – Wireless Broadband	Local Area Licensing	Available
France	2.6 GHz (PMR – Private Mobile Radio Networks) 3.8-4.0 GHz & 26 GHz	Local Area Licensing Local Area Licensing	Available Pilot Phase
Spain	2.3 GHz (Private Broadband Systems) 26 GHz (Local Self-Provisioned Networks)	Local Area Licensing Local Area Licensing	Available Available
Netherlands	1.8 GHz Unlicensed 3.5 GHz (Plot-Based Networks)	License-Exempt Access Local Area Licensing	Available Available
Belgium	3.8-4.2 GHz (Private Broadband Local Area Networks)	Local Area Licensing	Available
Switzerland	3.4-3.5 GHz (NPNs – Non-Public Networks)	Local Area Licensing	Pilot Phase
Sweden	1.8 GHz Unlicensed 3.7 GHz & 26 GHz (Local Permits)	License-Exempt Access Local Area Licensing	Available Available
Norway	3.8-4.2 GHz (Local Mobile Networks)	Local Area Licensing	Available
Finland	2.3 GHz & 26 GHz (Local 4G/5G Networks)	Local Area Licensing	Available
Poland	3.8-4.2 GHz	Local Area Licensing	Available
Slovenia	3.8-4.2 GHz	Local Area Licensing	Available

Croatia	3.40-3.48 GHz (Regional County Licenses)	Local Area Licensing	Available
Saudi Arabia	4.0-4.2 GHz & 28 GHz	Local Area Licensing	Available
Bahrain	3.8-4.2 GHz	Local Area Licensing	Pilot Phase
Japan	1.9 GHz (sXGP – Shared Extended Global Platform) 4.6-4.9 GHz & 28 GHz (Local 5G)	License-Exempt Access Local Area Licensing	Available Available
South Korea	4.7 GHz & 28 GHz (e-Um 5G)	Local Area Licensing	Available
Taiwan	4.8-4.9 GHz	Local Area Licensing	Available
Hong Kong	26/28 GHz (Localized Wireless Broadband Systems)	Local Area Licensing	Available
Australia	1.7/1.8 GHz & 1.9/2.1 GHz (PTS – Licenses in Remote Areas) 3.4-4.0 GHz & 26/28 GHz (AWLs – Area Wide Licenses)	Local Area Licensing Local Area Licensing	Available Available
New Zealand	2.5 GHz (MSP – Managed Spectrum Park)	Local Area Licensing	Available
Brazil	700 MHz, 1.5 GHz, 2.3 GHz, 2.4 GHz, 3.7-3.8 GHz & 28 GHz (SLP – Private Limited Service Licenses)	Local Area Licensing	Available
Chile	2.3 GHz & 3.75-3.60 GHz	Local Area Licensing	Pilot Phase

Global Availability of Shared & Local Area Licensed Spectrum for Private 4G/5G Networks
Source: Private LTE & 5G Network Ecosystem: 2024 – 2030 (https://www.snstelecom.com/private-lte)

In some cases – particularly in countries where suitable shared or locally licensed frequencies have not been set aside – regulators have imposed leasing obligations on public mobile operators' national 5G licenses to provide spectrum for private networks in specific geographic locations. Furthermore, dedicated wide area spectrum is available in many countries for private networks serving specific vertical application scenarios, particularly in the critical communications domain, where national or regional coverage is required for PPDR (Public Protection & Disaster Relief), A2G (Air-to-Ground), railway and utility communications.

Wireless Connectivity in Indoor, Industrial & Remote Environments

The lack of reliable wireless coverage and service availability is perhaps the most fundamental driver for the adoption of private 4G/5G networks. The coverage of on-premise Wi-Fi and wide area public cellular networks is often patchy in indoor and harsh industrial environments due to the type of construction, building materials and physical constraints that adversely affect the transmission of wireless signals. In addition, the challenging economics of deploying and operating networks in remote areas limit the commercial provision of mobile operator services. Unlike Wi-Fi, which operates at relatively lower power levels and uses unlicensed spectrum prone to interference, private 4G/5G networks leverage higher transmission power, dedicated spectrum and more robust signal penetration, enabling superior performance in challenging environments with fewer access points. Furthermore, unlike the broader, less focused coverage of public cellular networks, private networks provide highly targeted coverage and service capabilities, specifically tailored to meet the needs of end users in both indoor and outdoor settings.

