

# Private 5G Market: 2025 – 2030 – Opportunities, Challenges, Strategies & Forecasts

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## Abstracts

Private LTE networks are a well-established market and have been around for more than a decade, albeit as a niche segment of the wider cellular infrastructure sector – iNET's (Infrastructure Networks) 700 MHz LTE network in the Permian Basin, Tampnet's offshore 4G infrastructure in the North Sea, Rio Tinto's private LTE network for its Western Australia mining operations, and other initial installations date back to the early 2010s. However, private cellular networks or NPNs (Non-Public Networks) based on 3GPP-defined 5G specifications are just on the cusp of becoming a mainstream technology, with a market potential exceeding that of private LTE. Over the last 12 months, there has been a noticeable increase in production-grade deployments of private 5G networks by household names and industrial giants such as Airbus, Aker BP, Boliden, CIL (Coal India Limited), Equinor, Etihad, Ford, Hutchison Ports, Hyundai, Jaguar Land Rover, John Deere, LG Electronics, Lufthansa, Newmont, POSCO, Tesla, Toyota, and Walmart, paving the way for Industry 4.0 and advanced application scenarios.

Compared to LTE technology, private 5G networks – also referred to as 5G MPNs (Mobile Private Networks), 5G campus networks, P5G, local 5G, or e-Um 5G systems depending on geography – can address far more demanding performance requirements in terms of throughput, latency, reliability, availability, and connection density. In particular, 5G's URLLC (Ultra-Reliable, Low-Latency Communications) and mMTC (Massive Machine-Type Communications) capabilities, along with a future-proof transition path to 6G networks in the 2030s, have positioned it as a viable alternative to physically wired connections for industrial-grade communications between machines, robots, and control systems. Furthermore, despite its relatively higher cost of ownership, 5G's wider coverage radius per radio node, scalability, determinism, security features, and mobility support have stirred strong interest in its potential as a replacement for

interference-prone unlicensed wireless technologies in IIoT (Industrial IoT) environments, where the number of connected sensors and other endpoints is expected to increase significantly over the coming years.

China remains the most mature national market thanks to state-funded directives aimed at accelerating the adoption of 5G connectivity in industrial settings such as factories, warehouses, mines, power plants, substations, oil and gas facilities, and ports. To provide context, the largest private 5G installations in China can comprise hundreds to even thousands of dedicated RAN (Radio Access Network) nodes supported by on-premise or edge cloud-based core network functions depending on specific latency, reliability, and security requirements. Several Chinese private 5G adopters – including State Grid, Midea, and Wanhua Chemical – are also among the front-runners in utilizing cost-efficient 5G RedCap (Reduced Capability) modules, primarily to support video surveillance and IoT sensor use cases. In addition, some of the most technically advanced features of 5G-Advanced – 5G's next evolutionary phase – have been implemented over private wireless installations in the country. For example, steel manufacturer Baosteel is leveraging DetNet (Deterministic Networking) enhancements for real-time coordination of multiple automated processes within its factories; China Huaneng Group relies on a tri-band (700 MHz, 2.6 GHz & 4.9 GHz) 5G-Advanced network to connect a fleet of 100 autonomous electric mining trucks at its Yimin open pit coal mine in Inner Mongolia; and automaker Great Wall Motor is using an indoor 5G-Advanced network for time-critical industrial control within a car roof production line to prevent wire abrasion in mobile application scenarios – an issue that had previously resulted in production interruptions averaging 60 hours of downtime per year. Recently, Chinese mobile operators and vendors have expanded beyond their domestic market in pursuit of private 5G business opportunities abroad, from Thailand's manufacturing sector to mining in South Africa.

As end user organizations in the United States, Canada, Germany, United Kingdom, France, Japan, South Korea, Taiwan, Australia, Brazil, and other countries ramp up their digitization and automation initiatives, private 5G networks are progressively being implemented to support use cases as diverse as wirelessly connected machinery for the rapid reconfiguration of production lines, distributed PLC (Programmable Logic Controller) environments, AMRs (Autonomous Mobile Robots) and AGVs (Automated Guided Vehicles) for intralogistics, connected workers with mobile and paperless workflows, AR (Augmented Reality)-assisted guidance and troubleshooting, machine vision-based quality control, wireless software flashing of manufactured vehicles, remote-controlled cranes, unmanned mining equipment, digital twin models of complex industrial systems, virtual visits for parents to see their infants in NICUs (Neonatal

Intensive Care Units), live broadcast production in locations not easily accessible by traditional solutions, operations-critical communications during major sporting events, precision agriculture and livestock farming, BVLOS (Beyond Visual Line-of-Sight) operation of drones, ATO (Automatic Train Operation), video analytics for railway crossing and station platform safety, remote visual inspections of aircraft engine parts, real-time collaboration for flight line maintenance, XR (Extended Reality)-based training, autonomous and remote operations at military bases, and missile field communications.

With non-smartphone device availability, end user conservatism, and other teething problems continuing to wane, early adopters are affirming their faith in the long-term potential of private 5G by investing in networks built in collaboration with specialist integrators, through traditional mobile operators, or independently via direct procurement from 5G equipment suppliers – made possible by the availability of new shared and local area licensed spectrum options in many national markets. As SNS Telecom & IT highlighted last year, some private 5G installations have progressed to a stage where practical and tangible benefits – particularly efficiency gains, cost savings, and worker safety – are becoming increasingly evident. Notable examples, featuring new additions this year, include but are not limited to:

Tesla's deployment of a private 5G network at its Gigafactory Texas facility in Austin has eliminated AGV (Automated Guided Vehicle) stoppages, previously caused by unstable Wi-Fi connections, within the 12 million square foot facility. Another private 5G implementation on the shop floor of its Gigafactory Berlin-Brandenburg plant in Germany has helped in overcoming up to 90% of the overcycle issues for a particular process in the factory's GA (General Assembly) shop. The electric automaker is integrating private 5G network infrastructure to address high-impact use cases in production, intralogistics, and quality operations across its global manufacturing facilities.

Rival luxury automaker Jaguar Land Rover's installation of a private 5G network at its Solihull plant in England, United Kingdom, has established connectivity for sensors and data within the plant's five-story paint shop, which had previously been left unconnected due to the cost and complexity of wired Ethernet links. The network has also resolved Wi-Fi-related challenges, including limited device connections, poor signal penetration in the metal-heavy environment, and unstable handovers between access points along the production line.

Lufthansa's private 5G network at its LAX (Los Angeles International Airport) cargo facility has resulted in a 60% reduction in processing time per item by

eliminating latency spikes and dropped connections from Wi-Fi and public cellular networks, which had previously delayed logistics operations and forced an occasional return to manual pen-and-paper processes. Another 5G campus network at the Lufthansa Technik facility in Hamburg, Germany, has removed the need for civil aviation customers to physically attend servicing by providing reliable, high-resolution video access for virtual parts inspections, and borescope examinations at both of its engine overhaul workshops. Previous attempts to implement virtual inspections using unlicensed Wi-Fi technology proved ineffective due to the presence of large metal structures.

At VINCI Airports' Lyon-Saint Exupéry Airport in the southeast of France, Stanley Robotics is using a standalone private 5G network to provide reliable and low-latency connectivity for autonomous valet parking robots, which have increased parking efficiency by 50%. Efforts are also underway to leverage 5G's precise positioning capabilities to further enhance the localization accuracy of the robots' control system.

Since adopting a private 5G network for public safety and smart city applications, the southern French city of Istres has reduced video surveillance camera installation costs from \$34,000 to less than \$6,000 per unit by eliminating the need for ducts, civil works, and other infrastructure-related overhead costs typically associated with fiber-based connections in urban environments.

HavelPort Berlin has increased its annual weighing capacity by up to 60% through automated weighing processes managed via tablets in lorry cabs using an Open RAN-compliant private 5G network. The network also supports drone-based inventory control for bulk goods monitoring and autonomous transportation within the inland port in Wustermark (Brandenburg), Germany.

John Deere is steadily progressing with its goal of reducing dependency on wired Ethernet connections from 70% to 10% over the next five years by deploying private 5G networks at its industrial facilities in the United States, South America, and Europe. Two of the most recent deployments are at the heavy machinery giant's 2.2 million square foot Davenport Works manufacturing complex in Iowa and its Horizontina factory in Rio Grande do Sul, Brazil, which is in the midst of continued expansion. In a similar effort, automotive aluminum die-castings supplier IKD has replaced 6 miles of cables connecting 600 pieces

of machinery with a private 5G network, thereby reducing cable maintenance costs to near zero and increasing the product yield rate by 10%.

