#EU4Digital

EU4Digital: supporting digital economy and society in the Eastern Partnership

5G private networks development

EU best practice report

March 2024

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List of acronyms and abbreviations

Abbreviation	Definition
3GPP	3rd Generation Partnership Project
ACIA (5G-ACIA)	5G Alliance for Connected Industries and Automation
AI	Artificial Intelligence
AR	Augmented Reality
CEPT	European Conference of Postal and Telecommunications Administrations
EIRP	Effective Isotropic Radiated Power
eMBB	Enhanced Mobile Broadband
FL	Forward Link
FSS	Fixed Satellite Service
IoT	Internet of Things
MNO	Mobile Network Operator
MVNO	Mobile Virtual Network Operator
NPN	Non Public Network
PLMN	Public Land Mobile Network
RAN	Radio Access Network
SD-LAN	Software-Defined Local Area Network
SD-WAN	Software-Defined Wide Area Network
TRP	Total Radiated Power
TSN	Time-Sensitive Networking
VR	Virtual Reality
WBB LMPs	Wireless BroadBand Low Medium Power services

Executive summary

Building on the "2030 Digital Compass: the European way for the Digital Decade"[1] ambition to increase roll-out of Very High Capacity Networks including 5G as well as needs and priorities of the Spectrum expert working group (SEWG) of the Eastern Partnership Electronic Communications Regulators Network (EaPeReg), the EU4Digital Facility prepared this best practice report on development of 5G private networks in the EU. The development of 5G private networks significantly enhances connectivity, industry innovations, security and overall communications efficiency, leading to improvements of different industries and businesses.

The report consists of four key parts to illustrate different aspects of 5G private networks development:

- 5G private networks use-cases from a business perspective;
- Comparison of the different types of 5G private networks;
- Frequencies allocation to 5G private networks, analysing different European cases;
- 5G private networks frequency standardisation at the EU level.

The main objective of this report is to present the business use-cases for developing 5G private networks as well as share experience gathered by the EU Member States on frequencies allocations. Thus, the report shall support the Eastern partner countries of Armenia, Azerbaijan, Georgia, Republic of Moldova and Ukraine towards facilitating the 5G private networks development in their respective countries.

[1] https://commission.europa.eu/system/files/2023-01/cellar_12e835e2-81af-11eb-9ac9-01aa75ed71a1.0001.02_DOC_1.pdf

1. 5G private networks – business perspective

1.1 Areas of 5G application across industries

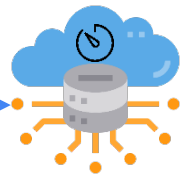
The 5G represents a great opportunity for increasing the income and will connect millions of devices worldwide at high speed and low latency, allowing the realization of advanced projects such as connected cars, the Internet of Things, Smart Cities and Smart Homes of new generation.

The Three Fundamental Pillars

Enhanced Mobile Broadband

This feature will go beyond faster downloads to provide a smoother user experience that will eclipse the quality of service we currently enjoy. It will allow 360° video streaming, truly engaging VR and AR applications, smart homes and offices and much more

- **Increased capacity & connectivity**: Internet **access** will be available **everywhere**
- **Increased user mobility**: the connection will be present on **high-speed** trains and **moving hotspots**



Ultra Low Latency Communications

Latency refers to the time it takes for a package to be sent from the source to its destination. This travel time will be reduced to 1ms, making remote connections possible, with 99.99% reliability

- With the help of the **eMBB, AR/VR** can be **implemented** for any type of **application**
- **Self-driving machines will become a reality**
- Increased productivity and revenue thanks to **factory automation**

Massive Machine type Communications

Instead, it will focus on providing connectivity to a large number of devices that sporadically transmit a low amount of traffic. It is the key technology needed to scale the Internet of Thing

- Introduction of **sensors**, will allow the exchange of data between objects
- **Improvement in the monitoring** of the structure or environment, **optimization of processes**