Industry 4.0 Revolution & Standalone Private 5G Networks

The growing significance of unobstructive wire-free connectivity to support increased mobility and flexible production as part of the fourth industrial revolution of manufacturing and process industries – commonly referred to as Industry 4.0 – is a principal theme that is accelerating the uptake of private 4G/5G networks. In particular, the Industry 4.0 revolution is widely regarded as a catalyst for cementing the business case for standalone 5G implementations that meet the performance, security, reliability and availability requirements of wireless communications for industrial digitization and automation goals.

Although most existing private cellular networks are based on 4G LTE technology, manufacturers and other end user organizations are starting to adopt standalone private 5G networks without 4G dependency to take advantage of 5G's full capabilities in supporting demanding industrial application scenarios, especially time-sensitive Industrial IoT use cases requiring lower latency and greater reliability.

Critical Communications Broadband Evolution

Critical communications user groups have traditionally relied on narrowband LMR (Land Mobile Radio) networks for mission-critical voice and low-speed data services. The industry is going through an evolution to support broadband-dependent field applications for public safety agencies, railway operators, utilities and other user groups, which in turn has led to aspirations to transition from LMR, GSM-R and other legacy technologies to private 4G LTE and eventually 5G networks.

Enterprise Transformation Initiatives

In addition to the Industry 4.0 and critical communications broadband movements, which focus on specific vertical sectors, horizontally-oriented digital transformation initiatives targeting enterprise environments are also driving demand for private 4G/5G networks, primarily to provide localized cellular coverage at offices, commercial buildings and business parks. Potential applications range from high-speed broadband access, carrier-grade telephony, messaging, telepresence and video conferencing to smart building operations, security management and monitoring, and autonomous mobile robots for convenience services such as delivering packages, coffee and lunch boxes.

Neutral Hosting & DAS Replacement

Private 4G/5G networks are also gaining recognition as a cost-effective alternative to DAS (Distributed Antenna Systems) for delivering neutral host cellular coverage in both carpeted enterprise spaces and industrial facilities, whereby staff and visitors gain access to public mobile operator networks from a private network. This trend is particularly prevalent in the United States due to the open accessibility of the GAA (General Authorized Access) tier of 3.5 GHz CBRS spectrum.

Security & IT/OT Convergence

Although private 4G/5G networks use the same security protocols and technologies that are used to secure commercial mobile operator networks, they can be tailored to provide higher levels of protection to fulfill specific physical and cyber security requirements. In addition, as data does not have to traverse over public network infrastructure, private networks ensure that sensitive or proprietary information is fully secured and controlled locally.

In industrial settings, private 4G/5G networks are increasingly being viewed as a means to drive the convergence of IT (Information Technology) and OT (Operational Technology) systems, which have traditionally depended on separate networks and protocols. By enabling users to leverage a common infrastructure for secure and reliable connectivity across both IT and OT domains, private networks pave the way for a unified zero trust model and greater cross-domain visibility, while supporting segregation between critical operational traffic and less-sensitive IT services.

Key industries & use cases

Private 4G/5G networks are continuing their upward trajectory with deployments targeting a multitude of use cases across a host of industries. Dozens of manufacturers across the automotive, aerospace, shipbuilding, steelmaking, chemical production, electronics and heavy machinery segments are investing in private 4G/5G networks for Industry 4.0 applications such as AGV (Automated Guided Vehicle) and AMR (Autonomous Mobile Robot) communications. Private cellular infrastructure is also being employed to provide industrial-grade wireless connectivity for autonomous material transportation and other applications in the warehousing vertical.