Newmont's implementation of one of Australia's first production-grade private 5G networks at its Cadia gold-copper underground mine in New South Wales has enabled remote-controlled operation of its entire dozer fleet across the full 2.5 kilometer width of the mine's tailings works construction area. Previously, the mining company was unable to connect more than two machines at distances of no more than 100 meters over Wi-Fi, with unstable connectivity causing up to six hours of downtime per shift. Newmont plans to leverage private 5G connectivity to roll out more teleremote and autonomous machines in its tier-one underground and surface mines worldwide.

The U.S. Marine Corps' private 5G network at MCLB (Marine Corps Logistics Base) in Southwest Georgia has significantly improved warehouse management and logistics operations, including 98% accuracy in inventory reordering, a 65% increase in goods velocity, and a 55% reduction in labor costs. Currently under a \$6 million sustainment contract for the next three years, the purpose-built 5G network was deployed to enhance automation and overcome the challenges posed by complex fiber optic installations and unreliable Wi-Fi systems in the logistics hub's demanding physical environment.

The Liverpool 5G Create network in the inner city area of Kensington has demonstrated substantial cost savings potential for digital health, education and social care services, including an astonishing \$10,000 drop in yearly expenditure per care home resident through a 5G-connected fall prevention system and a \$2,600 reduction in WAN (Wide Area Network) connectivity charges per GP (General Practitioner) surgery – which represents \$220,000 in annual savings for the United Kingdom's NHS (National Health Service) when applied to 86 surgeries in Liverpool.

The EWG (East-West Gate) Intermodal Terminal's private 5G network has increased productivity from 23-25 containers per hour to 32-35 per hour and reduced the facility's personnel-related operating expenses by 40% while eliminating the possibility of crane operator injury due to remote-controlled operation with a latency of less than 20 milliseconds.

NEC Corporation has improved production efficiency by 30% through the introduction of a local 5G-enabled autonomous transport system for intralogistics

at its new factory in Kakegawa (Shizuoka Prefecture), Japan. The manufacturing facility's on-premise 5G network has also resulted in an elevated degree of freedom in terms of the factory floor layout, thereby allowing NEC to flexibly respond to changing customer needs, market demand fluctuations, and production adjustments.

A local 5G installation at Ushino Nakayama's Osumi farm in Kanoya (Kagoshima Prefecture), Japan, has enabled the Wagyu beef producer to achieve labor cost savings of more than 10% through reductions in accident rates, feed loss, and administrative costs. The 5G network provides wireless connectivity for AI (Artificial Intelligence)-based image analytics and autonomous patrol robots.

CJ Logistics has achieved a 20% productivity increase at its Ichiri center in Icheon (Gyeonggi), South Korea, following the adoption of a private 5G network to replace the 40,000 square meter warehouse facility's 300 Wi-Fi access points for Industry 4.0 applications, which experienced repeated outages and coverage issues.

Delta Electronics – which has installed private 5G networks for industrial wireless communications at its plants in Taiwan and Thailand – estimates that productivity per direct labor and output per square meter have increased by 69% and 75% respectively following the implementation of 5G-connected smart production lines.

Yawata Electrode has improved the efficiency of its goods transportation processes – involving the movement of raw materials, semi-completed goods, and finished products between production floors – by approximately 24% since adopting a private 5G network for autonomous mobile robots at its electrode manufacturing plant in Nakhon Ratchasima, Thailand.

An Open RAN-compliant standalone private 5G network in Taiwan's Pingtung County has facilitated a 30% reduction in pest-related agricultural losses and a 15% boost in the overall revenue of local farms through the use of 5G-equipped UAVs (Unmanned Aerial Vehicles), mobile robots, smart glasses and AI-enabled image recognition.

JD Logistics – the supply chain and logistics arm of online retailer JD.com – has achieved near-zero packet loss and reduced the likelihood of connection

timeouts by an impressive 70% since migrating AGV communications from unlicensed Wi-Fi systems to private 5G networks at its logistics parks in Beijing and Changsha (Hunan), China.

Risun Group has deployed a private 5G network at its Risun Zhongran Park facility in Hohhot (Inner Mongolia), China, to provide industrial-grade wireless connectivity for both wheeled and rail-mounted transport machinery, typically measuring tens of meters in height and length. Since transitioning from Wi-Fi to private 5G, the coke producer has increased production efficiency by nearly 20% and reduced labor costs by approximately 30%.

Baosteel – a business unit of the world's largest steelmaker China Baowu Steel Group – credits its 43-site private 5G deployment at two neighboring factories with reducing manual quality inspections by 50% and achieving a steel defect detection rate of more than 90%, which equates to \$7 million in annual cost savings by reducing lost production capacity from 9,000 tons to 700 tons.

Dongyi Group Coal Gasification Company ascribes a 50% reduction in manpower requirements and a 10% increase in production efficiency – which translates to more than \$1 million in annual cost savings – at its Xinyan coal mine in Lvliang (Shanxi), China, to private 5G-enabled digitization and automation of underground mining operations.

Sinopec's (China Petroleum & Chemical Corporation) explosion-proof 5G network at its Guangzhou oil refinery in Guangdong, China, has reduced accidents and harmful gas emissions by 20% and 30% respectively, resulting in an annual economic benefit of more than \$4 million. The solution is being replicated across more than 30 refineries of the energy giant.

Since adopting a hybrid public-private 5G network to enhance the safety and efficiency of urban rail transit operations, the Guangzhou Metro rapid transit system has reduced its maintenance costs by approximately 20% using 5G-enabled digital perception applications for the real-time identification of water logging and other hazards along railway tracks.

Although the vast majority of the networks referenced above have been built using 5G equipment supplied by traditional wireless infrastructure players – from incumbents Ericsson, Nokia, Huawei, and ZTE to the likes of Samsung and NEC – alternative

suppliers are continuing to gain traction in the private 5G market. Noteworthy examples include Celona – whose 5G LAN solution has been deployed by over 100 customers; Globalstar – which has developed a 3GPP Release 16-compliant multipoint terrestrial RAN system optimized for dense private wireless deployments in Industry 4.0 automation environments; Airspan Networks – a well-known Open RAN and small cell technology provider; Mavenir – an end-to-end provider of Open RAN and converged packet core solutions; GXC – a private cellular technology provider recently acquired by Motive Companies; Baicells – a 4G and 5G NR access equipment manufacturer; JMA Wireless – an American RAN equipment vendor; HFR Mobile – the private 5G business unit of Korean telecommunications equipment maker HFR; Ataya – a private 5G startup focused on unifying and simplifying enterprise connectivity; Moso Networks – a U.S.-based provider of private 5G radio products backed by Taiwanese small cell pioneer Sercomm; Abside Networks – an American manufacturer of military-grade 5G infrastructure; Radisys – a RAN software vendor for many private network deployments; Druid Software – whose mobile core platform has been deployed for private networks worldwide; HPE (Hewlett Packard Enterprise) – which is transitioning from a mobile core specialist to end-to-end private 5G network provider; Cisco Systems – a mobile core and transport network technology provider for both public and private 5G networks; Pente Networks – a mobile core and orchestration solution provider; Highway 9 Networks – which has developed a cloud-based platform to simplify private 5G deployments; Neutron Technologies – another private 5G orchestration specialist; Qucell – a Korean manufacturer specializing in 5G small cell equipment; Askey Computer – a Taiwanese telecommunications equipment manufacturer; QCT (Quanta Cloud Technology) – a Taiwanese data center and 5G solutions provider; G REIGNS – a business unit of HTC specializing in portable private 5G network solutions; Pegatron – a Taiwanese manufacturer that has recently entered the Open RAN-compliant 5G infrastructure market; AsiaInfo Technologies – a Chinese provider of lightweight mobile core software and end-to-end private 5G solutions; Siemens – which has developed an in-house private 5G network solution for use at its own plants as well as those of industrial customers; Firecell – a French startup specializing in industrial-grade private 5G solutions; CampusGenius – which has developed a customizable 5G core solution for small and medium-sized enterprises; Blackned – a German developer of tactical core middleware for defense communications; Cumucore – a provider of mobile core software for private networks; Accelleran – a Belgian provider of Open RAN software solutions; IS-Wireless – a Polish Open RAN software vendor; Benetel – an Irish Open RAN radio developer; and Wireless Excellence – a British 5G equipment vendor.