1.1 Areas of 5G application across industries

5G unlocks new use cases

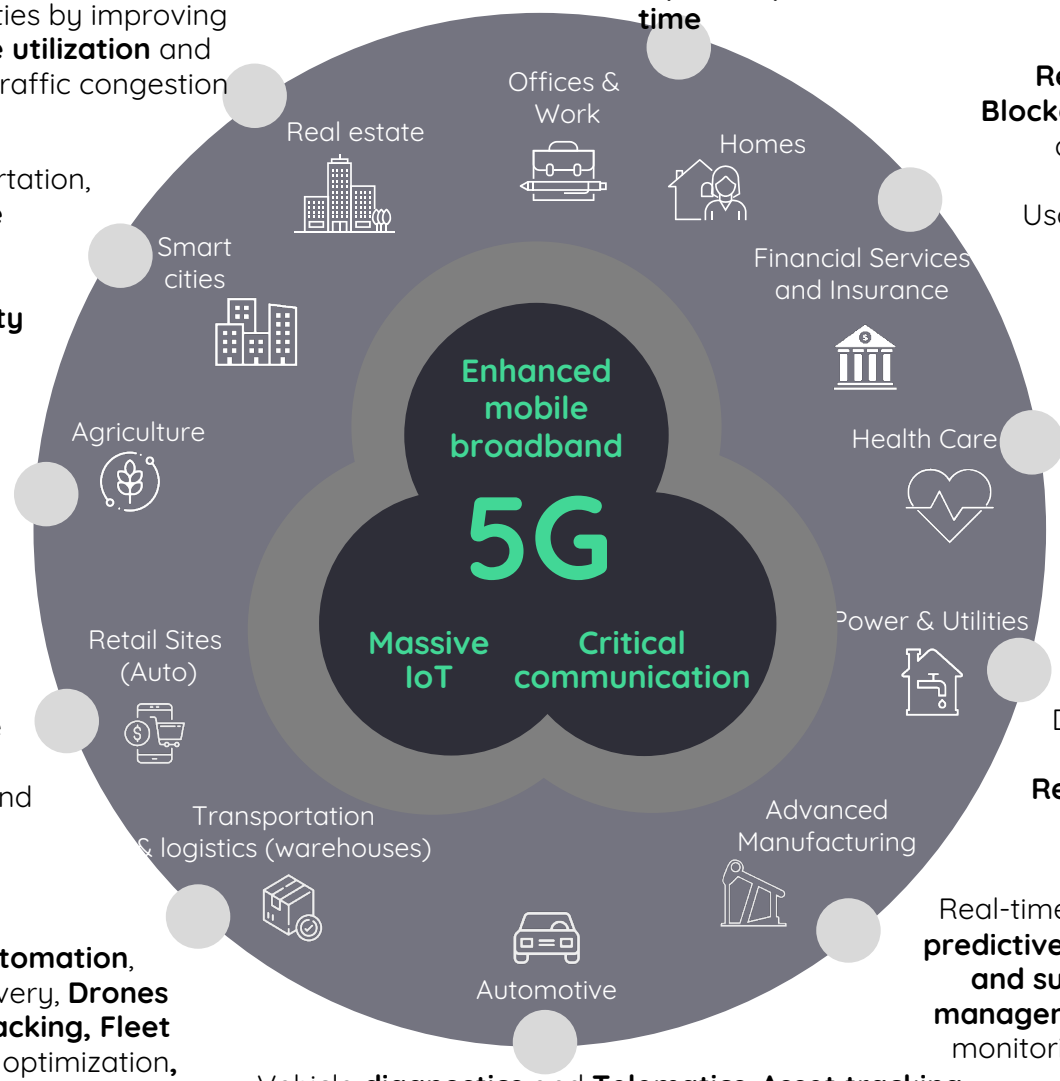
Speed
10 Gbps
100 times of 4G speeds

Latency
10%
of 4G latency (Time taken for signal to be recognized by an end point)

Mobile data volume per area
1000x
greater than today

Connected devices per area
1000x

Energy consumption
1/10th
compared to 2010



Safer, more **efficient**, and cleaner cities by improving **resource utilization** and reducing traffic congestion

Remotely monitoring and **automation** of homes, facilities, and **public spaces** in **real-time**

Real-time Life Insurance, **Blockchain** for secured payments and **Chatbots,** Remote maintenance of **ATMs** Usage based **car insurance based on telematics**