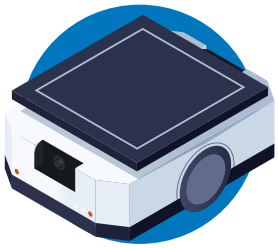
In the oil and gas, mining and energy industries, private 4G/5G networks are increasingly being deployed at refineries, mines, power plants, wind farms and other remote facilities to enhance productivity and safety by enabling site-wide communications between workers, real-time video monitoring and teleoperation of equipment. In the transportation sector, private networks are being utilized to provide voice, data, messaging and IoT connectivity services for internal operations at airports, maritime ports and across railway lines.

Militaries around the globe are investing in permanent private 4G/5G networks at military bases, as well as rapidly deployable systems for warfighters at the tactical edge. In the wider public sector, municipalities are taking advantage of shared and local area licensed spectrum to implement their own dedicated 4G/5G networks for smart city services and distance learning in underserved school districts. Similarly, higher education institutions are embracing private networks to improve wireless coverage, public safety and campus operations, as are healthcare facilities, where reliable connectivity is crucial for critical care, patient monitoring and administrative systems.

Private 4G/5G networks are also being deployed at sports and special event venues in support of enhanced fan engagement, professional TV broadcasting, POS (Point-of-Sale) and other backend operations. Other vertical sectors where private networks are being adopted extend from retail and hospitality to agriculture, forestry and construction. From a horizontal perspective, enterprise RAN (Radio Access Network) systems for indoor coverage enhancement are relatively common and end-to-end private networks are starting to be implemented in office buildings and other indoor spaces.

Connected Worker

Wireless connectivity for handhelds, tablets, bar code scanners and other devices



Industrial Automation

AGV/AMR communications, reconfigurable production lines, remote control & digital twins

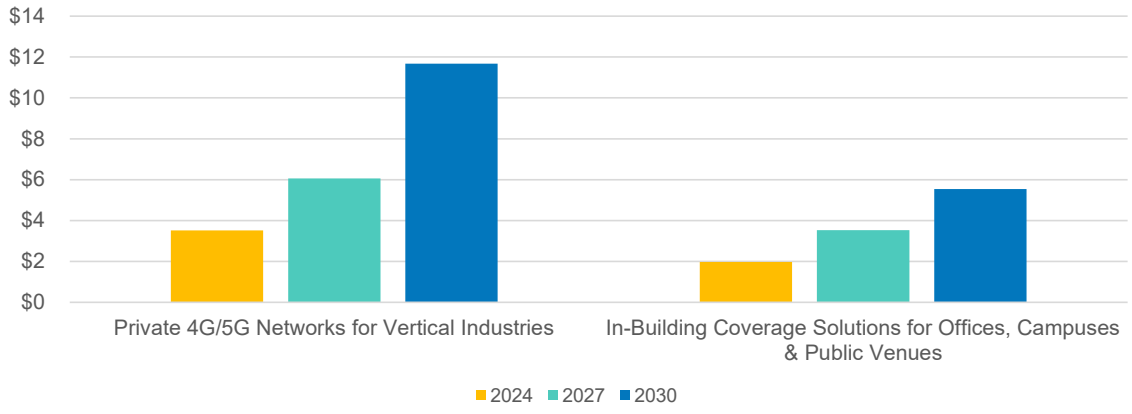
High-Definition Video

Video transmission and analytics for security monitoring, machine vision and quality inspections

Market sizing & forecast

SNS Telecom & IT estimates that global spending on private 4G/5G network infrastructure for vertical industries will grow at a CAGR of approximately 20% between 2024 and 2027, eventually exceeding $6 billion annually. From a longer-term perspective, the market is projected to grow at an even higher rate beyond 2027, reaching nearly $12 billion by 2030. Much of this growth will be underpinned by highly localized 5G networks for the digitization and automation of manufacturing and process industries, including multi-site, multi-national deployments by some of the most well-known household brand names.

Taking into account dedicated 4G/5G network equipment for public cellular coverage enhancement in offices, buildings and public venues, where private network-based neutral host solutions are beginning to replace DAS and single operator small cell installations, the market will be collectively worth more than $9 billion in annual investments by 2027 and as much as $17 billion by 2030.