SNS Telecom & IT projects that annual investments in private 5G networks for vertical industries will grow at a CAGR of approximately 41% between 2025 and 2028,

eventually surpassing \$5 billion by the end of 2028. Much of this growth will initially be driven by highly localized 5G networks covering geographically limited areas for Industry 4.0 applications in manufacturing and process industries. Industrial giants experiencing patchy Wi-Fi coverage, cabling-related inflexibility, and network scalability limitations at their facilities are championing the private 5G movement for local area networking. Additionally, sub-1 GHz wide area critical communications networks for public safety, utility, and railway communications are anticipated to accelerate their transition from LTE, GSM-R, and other legacy narrowband technologies to 5G towards the latter half of the forecast period, as 5G-Advanced technology reaches commercial maturity. Among other features for mission-critical networks, 3GPP Release 18 – which defines the first set of 5G-Advanced specifications – adds support for 5G NR equipment operating in dedicated spectrum with less than 5 MHz of bandwidth, paving the way for private 5G networks operating in sub-500 MHz, 700 MHz, 850 MHz, and 900 MHz bands for public safety broadband, smart grid modernization, and FRMCS (Future Railway Mobile Communication System).

The “Private 5G Market: 2025 – 2030 – Opportunities, Challenges, Strategies & Forecasts” report presents an in-depth assessment of the private 5G network market, including the value chain, market drivers, barriers to uptake, enabling technologies, operational and business models, vertical industries, application scenarios, key trends, future roadmap, standardization, spectrum availability and allocation, regulatory landscape, case studies, ecosystem player profiles, and strategies. The report also presents global and regional market size forecasts from 2025 to 2030. The forecasts cover three infrastructure submarkets, 16 vertical industries, and five regional markets.

The report comes with an associated Excel datasheet suite covering quantitative data from all numeric forecasts presented in the report, as well as a database of over 8,300 global private cellular engagements – including more than 3,700 private 5G installations – as of Q3’2025.

## **Topics Covered**

The report covers the following topics:

Introduction to private 5G networks

Value chain and ecosystem structure

Market drivers and challenges

System architecture and key elements of private 5G networks

Operational and business models, network size, geographic reach, and other practical aspects of private 5G networks

Industry 4.0-driven wireless connectivity requirements, critical communications broadband evolution, enterprise transformation, and other themes shaping the adoption of private 5G networks

Enabling technologies and concepts, including 3GPP-defined URLLC, TSC, DetNet, NR-U, SNPN and PNI-NPN, MCX, RedCap/eRedCap, cellular IoT, high-precision positioning, network slicing, edge computing, and network automation capabilities

Key trends such as the emergence of new classes of specialized network operators, shared and local area spectrum licensing, private NaaS (Network-as-a-Service) offerings, IT/OT convergence, Open RAN, vRAN, and rapidly deployable 5G systems

Analysis of vertical industries and application scenarios such as reconfigurable wireless production lines, collaborative mobile robots, autonomous transport systems, untethered AR/VR/MR (Augmented, Virtual & Mixed Reality), UHD (Ultra High-Definition) video transmission, machine vision, digital twins, and mission-critical group communications

Future roadmap of private 5G networks

Review of private 5G network installations worldwide, including 125 case studies spanning 16 verticals

Database tracking more than 3,700 private 5G installations in over 60 countries across the globe

Spectrum availability, allocation, and usage across the global, regional, and national domains

Standardization, regulatory, and collaborative initiatives

Profiles and strategies of more than 1,800 ecosystem players

Strategic recommendations for 5G equipment and chipset suppliers, system integrators, private network specialists, mobile operators, and end user organizations

Market analysis and forecasts from 2025 to 2030

## **Forecast Segmentation**

Market forecasts are provided for each of the following submarkets and their subcategories:

### Infrastructure Submarkets

5G NR RAN (Radio Access Network)

Base Station RUs (Radio Units)

DUs/CUs (Distributed & Centralized Baseband Units)

5GC (5G Core)

UPF (User Plane Function)

Control Plane Functions

5G Transport (Fronthaul, Midhaul & Backhaul)

Fiber & Wireline

Microwave

Satellite Communications

### Cell Sizes

## Small Cells

Indoor

Outdoor

## Macrocells

## Frequency Ranges

Sub-6 GHz

mmWave (Millimeter Wave)

## End User Markets

### Vertical Industries

Agriculture

Aviation

Broadcasting

Construction

Education

Forestry

Healthcare

Manufacturing

Military

Mining

Oil & Gas

Ports & Maritime Transport

Public Safety

Railways

Utilities

Warehousing & Others

Offices, Buildings & Public Venues

## Regional Markets

North America

Asia Pacific

Europe

Middle East & Africa

Latin & Central America

## Key Questions Answered

The report provides answers to the following key questions:

How big is the private 5G network opportunity?

What trends, drivers, and challenges are influencing its growth?

What will the market size be in 2028 and at what rate will it grow?

Which submarkets, verticals, and regions will see the highest percentage of growth?

What is the status of private 5G network adoption in each country and what are the primary application scenarios of these networks?

How is private 5G connectivity facilitating the digital transformation of agriculture, manufacturing, mining, oil and gas, transportation, utilities, warehousing, and other vertical industries?

What are the practical and quantifiable benefits of private 5G networks in terms of productivity improvement, cost reduction, and worker safety?

What are the key characteristics of standalone private 5G connectivity and when will URLLC, TSC, RedCap/eRedCap, and other 3GPP-defined IIoT features be widely employed?

Where does network slicing for differentiated service requirements fit in the private cellular networking space?

How can private edge computing accommodate latency-sensitive applications while enhancing data sovereignty and security?

What are the existing and candidate frequency bands for the operation of private 5G networks?

How are CBRS and other coordinated shared/local spectrum licensing frameworks accelerating the uptake of private 5G networks?

What are the prospects of private 5G networks operating in mmWave spectrum?

What is the outlook for 5G NR-U (NR in Unlicensed Spectrum) deployments?

How do private 5G networks compare with Wi-Fi 6/6E/7 systems in industrial settings?

When will sub-1 GHz critical communications LTE networks begin their transition to 5G technology?

How can satellite backhaul and direct-to-device NTN access expand the reach of private 5G networks in remote environments?

How are telecommunications infrastructure giants, national mobile operators, and other incumbents asserting their presence in the private 5G market?

What opportunities exist for managed private 5G service providers, neutral host operators, global system integrators, hyperscalers, and other new entrants?

Who are the key ecosystem players and what are their strategies?

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  - 3.4.1 5GC (5G Core): Core Network for Standalone 5G Implementations
    - 3.4.1.1 Access, Mobility & Session Management
      - 3.4.1.1.1 AMF (Access & Mobility Management Function)
      - 3.4.1.1.2 SMF (Session Management Function)
      - 3.4.1.1.3 UPF (User Plane Function)
    - 3.4.1.2 Subscription & Data Management
      - 3.4.1.2.1 AUSF (Authentication Server Function)
      - 3.4.1.2.2 AAnF (AKMA Anchor Function)
      - 3.4.1.2.3 UDM (Unified Data Management)
      - 3.4.1.2.4 UDR (Unified Data Repository)
      - 3.4.1.2.5 UDSF (Unstructured Data Storage Function)
      - 3.4.1.2.6 UCMF (UE Radio Capability Management Function)
      - 3.4.1.2.7 5G-EIR (5G Equipment Identity Register)
    - 3.4.1.3 Policy & Charging
      - 3.4.1.3.1 PCF (Policy Control Function)
      - 3.4.1.3.2 CHF (Charging Function)
    - 3.4.1.4 Signaling & Routing
      - 3.4.1.4.1 SCP (Service Communication Proxy)
      - 3.4.1.4.2 SEPP (Security Edge Protection Proxy)
      - 3.4.1.4.3 BSF (Binding Support Function)

### 3.4.1.5 Network Resource Management

3.4.1.5.1 NEF (Network Exposure Function)

3.4.1.5.2 NRF (Network Repository Function)

3.4.1.5.3 NSSF (Network Slice Selection Function)

3.4.1.5.4 NSSAAF (Network Slice-Specific & SNPN Authentication-Authorization Function)

3.4.1.5.5 NSACF (Network Slice Admission Control Function)

### 3.4.1.6 Data Analytics & Automation

3.4.1.6.1 NWDAF (Network Data Analytics Function)

3.4.1.6.2 AnLF (Analytics Logical Function)

3.4.1.6.3 MTLF (Model Training Logical Function)

3.4.1.6.4 DCCF (Data Collection Coordination Function)

3.4.1.6.5 ADRF (Analytics Data Repository Function)

3.4.1.6.6 MFAF (Messaging Framework Adaptor Function)

3.4.1.6.7 MDAF (Management Data Analytics Function)

### 3.4.1.7 Location Services

3.4.1.7.1 LMF (Location Management Function)

3.4.1.7.2 GMLC (Gateway Mobile Location Center)

### 3.4.1.8 Application Enablement

3.4.1.8.1 AFs (Application Functions)

3.4.1.8.2 SMSF (Short Message Service Function)

3.4.1.8.3 CBCF (Cell Broadcast Center Function)

3.4.1.8.4 5G DDNMF (5G Direct Discovery Name Management Function)