Smart energy, transportation, **water** and **waste management** Smart building **Safety** and **security**

Sensors, **smart gateways**, and **monitoring systems** to optimize farming decisions and **increase output,** Environmental **control**

Real-time visibility into **diagnostic data**, health alerts, Telemedicine **Remote surgery**

Improving **customer service experience** while gaining valuable insights into **trends**, **conditions** and **loyalty programs**

Distribution of energy within a **Smart-grid**, **Remote monitoring** and **Energy efficiency**

Real-time visibility into **predictive maintenance and supply chain management,** Remote monitoring of assets

Warehouse automation, **Autonomous** delivery, **Drones** logistics**, Asset tracking, Fleet** management and optimization**, Navigation** and **fuel** management

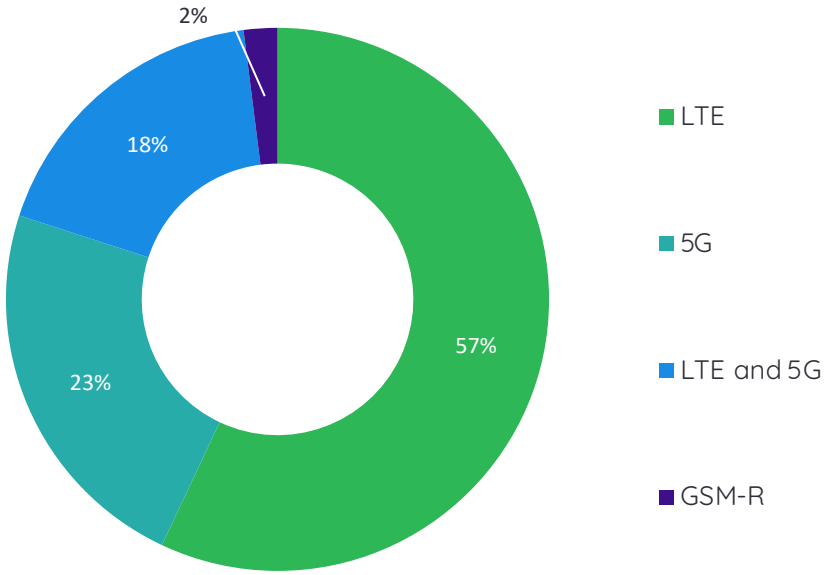
Vehicle **diagnostics** and **Telematics**, **Asset tracking**, **Connected** and **Autonomous** vehicles, In-car **emergency systems**, **Infotainment** and **positioning** services

1.2 Leading industries (1/2)

As of June 2022, about 955 organisations are known to be deploying LTE or 5G private mobile networks across 72 countries and territories. Out of the 214 private network announcement in 2022, 5G was used in 55% of references.

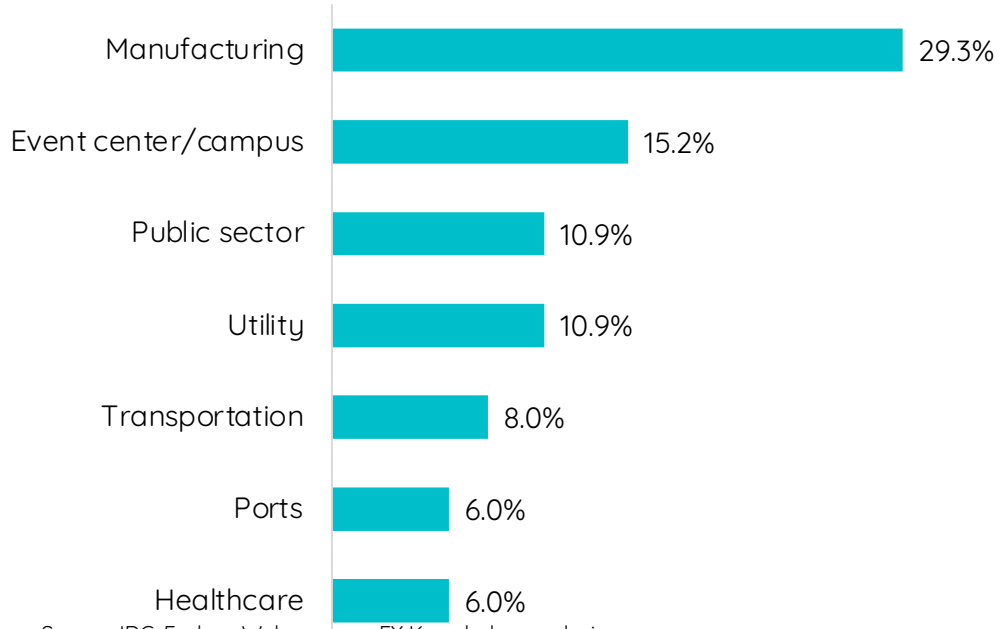
Based on value of network contracts Manufacturying industry is leading in impementation of private 4G/5G networks