Annual Spending on Private 4G/5G Networks ($ Billion)
Source: Private LTE & 5G Network Ecosystem: 2024 – 2030 (https://www.snstelecom.com/private-lte)

4G LTE vs. 5G Technology

SNS Telecom & IT expects to see continued investments in both 4G LTE and 5G-based private networks in the coming years, with a steady shift towards standalone 5G technology. By the end of 2027, standalone private 5G networks will account for more than two third of the total market, fueled by increasingly sophisticated application scenarios requiring support for deterministic networking, extreme reliability, precise positioning and other advanced capabilities.

Regional Segmentation

The Asia Pacific region will continue to lead investments as newer local spectrum-enabled deployments in Japan, South Korea, Taiwan and Australia narrow the gap with China's large-scale private 5G installations. Thanks to supportive regulatory frameworks, the United States and Europe are not far behind, collectively accounting for close to half of the global market. In the rest of the world, Brazil has emerged as one of the fastest growing national markets owing to the country's forward-thinking approach to spectrum licensing for private wireless networks.

Quantifiable benefits

Some private 4G/5G network installations have progressed to a stage where quantifiable benefits – particularly efficiency gains, cost savings and worker safety – are becoming increasingly evident.

Efficiency Gains

End user organizations have credited private 4G/5G networks with productivity and efficiency gains for specific manufacturing, quality control and intralogistics processes in the range of 20 to 90%. An online retailer has reduced connection timeouts by an impressive 70% since migrating AGV communications from unlicensed Wi-Fi to private 5G networks at its logistics parks. Likewise, an electric automaker's private 5G implementation has facilitated in overcoming up to 90% of the overcycle issues for a particular process in the general assembly shop of one of its factories. As another noteworthy example, an aircraft maintenance service provider has completely eliminated the need for its aviation customers to physically attend servicing by providing private 5G-enabled reliable, high-resolution video access to its workshops.

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Cost Savings

Private 4G/5G networks have also been instrumental in reducing costs. A private 5G network at an intermodal rail terminal has reduced the facility's personnel-related operating expenses by 40% through automation and remote-controlled operations. One of the world's largest home appliance manufacturers has achieved more than $2 million in annual cost savings at an air conditioner factory by employing private 5G connectivity for paperless inspection tablets, machine vision and AGVs. Similarly, a steelmaker has cut labor costs by 23% and decreased energy consumption by 10% since installing a private 5G network to remotely operate heavy machinery at a steel plant. Among other examples, a supplier of aluminum die castings has reducing cable maintenance costs to near zero by replacing 6 miles of cables connecting 600 pieces of machinery with a private 5G network.

Worker Safety

Additionally, private 4G/5G networks have led to substantial improvements in worker safety and accident reduction. An energy giant has reduced accidents and harmful gas emissions by 20% and 30% respectively since adopting an explosive-proof private 5G network at an oil refinery. In a similar vein, a multi-national offshore private 4G network has improved oil and gas worker safety with a 75% reduction in hazardous, manual inspections. Furthermore, mining companies have been able to reduce the workers needed in dangerous underground and exposed areas by up to a third through the application of private 4G/5G-enabled unmanned machinery and remote control from a safe distance.

Conclusion

As more end user organizations recognize the practical and quantifiable benefits of private 4G/5G networks, SNS Telecom & IT expects the market to continue its positive momentum, with private network deployments targeting a host of diverse use cases. These extend from remote connectivity for mobile workers in mines, refineries, offshore windfarms and other isolated facilities to reliable, low-latency wireless links for AGVs, AMRs, autonomous yard trucks and forklifts for material transportation across indoor and outdoor spaces in manufacturing plants and distribution centers.

Although some of these application scenarios have historically been addressed by non-cellular technologies, the business case for private 4G/5G networks is getting stronger with the world's largest manufacturers and industrial giants committing to multi-site, multi-national deployments of the technology. In particular, a growing number of recent projects are specifically aimed at substituting dozens of Wi-Fi access points with a much smaller footprint of on-premise cellular infrastructure to provide consistent and uninterruptable wireless coverage in expansive industrial facilities, where Wi-Fi signals are often obstructed by metal structures, machinery and thick concrete walls.