3.4.1.8.5 TSCTSF (Time-Sensitive Communication & Time Synchronization Function)

3.4.1.8.6 TSN AF (Time-Sensitive Networking Application Function)

3.4.1.8.7 EASDF (Edge Application Server Discovery Function)

### 3.4.1.9 Multicast-Broadcast Support

3.4.1.9.1 MB-SMF (Multicast-Broadcast SMF)

3.4.1.9.2 MB-UPF (Multicast-Broadcast UPF)

3.4.1.9.3 MBSF (Multicast-Broadcast Service Function)

3.4.1.9.4 MBSTF (Multicast-Broadcast Service Transport Function)

## 3.5 Transport Network

3.5.1 Fronthaul: RU-to-DU Transport

3.5.2 Midhaul: DU-to-CU Transport

3.5.3 Backhaul: RAN-to-Core Transport

### 3.5.4 Physical Transmission Mediums

3.5.4.1 Fiber & Wireline Transport Technologies

3.5.4.1.1 Owned, Lit & Dark Fiber

3.5.4.1.2 Ethernet & IP-Based Transport

- 3.5.4.1.3 WDM (Wavelength Division Multiplexing)
- 3.5.4.1.4 PON (Passive Optical Network)
- 3.5.4.1.5 OTN (Optical Transport Network)
- 3.5.4.1.6 DOCSIS, G.fast & Other Technologies
- 3.5.4.2 Microwave & mmWave (Millimeter Wave) Wireless Links
  - 3.5.4.2.1 Traditional Bands (6 – 42 GHz)
  - 3.5.4.2.2 V-Band (60 GHz)
  - 3.5.4.2.3 E-Band (70/80 GHz)
  - 3.5.4.2.4 W-Band (92 – 114.25 GHz)
  - 3.5.4.2.5 D-Band (130 – 174.8 GHz)
- 3.5.4.3 Satellite Communications
  - 3.5.4.3.1 GEO (Geostationary Earth Orbit)
  - 3.5.4.3.2 MEO (Medium Earth Orbit)
  - 3.5.4.3.3 LEO (Low Earth Orbit)
- 3.6 Services & Interconnectivity
  - 3.6.1 End User Application Services
    - 3.6.1.1 Generic Broadband, Messaging & IoT Services
    - 3.6.1.2 IMS Core: VoNR (Voice Over NR) & MMTel (Multimedia Telephony)
    - 3.6.1.3 5G MBS/5MBS (5G Multicast-Broadcast Services)
    - 3.6.1.4 Group Communications & MCS (Mission-Critical Services)
    - 3.6.1.5 IIoT (Industrial IoT), Cyber-Physical Control & Domain-Specific Connected Services
    - 3.6.1.6 ProSe (Proximity-Based Services) for Direct D2D (Device-to-Device) Discovery & Communications
    - 3.6.1.7 Vehicular, Aviation, Maritime & Railway-Related Applications
    - 3.6.1.8 3GPP Service Frameworks for Vertical Industries
      - 3.6.1.8.1 CAPIF (Common API Framework)
      - 3.6.1.8.2 SEAL (Service Enabler Architecture Layer for Verticals)
      - 3.6.1.8.3 EDGEAPP (Architecture for Enabling Edge Applications)
    - 3.6.1.9 VAL (Vertical Application Layer) Enablers
      - 3.6.1.9.1 V2X (Vehicle-to-Everything)
      - 3.6.1.9.2 UAS (Uncrewed Aerial Systems)
      - 3.6.1.9.3 5GMARCH/MSGin5G (Messaging in 5G)
      - 3.6.1.9.4 FF (Factories of the Future)
      - 3.6.1.9.5 PINAPP (Personal IoT Networks), XR (Extended Reality) & Others
  - 3.6.2 Interconnectivity With 3GPP & Non-3GPP Networks
    - 3.6.2.1 3GPP Roaming & Service Continuity
      - 3.6.2.1.1 National & International Roaming
      - 3.6.2.1.2 Service Continuity Outside Network Footprint

- 3.6.2.2 Non-3GPP Network Integration
  - 3.6.2.2.1 N3IWF (Non-3GPP Interworking Function)
  - 3.6.2.2.2 TNGF (Trusted Non-3GPP Gateway Function)
  - 3.6.2.2.3 TWIF (Trusted WLAN Interworking Function)
  - 3.6.2.2.4 NSWOF (Non-Seamless WLAN Offload Function)
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    - 3.7.3.4 Native 3GPP Framework for TSC (Time-Sensitive Communications)
    - 3.7.3.5 Support for IETF DetNet (Deterministic Networking)
    - 3.7.3.6 5G NR Light: RedCap (Reduced Capability) UE Type
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    - 3.7.3.8 Ambient IoT Technology Supporting Battery-Less Operation
  - 3.7.4 Critical Communications
    - 3.7.4.1 MCX (Mission-Critical PTT, Video & Data)
    - 3.7.4.2 QPP (QoS, Priority & Preemption)
    - 3.7.4.3 IOPS (Isolated Operation for Public Safety)
    - 3.7.4.4 Cell Site & Infrastructure Hardening

- 3.7.4.5 HPUE (High-Power User Equipment)
- 3.7.4.6 Other UE-Related Functional Enhancements
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  - 3.7.10.1 DSS (Dynamic Spectrum Sharing): LTE & 5G NR Coexistence
  - 3.7.10.2 CBRS (Citizens Broadband Radio Service): Three-Tiered Sharing

- 3.7.10.3 LSA (Licensed Shared Access) & eLSA (Evolved LSA): Two-Tiered Sharing
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- 3.7.10.5 Local Area Licensing of Shared Spectrum
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  - 3.7.11.2 Vehicular COWs (Cells-on-Wheels)
  - 3.7.11.3 Aerial Cell Sites
  - 3.7.11.4 Maritime Cellular Platforms
- 3.7.12 Direct Communications & Coverage Expansion
  - 3.7.12.1 Sidelink for Direct Mode D2D Communications
  - 3.7.12.2 UE-to-Network & UE-to-UE Relays
  - 3.7.12.3 Indoor & Outdoor Small Cells
  - 3.7.12.4 DAS (Distributed Antenna Systems)
  - 3.7.12.5 IAB (Integrated Access & Backhaul)
  - 3.7.12.6 Mobile IAB: VMRs (Vehicle-Mounted Relays)
  - 3.7.12.7 MWAB (Mobile gNB With Wireless Access Backhauling)
  - 3.7.12.8 NCRs (Network-Controlled Repeaters)
  - 3.7.12.9 NTN (Non-Terrestrial Networks)
  - 3.7.12.10 ATG/A2G (Air-to-Ground) Connectivity
- 3.7.13 Cloud-Native, Software-Driven & Open Networking
  - 3.7.13.1 Cloud-Native Technologies
  - 3.7.13.2 Microservices & SBA (Service-Based Architecture)
  - 3.7.13.3 Containerization of Network Functions
  - 3.7.13.4 NFV (Network Functions Virtualization)
  - 3.7.13.5 SDN (Software-Defined Networking)
  - 3.7.13.6 Cloud Compute, Storage & Networking Infrastructure
  - 3.7.13.7 APIs (Application Programming Interfaces)
  - 3.7.13.8 Open RAN & Core Architectures
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  - 3.7.14.2 Machine & Deep Learning
  - 3.7.14.3 Big Data & Advanced Analytics
  - 3.7.14.4 SON (Self-Organizing Networks)
  - 3.7.14.5 Intelligent Control, Management & Orchestration
  - 3.7.14.6 Support for Network Intelligence & Automation in 3GPP Standards