Deployment of private mobile networks by technology, 2022



Source: GSA Private Mobile Networks, December 2022;
Note: Base: 955 catalogued customers deploying private wireless networks

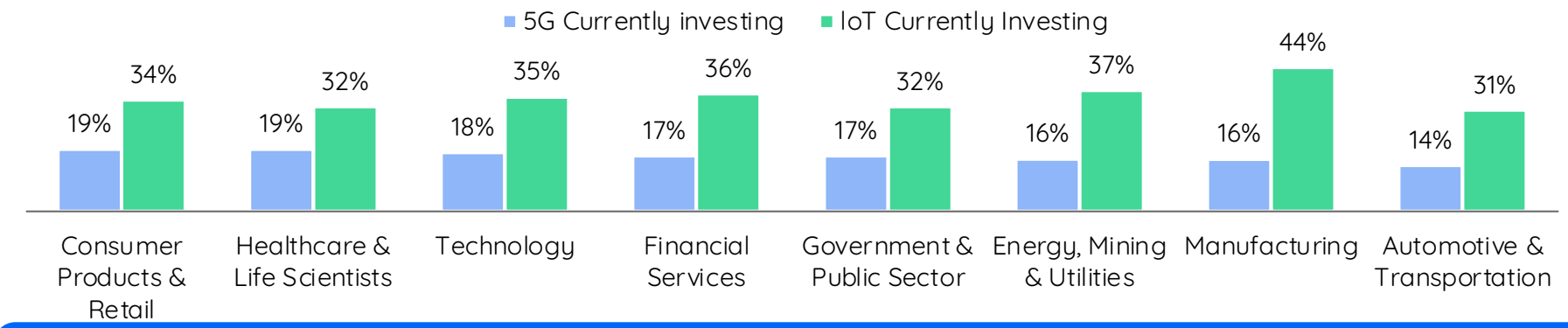
Private 4G/5G Network Contracts Share by Vertical, 2022



Source: IDC, Forbes, Web sources, EY Knowledge analysis

1.2 Leading industries (1/2)

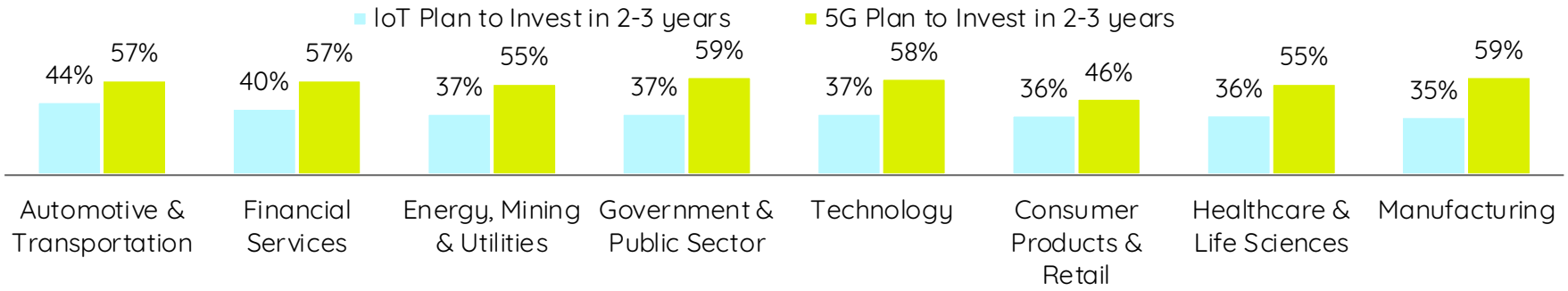
Which of the following emerging technologies is your organization investing in? 5G, IoT



The gap between IOT and 5G is highest in Energy and Manufacturing, reflecting established IOT positions. Current IOT investments has dropped due to disruptive challenges like semiconductor shortage.