With the private 4G/5G market's transition from predominantly 4G LTE networks to standalone 5G technology supporting lower latency and greater reliability, industrial users are setting their long-term sights on 5G connectivity to reduce dependence on wired connections for OT communications between machines, robots and control systems. Newer private 5G security solutions are also enabling the convergence of IT and OT domains in a secure manner with SIM-based authentication, end-to-end encryption and traffic segregation.

Another emerging trend is the growing recognition of private network-based neutral host solutions for public cellular coverage enhancement in indoor locations where DAS systems are deemed too costly and complex to deploy. Facilitated by the open accessibility of 3.5 GHz CBRS spectrum, private networks supporting neutral host connectivity are increasingly being deployed in carpeted enterprise spaces, industrial facilities, public venues, hospitals, hotels, higher education campuses and schools across the United States. Similar neutral host coverage solutions are also expected to gain traction in other national markets. For example, in Japan, private cellular integrators are actively negotiating with the country's mobile operators to deploy neutral host small cells in 1.9 GHz sXGP spectrum.

Finally, it is important to acknowledge the significance of spectrum liberalization initiatives worldwide, which have played a pivotal role in driving the expansion of private 4G/5G networks from a niche market to a cornerstone of industrial digitization and automation. The availability of shared and locally licensed spectrum in the United States, Germany, United Kingdom, France, Japan, South Korea, Taiwan, Brazil and other pioneering markets has effectively eliminated barriers to spectrum access for private networks. In countries where suitable spectrum is yet to be allocated, public mobile operators are increasingly being mandated by regulators to lease portions of their national spectrum holdings for private network deployments in specific geographic locations.

An interview with Celona

To gauge a deeper understanding of the private 4G/5G market from a specialist vendor's perspective, we interviewed Sajag Chikarsal, VP Marketing at Celona.

What is your company's background and involvement in the market?

Sajag: Celona was founded in 2019. The Celona founders all come from deep industry experience and expertise in enterprise wireless networking. They recognized a gap in the market where telco and proprietary solutions were causing private 4G/5G network deployments to be complex and costly at the very same time that shared mid-band spectrum was being opened up for enterprise use. There was also growing demand for more deterministic wireless connectivity for critical business applications and vital use cases not met by even the best Wi-Fi. The team set a vision – make private 5G as easy and cost-effective to deploy as Wi-Fi. Their goal was to remove friction from every element of the product, deployment and operation of private cellular networks.

Today Celona provides a turnkey private wireless solution uniquely engineered for the enterprise. The Celona 5G LAN platform is designed on an integrated software stack and includes everything needed for building a high-performance private 4G/5G network – from the access points to the core to network orchestration and management. It is delivered with management software to give our enterprise customers complete visibility and control, including policy management, device management and security. It's built from the ground up to create the best possible experience for enterprise customers at a low TCO.

From day one the founders also designed robust security into the platform. A business-critical wireless network requires enterprise-grade security to protect against cybersecurity threats, and the industries that need private cellular most - energy, manufacturing, logistics – are often the very targets of global bad actors. The Celona 5G LAN platform extends the inherently strong security architecture of cellular networks, including support for eSIMs, with tight integration between existing enterprise security systems to safeguard the network from edge-to-cloud.

The team continues to whittle away at the areas that cause friction in designing, deploying, and managing a private 4G/5G network, and constantly implement new features to address this friction. For example, our patented MicroSlicing™ architecture enables QoS (Quality-of-Service) and granular device and policy management offered nowhere else, and we were first to improve device provisioning with automated eSIMs that work with common enterprise MDM (Mobile Device Management) systems, such as JAMF and AirWatch.

Can you explain the key trends and recent developments?