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- 4.1 Cross-Sector & Enterprise Application Capabilities
  - 4.1.1 Mobile Broadband
  - 4.1.2 FWA (Fixed Wireless Access)
  - 4.1.3 Voice & Messaging Services
  - 4.1.4 High-Definition Video Transmission
  - 4.1.5 Telepresence & Video Conferencing
  - 4.1.6 Multimedia Broadcasting & Multicasting
  - 4.1.7 IoT (Internet of Things) Networking
  - 4.1.8 Wireless Connectivity for Wearables
  - 4.1.9 Untethered AR/VR/MR (Augmented, Virtual & Mixed Reality)
  - 4.1.10 Real-Time Holographic Projections
  - 4.1.11 Tactile Internet & Haptic Feedback
  - 4.1.12 Precise Positioning & Tracking
  - 4.1.13 Industrial Automation
  - 4.1.14 Remote Control of Machines
  - 4.1.15 Connected Mobile Robotics
  - 4.1.16 Unmanned & Autonomous Vehicles
  - 4.1.17 BVLOS (Beyond Visual Line-of-Sight) Operation of Drones
  - 4.1.18 Data-Driven Analytics & Insights
  - 4.1.19 Sensor-Equipped Digital Twins
  - 4.1.20 Predictive Maintenance of Assets
- 4.2 Vertical Industries & Specific Application Scenarios
  - 4.2.1 Agriculture
    - 4.2.1.1 Intelligent Monitoring of Crop, Soil & Weather Conditions
    - 4.2.1.2 IoT & Advanced Analytics-Driven Yield Optimization
    - 4.2.1.3 Sensor-Based Smart Irrigation Control Systems
    - 4.2.1.4 Real-Time Tracking & Geofencing in Farms
    - 4.2.1.5 Livestock & Aquaculture Health Management
    - 4.2.1.6 Video-Based Remote Veterinary Inspections
    - 4.2.1.7 Unmanned Autonomous Tractors & Farm Vehicles
    - 4.2.1.8 Robots for Planting, Weeding & Harvesting
    - 4.2.1.9 5G-Equipped Agricultural Drones
    - 4.2.1.10 Connected Greenhouses & Vertical Farms
  - 4.2.2 Aviation
    - 4.2.2.1 Inflight Connectivity for Passengers & Cabin Crew
    - 4.2.2.2 Connected Airports for Enhanced Traveler & Visitor Experience
    - 4.2.2.3 Coordination of Ground Support Equipment, Vehicles & Personnel
    - 4.2.2.4 ATM (Air Traffic Management) for Drones & Urban Air Mobility Vehicles
    - 4.2.2.5 Wireless Upload of EFB (Electronic Flight Bag) & IFE (In-Flight Entertainment)

## Updates

4.2.2.6 Aircraft Data Offload for Operational & Maintenance Purposes

4.2.2.7 Video Surveillance of Airport Surface & Terminal Areas

4.2.2.8 5G-Enabled Remote Inspection & Repair of Aircraft

4.2.2.9 Navigation, Weather & Other IoT Sensors

4.2.2.10 Smart Baggage Handling

4.2.2.11 Asset Awareness & Tracking

4.2.2.12 Passenger Flow & Resource Management

4.2.2.13 Automation of Check-In & Boarding Procedures

4.2.2.14 Intelligent Airport Service Robots

4.2.3 Broadcasting

4.2.3.1 3GPP-Based PMSE (Program Making & Special Events)

4.2.3.2 Live AV (Audio-Visual) Media Production Using NPNs

4.2.3.3 Private 5G-Enabled Production in Remote Locations

4.2.3.4 Network Slicing for Contribution Feeds

4.2.3.5 Wire-Free Cameras & Microphones

4.2.3.6 Multicast & Broadcast Content Distribution

4.2.4 Construction

4.2.4.1 Wireless Connectivity for Construction Sites & Field Offices

4.2.4.2 Instantaneous Access to Business-Critical Applications

4.2.4.3 5G-Based Remote Control of Heavy Machinery

4.2.4.4 Autonomous Mobile Robots for Construction

4.2.4.5 IoT Sensor-Driven Maintenance of Equipment

4.2.4.6 Video Surveillance & Analytics for Site Security

4.2.4.7 Real-Time Visibility of Personnel, Assets & Materials

4.2.4.8 Aerial Surveying & Monitoring of Construction Sites

4.2.5 Education

4.2.5.1 Remote & Distance Learning Services

4.2.5.2 Mobile Access to Academic Resources

4.2.5.3 5G-Connected Smart Classrooms

4.2.5.4 Automation of Administrative Tasks

4.2.5.5 Personalized & Engaging Learning

4.2.5.6 AR/VR-Based Immersive Lessons

4.2.5.7 5G-Enabled Virtual Field Trips

4.2.5.8 Educational Telepresence Robots

4.2.6 Forestry

4.2.6.1 Wireless Connectivity for Forestry Operations & Recreation

4.2.6.2 5G-Facilitated Teleoperation of Forestry Equipment

4.2.6.3 Autonomous Harvesting & Milling Machinery

- 4.2.6.4 Real-Time Tracking of Equipment, Vehicles & Personnel
- 4.2.6.5 Cellular IoT Sensors for Biological & Environmental Monitoring
- 4.2.6.6 Wireless Cameras for Wildlife Observation, Conservation & Security
- 4.2.6.7 Early Wildfire Detection & Containment Systems
- 4.2.6.8 Drones for Search & Rescue Operations
- 4.2.7 Healthcare
  - 4.2.7.1 5G-Connected Smart Hospitals & Healthcare Facilities
  - 4.2.7.2 Wireless Transmission of Medical Imagery & Rich Datasets
  - 4.2.7.3 Real-Time Monitoring of Patients in Acute & Intensive Care
  - 4.2.7.4 Telehealth Video Consultations for Visual Assessment
  - 4.2.7.5 Connectivity for AI-Based Healthcare Applications
  - 4.2.7.6 AR Systems for Complex Medical Procedures
  - 4.2.7.7 Remote-Controlled Surgery & Examination
  - 4.2.7.8 Assisted Living & Rehabilitation Robotics
  - 4.2.7.9 Immersive VR-Based Medical & Surgical Training
  - 4.2.7.10 Connected Ambulances for EMS (Emergency Medical Services)
- 4.2.8 Manufacturing
  - 4.2.8.1 Untethered Connectivity for Production & Process Automation
  - 4.2.8.2 Wireless Motion Control & C2C (Control-to-Control) Communications
  - 4.2.8.3 Cellular-Equipped Mobile Control Panels
  - 4.2.8.4 Mobile Robots & AGVs (Automated Guided Vehicles)
  - 4.2.8.5 Autonomous Forklifts & Warehouse Robotics
  - 4.2.8.6 AR-Facilitated Factory Floor Operations
  - 4.2.8.7 Machine Vision-Based Quality Inspection
  - 4.2.8.8 Closed-Loop Process Control
  - 4.2.8.9 Process & Environmental Monitoring
  - 4.2.8.10 Precise Indoor Positioning for Asset Management
  - 4.2.8.11 Remote Access & Maintenance of Equipment
- 4.2.9 Military
  - 4.2.9.1 5G-Based Tactical Battlefield Communications
  - 4.2.9.2 Smart Military Bases & Command Posts
  - 4.2.9.3 ISR (Intelligence, Surveillance & Reconnaissance)
  - 4.2.9.4 Command & Control of Weapon Systems
  - 4.2.9.5 Remote Operation of Robotics & Unmanned Assets
  - 4.2.9.6 AR HUD (Heads-Up Display) Systems
  - 4.2.9.7 Wireless VR/MR-Based Military Training
  - 4.2.9.8 Perimeter Security & Force Protection
- 4.2.10 Mining
  - 4.2.10.1 Safety-Critical Communications in Remote Mining Environments

- 4.2.10.2 Wireless Control of Drilling, Excavation & Related Equipment
- 4.2.10.3 Automated Loading, Haulage & Train Operations
- 4.2.10.4 Video-Based Monitoring of Personnel & Assets
- 4.2.10.5 Underground Positioning & Geofencing
- 4.2.10.6 Smart Ventilation & Water Management
- 4.2.10.7 Real-Time Operational Intelligence
- 4.2.10.8 AR & VR for Mining Operations
- 4.2.11 Oil & Gas
  - 4.2.11.1 Wireless Connectivity for Remote Exploration & Production Sites
  - 4.2.11.2 Critical Voice & Data-Based Mobile Workforce Communications
  - 4.2.11.3 Push-to-Video & Telepresence Conferencing for Field Operations
  - 4.2.11.4 Cellular-Equipped Surveillance Cameras for Situational Awareness
  - 4.2.11.5 IoT Sensor-Enabled Remote Monitoring & Automation of Processes
  - 4.2.11.6 SCADA (Supervisory Control & Data Acquisition) Communications
  - 4.2.11.7 Location Services for Worker Safety & Asset Tracking
  - 4.2.11.8 AR Smart Helmets for Hands-Free Remote Assistance
  - 4.2.11.9 Predictive Maintenance of Oil & Gas Facilities
  - 4.2.11.10 Mobile Robots for Safety Hazard Inspections
- 4.2.12 Ports & Maritime Transport
  - 4.2.12.1 Critical Communications for Port Workers
  - 4.2.12.2 Automation of Port & Terminal Operations
  - 4.2.12.3 5G-Connected AGVs for Container Transport
  - 4.2.12.4 Remote-Controlled Cranes & Terminal Tractors
  - 4.2.12.5 Video Analytics for Operational Purposes
  - 4.2.12.6 Environmental & Condition Monitoring
  - 4.2.12.7 Port Traffic Management & Control
  - 4.2.12.8 AR & VR Applications for Port Digitization
  - 4.2.12.9 Unmanned Aerial Inspections of Port Facilities
  - 4.2.12.10 Private Cellular-Enabled Maritime Communications
  - 4.2.12.11 Wireless Ship-to-Shore Connectivity in Nearshore Waters
  - 4.2.12.12 5G-Facilitated Remote Steering of Unmanned Vessels
- 4.2.13 Public Safety
  - 4.2.13.1 Mission-Critical PTT Voice Communications
  - 4.2.13.2 Real-Time Video & High-Resolution Imagery
  - 4.2.13.3 Messaging, File Transfer & Presence Services
  - 4.2.13.4 Secure & Seamless Mobile Broadband Access
  - 4.2.13.5 Location-Based Services & Enhanced Mapping
  - 4.2.13.6 Multimedia CAD (Computer-Aided Dispatch)
  - 4.2.13.7 Massive-Scale Video Surveillance & Analytics

- 4.2.13.8 Smart Glasses & AR Headgear for First Responders
- 4.2.13.9 5G-Equipped Police, Firefighting & Rescue Robots
- 4.2.13.10 5G MBS/5MBS in High-Density Environments
- 4.2.13.11 Sidelink-Based Direct Mode Communications
- 4.2.14 Railways
  - 4.2.14.1 FRMCS (Future Railway Mobile Communication System)
  - 4.2.14.2 Train-to-Ground & Train-to-Train Connectivity
  - 4.2.14.3 Wireless Intra-Train Communications
  - 4.2.14.4 Rail Operations-Critical Voice, Data & Video Services
  - 4.2.14.5 ATO (Automatic Train Operation) & Traffic Management
  - 4.2.14.6 Video Surveillance for Operational Safety & Security
  - 4.2.14.7 Smart Maintenance of Railway Infrastructure
  - 4.2.14.8 Intelligent Management of Logistics Facilities
  - 4.2.14.9 Onboard Broadband Internet Access
  - 4.2.14.10 PIS (Passenger Information Systems)
  - 4.2.14.11 Smart Rail & Metro Station Services
- 4.2.15 Utilities
  - 4.2.15.1 Multi-Service FANs (Field Area Networks)
  - 4.2.15.2 Critical Applications for Field Workforce Communications
  - 4.2.15.3 AMI (Advanced Metering Infrastructure)
  - 4.2.15.4 DA (Distribution Automation) Systems
  - 4.2.15.5 Microgrid & DER (Distributed Energy Resource) Integration
  - 4.2.15.6 5G-Enabled VPPs (Virtual Power Plants)
  - 4.2.15.7 Low-Latency SCADA Applications for Utilities
  - 4.2.15.8 Teleprotection of Transmission & Distribution Grids
  - 4.2.15.9 Video Monitoring for Critical Infrastructure Protection
  - 4.2.15.10 Sensor-Based Detection of Water & Gas Leaks
  - 4.2.15.11 AR Information Overlays for Repairs & Maintenance
  - 4.2.15.12 Drone & Robot-Assisted Inspections of Utility Assets
  - 4.2.15.13 Local Wireless Connectivity for Remote & Offshore Facilities
- 4.2.16 Warehousing & Other Verticals

## **5 CHAPTER 5: SPECTRUM AVAILABILITY, ALLOCATION & USAGE**

- 5.1 National & Local Area Licensed Spectrum
  - 5.1.1 Low-Band (Sub-1 GHz)
    - 5.1.1.1 200 – 400 MHz
    - 5.1.1.2 410 & 450 MHz
    - 5.1.1.3 600 MHz

- 5.1.1.4 700 MHz
- 5.1.1.5 800 MHz
- 5.1.1.6 900 MHz
- 5.1.2 Mid-Band (1 – 6 GHz)
  - 5.1.2.1 1.4 GHz
  - 5.1.2.2 1.6 GHz
  - 5.1.2.3 1.7 GHz
  - 5.1.2.4 1.8 GHz
  - 5.1.2.5 1.9 GHz
  - 5.1.2.6 2.1 GHz
  - 5.1.2.7 2.3 GHz
  - 5.1.2.8 2.4 GHz
  - 5.1.2.9 2.5 GHz
  - 5.1.2.10 2.6 GHz
  - 5.1.2.11 3.4 GHz
  - 5.1.2.12 3.5 GHz CBRS PAL Tier
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## **6 CHAPTER 6: STANDARDIZATION, REGULATORY & COLLABORATIVE INITIATIVES**

- 6.1 3GPP (Third Generation Partnership Project)
  - 6.1.1 Release 15: 5G eMBB Capabilities, Introduction of Network Slicing & New Operating Bands
  - 6.1.2 Release 16: 3GPP Support for NPNs, 5G URLLC, TSN, NR-U & Vertical Application Enablers
  - 6.1.3 Release 17: NPN Enhancements, Edge Computing, TSC, Expansion of IIoT Features, RedCap & NTN Connectivity
  - 6.1.4 Release 18: 5G-Advanced, Further NPN Refinements, DetNet, Intelligent Automation, Spectrum Flexibility & eRedCap
  - 6.1.5 Release 19 & Beyond: 5G NR Femto Architecture, MWAB, IOPS Over 5G, ProSe in NPNs, Ambient IoT & Regenerative NTN