Sajag: There is a real shift underway. We are involved in daily discussions about when Wi-Fi is good enough, and it is increasingly and rapidly not good enough for much more than just mission-critical applications. Any mine, refinery, warehouse or manufacturing plant that is trying to add automation to their operation, both indoors and out, is quickly running into the limitations of Wi-Fi. You cannot reliably and safely run AGVs and automated forklifts on Wi-Fi. If you can run one reliably in a small section of the warehouse where Wi-Fi coverage is not impeded by racks of goods, you cannot run that AGV down an aisle or into a corner, and network performance plummets as you try to add more AGVs onto the network. We are talking to CIOs who spend $10-15 million on Wi-Fi every four years, and they want to start transitioning this budget to private 4G/5G because they are realizing that throwing more money at Wi-Fi is just getting them more APs but not solving their fundamental connectivity problems.

In some cases – more than you might expect – we are also talking to customers about providing basic connectivity for data collection tasks where clipboards and pens are being used today. It can be cost-prohibitive to run the cable and power needed to light up Wi-Fi access points in the far reaches of a mine or refinery, but these same areas can easily and cost-effectively be covered by a handful of outdoor private 4G/5G APs. Our CEO Rajeev Shah is calling this the Industrial Digital Divide.

How do you expect the market to evolve in the coming years?

Sajag: We see three major drivers that will cause the market to explode in the coming years. The first is the maturation of the private 5G device ecosystem. Most private wireless deployments, around 80% by most estimates, are using 4G today. This is because the private 4G ecosystem is mature and robust, and 4G can reliably handle most of today's use cases. As the private 5G ecosystem matures, which is starting to happen, and as the more advanced 5G features are delivered – like ultra-low latency and precise indoor positioning – more sophisticated use cases like digital twins and machine vision can be supported. The second driver is increased availability of spectrum globally. The FCC recently **announced** that the areas in the US where shared CBRS spectrum can be deployed are being increased, positively impacting thousands of businesses and millions of people. Globally we also are seeing an increase in countries setting aside mid-band spectrum for local licensing directly by enterprises. There is increasing government recognition of the positive economic impact of making spectrum directly available for enterprises to deploy private cellular networks. The third factor is the growth of a neutral host model built on private 4G/5G. As telcos start to abandon subsidizing DAS deployments for all but the largest enterprises, neutral host networks based on private 4G/5G networks will increasingly be recognized as a solution that allows staff and guests to cost-effectively access public cellular networks from a private cellular network.

Which are the most promising use cases and vertical sectors in your opinion?

Sajag: We are seeing global traction in manufacturing of all kinds – from automotive to petrochemicals –, in warehousing and logistics, and in oil and gas, mining, refineries, etc. Some are calling these the "uncarpeted" enterprise. We think that the "carpeted" enterprise (retail, healthcare, hospitality, financial services) will start to explode when full neutral host capability comes into play, and a single private network can provide data connectivity for business operations while servicing staff and guests with voice connectivity from their preferred mobile network operator. We expect to see real growth in this area in 2025.

Can you list any of your commercial wins/ engagements?

Sajag: We are deployed with over 100 customers, including BP, LyondellBasell, Stanford Health Care, and Standard Steel. Verizon, NTT DATA, and stc Group all use Celona as part of their private cellular business offerings. One of our recent deployments is with Del Conca USA, a fine Italian tile manufacturer, where we were able to drastically reduce their downtime. As Head of IT Operations Luca Chichiarelli mentioned in a recent **webinar**: "We went from about 2 days a month of service disruption with Wi-Fi to almost zero disruption with private wireless." The details of the Del Conca deployment can be found in this **blog** by our CTO Mehmet Yavuz.

Any final thoughts or additional comments on the market?

Sajag: We see worldwide skilled labor shortages as a key growth driver in this market. One of the first conversations we often have with a new customer is the labor shortage challenge they are faced with. This shortage is driving many of the automation projects they are taking on. And when they first deploy a new automation solution – from simple scanners to AMRs – this is when they are confronted with the shortcomings of Wi-Fi for industrial automation. And if the private 4G/5G network is truly designed for the enterprise, with simplicity and ease of use in mind, it does not require a skilled labor force to roll it out and manage it.

Case Studies

celona.io/case-studies

TCO and ROI Calculator

celona.io/tco-calculator

Comparison with Wi-Fi

celona.io/CS-Distr-MSB

Custom Demo

celona.io/live-product-tour

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