## 6.2 450 MHz Alliance

### 6.2.1 Promoting 3GPP Technologies in the 380 – 470 MHz Frequency Range

## 6.3 5G-ACIA (5G Alliance for Connected Industries and Automation)

### 6.3.1 Maximizing the Applicability of 5G Technology in the Industrial Domain

## 6.4 5GAIA (5G Applications Industry Array)

### 6.4.1 Advancing the Development of China's 5G Applications Industry

## 6.5 5G Campus Network Alliance

### 6.5.1 Supporting the Market Development of 5G Campus Networks in Germany

## 6.6 5GDNA (5G Deterministic Networking Alliance)

### 6.6.1 Industry Collaboration & Promotion of 5GDN (5G Deterministic Networking)

## 6.7 5GFF (5G Future Forum)

### 6.7.1 Accelerating the Delivery of 5G MEC (Multi-Access Edge Computing) Solutions

## 6.8 5G Forum (South Korea)

### 6.8.1 Expanding Convergence Between 5G Technology & Vertical Industries

## 6.9 5G Health Association

### 6.9.1 Interfacing 5G-Based Connectivity & Healthcare Applications

## 6.10 5G-MAG (5G Media Action Group)

### 6.10.1 5G-Based NPNs in Media Production

## 6.11 5GMF (Fifth Generation Mobile Communication Promotion Forum, Japan)

### 6.11.1 Initiatives Related to Local 5G Networks in Japan

## 6.12 5G-OT Alliance

### 6.12.1 Accelerating Private 5G Adoption in OT (Operational Technology) Environments

## 6.13 5GSA (5G Slicing Association)

### 6.13.1 Addressing Vertical Industry Requirements for 5G Network Slicing

## 6.14 6G-IA (6G Smart Networks and Services Industry Association)

### 6.14.1 Private 5G-Related Projects & Activities

## 6.15 AGURRE (Association of Major Users of Operational Radio Networks, France)

### 6.15.1 Spectrum Access, Regulatory Framework & Industrial Ecosystem for Private Mobile Networks

## 6.16 APCO (Association of Public-Safety Communications Officials) International

### 6.16.1 Public Safety 5G-Related Advocacy Efforts

## 6.17 ATIS (Alliance for Telecommunications Industry Solutions)

### 6.17.1 Deployment & Operational Requirements of 5G-Based NPNs

### 6.17.2 Shared HNI & IBN Administration for CBRS Spectrum

### 6.17.3 Other Private 5G-Related Initiatives

## 6.18 BEREC (Body of European Regulators for Electronic Communications)

### 6.18.1 Private 5G-Related Consultations & Analysis for European NRAs (National Regulatory Authorities)

## 6.19 BTG (Dutch Association of Large-Scale ICT & Telecommunications Users)

- 6.19.1 KMBG (Dutch Critical Mobile Broadband Users) Expert Group
- 6.20 B-TrunC (Broadband Trunking Communication) Industry Alliance
  - 6.20.1 B-TrunC Standard for 3GPP-Based Critical Communications
- 6.21 CAMET (China Association of Metros)
  - 6.21.1 Adoption of 3GPP Networks for Urban Rail Transit Systems
  - 6.21.2 Public-Private 5G Network Series of Specifications
- 6.22 CEPT (European Conference of Postal and Telecommunications Administrations)
  - 6.22.1 Common Spectrum Policies for Local 5G, PPDR Broadband & FRMCS
- 6.23 DSA (Dynamic Spectrum Alliance)
  - 6.23.1 Promoting Unlicensed & Dynamic Access to Spectrum
- 6.24 Electricity Canada (Canadian Electricity Association)
  - 6.24.1 PVNO & Dedicated Spectrum for Smart Grid Communications
- 6.25 ENTELEC (Energy Telecommunications and Electrical Association)
  - 6.25.1 Policy Advocacy & Other Private 5G-Related Activities
- 6.26 EPRI (Electric Power Research Institute)
  - 6.26.1 Research & Guidelines in Support of 3GPP-Based Utility Communications
- 6.27 ERA (European Union Agency for Railways)
  - 6.27.1 Evolution of Railway Radio Communication Project
- 6.28 ETSI (European Telecommunications Standards Institute)
  - 6.28.1 Technical Specifications for FRMCS, PPDR Broadband, MCX & TETRA-3GPP Interworking
  - 6.28.2 Other Work Relevant to Private 5G Networks
- 6.29 EU-Rail (Europe's Rail Joint Undertaking)
  - 6.29.1 FRMCS-Related Research & Innovation Activities
- 6.30 EUTC (European Utilities Telecom Council)
  - 6.30.1 Addressing 5G-Related Requirements for European Utilities
- 6.31 EUWENA (European Users of Enterprise Wireless Networks Association)
  - 6.31.1 Catalyzing the Wider Adoption of 3GPP-Based Private Networks
- 6.32 EWA (Enterprise Wireless Alliance)
  - 6.32.1 Supporting the Private Wireless Industry in the United States
- 6.33 free5GC
  - 6.33.1 Open-Source 5GC Software
- 6.34 GSA (Global Mobile Suppliers Association)
  - 6.34.1 Advocacy for Private Mobile Networks
- 6.35 GSMA (GSM Association)
  - 6.35.1 Guidelines for 5G Private & Dedicated Networks
- 6.36 GUTMA (Global UTM Association)
  - 6.36.1 ACJA (Aerial Connectivity Joint Activity) Initiative
- 6.37 ITU (International Telecommunication Union)

- 6.37.1 International & Regional Harmonization of 5G Spectrum
- 6.37.2 Defining the Role of IMT-2020 to Support Vertical Applications
- 6.38 JOTS (Joint Operators Technical Specification) Forum
  - 6.38.1 NHIB (Neutral Host In-Building) Specification
- 6.39 JRC (Joint Radio Company)
  - 6.39.1 Supporting 5G-Based Smart Grid Initiatives
- 6.40 KRRRI (Korea Railroad Research Institute)
  - 6.40.1 Functional Testing & Certification of 3GPP-Based Railway Communications Systems
- 6.41 LF (Linux Foundation)
  - 6.41.1 Magma Mobile Core Software Platform
  - 6.41.2 LF Networking's 5G Super Blueprint
  - 6.41.3 LF Edge's Akraino Private 5G ICN (Integrated Cloud-Native) Blueprint
  - 6.41.4 Other Projects Relevant to Private 5G Networks
- 6.42 MFA (Alliance for Private Networks)
  - 6.42.1 Uni5G Technology Blueprints for Private 5G Networks
  - 6.42.2 Network Identifier Program Supporting Private & Neutral Host Networks
- 6.43 MSSA (Mobile Satellite Services Association)
  - 6.43.1 Advancing the Global Direct-to-Device NTN Ecosystem
- 6.44 NGA (Next G Alliance)
  - 6.44.1 Building the Foundation for North American Leadership in 6G
- 6.45 NGMN (Next-Generation Mobile Networks) Alliance
  - 6.45.1 Work Related to Private 5G & Network Slicing
- 6.46 NSC (National Spectrum Consortium)
  - 6.46.1 Enhancing Spectrum Superiority & 5G Capabilities for Federal Users
- 6.47 OCP (Open Compute Project) Foundation
  - 6.47.1 Initiatives Aimed at Open Designs for Telco Hardware
- 6.48 one6G Association
  - 6.48.1 Driving 6G Innovation & Development Across Vertical Industries
- 6.49 ONF (Open Networking Foundation)
  - 6.49.1 Aether Private 5G Connected Edge Platform
  - 6.49.2 SD-RAN, SD-Core, OMEC & Other Relevant Projects
- 6.50 OnGo Alliance
  - 6.50.1 Promoting 5G OnGo Wireless Network Technology
  - 6.50.2 Technical Specifications & Guidelines for 5G NR-Based CBRS Networks
  - 6.50.3 Product Certification Program Supporting Multi-Vendor Interoperability
- 6.51 OPC Foundation
  - 6.51.1 OPC UA (Unified Architecture) Over 5G for Industry 4.0 Applications
- 6.52 Open RAN Policy Coalition

- 6.52.1 Promoting Policies to Drive the Adoption of Open RAN
- 6.53 Open5GCore
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- 6.54 Open5GS & NextEPC
  - 6.54.1 Open-Source 5GC & EPC Software
- 6.55 OpenInfra (Open Infrastructure) Foundation
  - 6.55.1 StarlingX Software Stack for Ultra-Low Latency Edge Applications
  - 6.55.2 OpenStack Cloud Software & Other Projects
- 6.56 O-RAN Alliance
  - 6.56.1 O-RAN Architecture Specifications
  - 6.56.2 O-RAN SC (Software Community)
  - 6.56.3 Testing & Integration Support
- 6.57 OSA (OpenAirInterface Software Alliance)
  - 6.57.1 OAI (OpenAirInterface) 5G RAN, Core & MOSAIC5G Projects
- 6.58 PIA (PSBN Innovation Alliance)
  - 6.58.1 PSBN (Public Safety Broadband Network) Governance in Canada's Ontario Province
- 6.59 PMeV (German Professional Mobile Radio Association)
  - 6.59.1 Professional Broadband & 5G Campus Network-Related Activities
- 6.60 PSBTA (Public Safety Broadband Technology Association)
  - 6.60.1 Public Safety 5G-Related Activities
- 6.61 PSCE (Public Safety Communication Europe)
  - 6.61.1 Public Safety Broadband-Related Standardization Activities
  - 6.61.2 BroadX Projects: Pan-European Interoperable Mobile Broadband System for Public Safety
- 6.62 Safe-Net Forum
  - 6.62.1 Technical & Policy Guidance for 3GPP-Based Critical Communications Networks
- 6.63 SCF (Small Cell Forum)
  - 6.63.1 Reference Blueprints for Private 5G Networks
  - 6.63.2 Neutral Hosting, Edge Computing & Other Relevant Work
- 6.64 Seamless Air Alliance
  - 6.64.1 Leading Global Standards for Inflight Connectivity
- 6.65 SimpleRAN
  - 6.65.1 Ensuring Interoperability & Transparency in the vRAN (Virtualized RAN) Ecosystem
- 6.66 srsRAN Project
  - 6.66.1 Open-Source 5G Software Suite
- 6.67 TCA (Trusted Connectivity Alliance)
  - 6.67.1 5G SIM/eSIM Recommendations for Private Networks

- 6.68 TCCA (The Critical Communications Association)
  - 6.68.1 BIG (Broadband Industry Group)
  - 6.68.2 CCBG (Critical Communications Broadband Group)
  - 6.68.3 IWF Working Group
  - 6.68.4 SCADA, Smart Grid & IoT Group
  - 6.68.5 Future Technologies Group
- 6.69 techUK
  - 6.69.1 SPF (Spectrum Policy Forum)
- 6.70 TIA (Telecommunications Industry Association)
  - 6.70.1 Defining Requirements for LMR-3GPP Interworking & Critical Broadband Capabilities
- 6.71 TIP (Telecom Infra Project)
  - 6.71.1 5G Private Networks Solution Group
  - 6.71.2 NHIS (Neutral Host & Infra Sharing) Project Group
  - 6.71.3 Neutral Host NaaS Solution Group
  - 6.71.4 OpenRAN & Open Core Network Groups
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  - 6.72.1 Bridging Commercial Real Estate Development With Wireless Technology
- 6.73 TTA (Telecommunications Technology Association, South Korea)
  - 6.73.1 Standardization Efforts for 3GPP-Based Public Safety, Railway & Maritime Communications
- 6.74 U.S. NIST (National Institute of Standards and Technology)
  - 6.74.1 Public Safety Broadband & 5G-Related R&D Initiatives
- 6.75 U.S. NPSTC (National Public Safety Telecommunications Council)
  - 6.75.1 Leadership for LMR-3GPP Interworking & Public Safety Broadband Communications
- 6.76 U.S. NTIA (National Telecommunications and Information Administration)
  - 6.76.1 Wireless Innovation & Supply Chain Security
- 6.77 UBBA (Utility Broadband Alliance)
  - 6.77.1 Championing the Advancement of Private Broadband Networks for Utilities
- 6.78 UIC (International Union of Railways)
  - 6.78.1 FRMCS Program for the Replacement of GSM-R Networks
- 6.79 UK5G Innovation Network
  - 6.79.1 Promoting Private 5G Adoption Projects, Testbeds & Trials
- 6.80 UNIFE (The European Rail Supply Industry Association)
  - 6.80.1 UNITEL Committee: Development & Implementation of FRMCS
- 6.81 UTC (Utilities Technology Council)
  - 6.81.1 Private 5G-Related Advocacy, Technology Development & Policy Efforts

- 6.82 UTCAL (Utilities Telecom & Technology Council Am?rica Latina)
  - 6.82.1 Promoting Private 5G Networks for Latin American Utilities
- 6.83 VDMA (German Mechanical and Plant Engineering Association)
  - 6.83.1 Guidelines for 5G in Mechanical & Plant Engineering
- 6.84 WBA (Wireless Broadband Alliance)
  - 6.84.1 5G & Wi-Fi Convergence in Private 5G Networks
  - 6.84.2 OpenRoaming for Private 5G
- 6.85 WhiteSpace Alliance
  - 6.85.1 Promoting the Use of 3GPP, IEEE & IETF Standards for TVWS Spectrum
- 6.86 WInnForum (Wireless Innovation Forum)
  - 6.86.1 CBRS Standards for the Implementation of FCC Rulemaking
  - 6.86.2 6 GHz Unlicensed Sharing & Other Committees
- 6.87 XGP (eXtended Global Platform) Forum
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- 7.1 ABP (Associated British Ports): Shared Access License-Enabled Private 5G Network for Port of Southampton
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- 7.2 Adif (Spanish Railway Infrastructure Administrator): Private 5G Infrastructure for Strategic Logistics Terminals
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  - 7.2.3 Integrators & Suppliers
  - 7.2.4 Deployment Summary
- 7.3 Agnico Eagle Mines: Streamlining Mining Operations With Industrial-Grade Private 5G Networks
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### 7.4 Airbus: Multi-Campus Private 5G Network for Global Aircraft Manufacturing Facilities

#### 7.4.1 Operational Model

#### 7.4.2 Spectrum Type

#### 7.4.3 Integrators & Suppliers

#### 7.4.4 Deployment Summary

### 7.5 ANA (All Nippon Airways): Local 5G-Powered Digital Transformation of Aviation Training

#### 7.5.1 Operational Model

#### 7.5.2 Spectrum Type

#### 7.5.3 Integrators & Suppliers

#### 7.5.4 Deployment Summary

### 7.6 ArcelorMittal: 5G Steel Project for Industrial Digitization & Automation

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#### 7.6.2 Spectrum Type

#### 7.6.3 Integrators & Suppliers

#### 7.6.4 Deployment Summary

### 7.7 ASE Group: 28 GHz mmWave 5G Network for Semiconductor Manufacturing

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#### 7.7.3 Integrators & Suppliers

#### 7.7.4 Deployment Summary

### 7.8 ASN (Alcatel Submarine Networks): Private 5G Networks for Calais & Greenwich Production Sites

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#### 7.8.2 Spectrum Type

#### 7.8.3 Integrators & Suppliers

#### 7.8.4 Deployment Summary

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#### 7.9.3 Integrators & Suppliers

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7.11.1 Operational Model

7.11.2 Spectrum Type

7.11.3 Integrators & Suppliers

7.11.4 Deployment Summary

7.12 BASF: 5G Campus Networks for Real-Time Wireless Connectivity in Chemical Production Sites

7.12.1 Operational Model

7.12.2 Spectrum Type

7.12.3 Integrators & Suppliers

7.12.4 Deployment Summary

7.13 BBC (British Broadcasting Corporation): Portable 5G-Based NPN Solution for News Contribution

7.13.1 Operational Model

7.13.2 Spectrum Type

7.13.3 Integrators & Suppliers

7.13.4 Deployment Summary

7.14 BHP: Transitioning From Private LTE to Standalone 5G Networks for Advanced Digitization & Automation

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7.14.2 Spectrum Type

7.14.3 Integrators & Suppliers

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7.15 BlackRock: On-Premise Private 5G Network Installation for New York Global Headquarters

7.15.1 Operational Model

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7.16.1 Operational Model

7.16.2 Spectrum Type

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- 7.17.3 Integrators & Suppliers
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- 7.18.1 Operational Model
- 7.18.2 Spectrum Type
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- 7.18.4 Deployment Summary
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- 7.20 China National Coal Group: Multi-Band 700 MHz & 2.6 GHz Private 5G Network for Dahaize Coal Mine
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- 7.21.3 Integrators & Suppliers
- 7.21.4 Deployment Summary
- 7.22 CJ Logistics: Bolstering Fulfillment Center Productivity Using Private 5G Network
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- 7.22.4 Deployment Summary
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- 7.23.1 Operational Model
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- 7.23.3 Integrators & Suppliers
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7.24.1 Operational Model

7.24.2 Spectrum Type

7.24.3 Integrators & Suppliers

7.24.4 Deployment Summary

7.25 COMAC (Commercial Aircraft Corporation of China): 5G-Connected Intelligent Aircraft Manufacturing Factories

7.25.1 Operational Model

7.25.2 Spectrum Type

7.25.3 Integrators & Suppliers

7.25.4 Deployment Summary

7.26 Crystal Palace Football Club: Unlocking Accessibility for Visually Impaired Fans With Private 5G Network

7.26.1 Operational Model

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7.26.3 Integrators & Suppliers

7.26.4 Deployment Summary

7.27 CSG (China Southern Power Grid): Harnessing Private Cellular Systems & 5G Network Slicing for Smart Grid Operations

7.27.1 Operational Model

7.27.2 Spectrum Type

7.27.3 Integrators & Suppliers

7.27.4 Deployment Summary

7.28 Cummins: Combined Neutral Host System & Private 5G Network for JEP (Jamestown Engine Plant)

7.28.1 Operational Model

7.28.2 Spectrum Type

7.28.3 Integrators & Suppliers

7.28.4 Deployment Summary

7.29 DB (Deutsche Bahn): Digitizing & Automating Rail Operations With 5G Campus Networks & FRMCS-Ready Cell Sites

7.29.1 Operational Model

7.29.2 Spectrum Type

7.29.3 Integrators & Suppliers

7.29.4 Deployment Summary

7.30 Delta Electronics: Private 5G Networks for Manufacturing Facilities in Taiwan & Thailand

7.30.1 Operational Model

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7.30.3 Integrators & Suppliers

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### 7.31 District of Ban Chang: 26 GHz mmWave Private 5G Network for Smart City Services

#### 7.31.1 Operational Model

#### 7.31.2 Spectrum Type

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#### 7.31.4 Deployment Summary

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#### 7.32.3 Integrators & Suppliers

#### 7.32.4 Deployment Summary

### 7.33 East West Railway Company: ECH-R (England's Connected Heartland Railways) Project

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#### 7.33.2 Spectrum Type

#### 7.33.3 Integrators & Suppliers

#### 7.33.4 Deployment Summary

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#### 7.34.3 Integrators & Suppliers

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#### 7.35.3 Integrators & Suppliers

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#### 7.37.2 Spectrum Type

#### 7.37.3 Integrators & Suppliers

#### 7.37.4 Deployment Summary

## 7.38 EWG (East-West Gate) Intermodal Terminal: Private 5G Network for Smart Railway Logistics

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### 7.38.2 Spectrum Type

### 7.38.3 Integrators & Suppliers

### 7.38.4 Deployment Summary

## 7.39 Ferrovial: Standalone Private 5G Network for Silvertown Tunnel Project

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### 7.39.2 Spectrum Type

### 7.39.3 Integrators & Suppliers

### 7.39.4 Deployment Summary

## 7.40 Fiskarheden: Local 3.7 GHz License-Based Private 5G Network for Transtrand Sawmill

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### 7.40.2 Spectrum Type

### 7.40.3 Integrators & Suppliers

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