Which of the following emerging technologies is your organization investing in? 5G, IoT

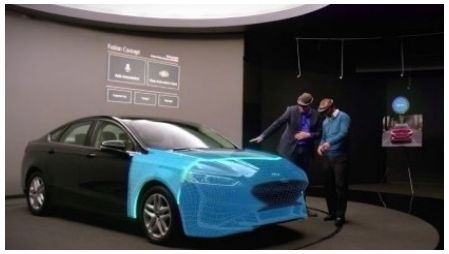
Going forward, Investment intentions in 5G outperform IOT. This relative uplift is most pronounced in Automotive, Energy, Financial Services, Manufacturing, Government and Technology sector.



Source: Reimagining industry futures – enterprise survey, EY, 2022

1.3 Use cases – Automotive

Automotive companies aim to utilise the high speed and low latency of 5G technology to improve production efficiency and precision and reduce downtime through real-time monitoring.

	Mercedes Benz (5G private network)	Ford (Automated vehicle production)	Volkswagen (Remote Monitoring, Inspection, and Diagnostics)
			
What	• **Mercedes Benz** partnered with **Telefónica Deutschland** and **Ericsson** to integrate worlds first 5G mobile network infrastructure in its "Factory 56" in Sindelfingen	• **Ford** partnered with **Vodafone** to build a 5G Private Network in Essex to enhance laser welding technology for EV manufacturing.	• **Volkswagen** partnered with **Nokia** for a private 5G network to facilitate remote monitoring and manage large number of connected assets.
How	• Telefónica Deutschland and Ericsson will build numerous indoor antennas and 5G hubs in the 20,000+ sq. m. facility.	• Vodafone's 5G pilot which will help in the process of image capture and AI processing during and after the welding process, thus improving production tolerances and eliminating rework.	• The 5G network will enable wireless upload of data to manufactured vehicles and intelligent networking of robots and wireless assembly tools.
Benefits	• Increased production efficiency and precision through data linking and production tracking on the assembly lines. Private 5G network will also prevent sensitive production data to be made available to third parties.	• Reduce downtime in the production line and minimize delays in manufacturing. The 5G pilot line will also provide ford engineers with high bandwidth for use of HoloLens system to fix problems in real time.	• The 5G pilot line deployment will provide high-bandwidth and low-latency connectivity for sensors, machines, vehicles and other equipment

1.3 Use cases – Industrial Products (1/2)

Industrial Products companies are connecting local industrial applications with 5G-enables solutions to deliver greater connectivity, faster and more reliable networks

ABB

(Factory Robot and Machine Interactions)

What

- **ABB** and **Ericsson** have partnered to bring flexibility and resilience through 5G for for flexible robotized manufacturing and machine interactions.

How

- Both companies will align 5G-enabled hardware and software solutions to bring together innovative 5G-capable solutions.

Benefits

- Seamless connectivity for industrial devices, strengthening connected services; creating safer workplaces, lowering downtime and reducing energy spend.

Samsung

(Predictive Machine Maintenance)

- **Samsung Austin Semiconductor, Samsung Electronics America** and **AT&T** unveiled the first manufacturing-focused 5G Innovation Zone in America.
- Designed for AT&T and Samsung to explore ideas and technology over 5G networks for improving manufacturing environments and creating smarter factories.
- Benefits include capacity, throughput and latency improvements at levels that were previously only available via wired technology.

Siemens

(Remote Monitoring, Inspection, and Diagnostics)

- **Siemens** is enabling the transmission of Profinet, which is an open standard for industrial networking in automation, via a private 5G network. It allows data to be transmitted in real time for industrial applications.
- It is made possible by the VXLAN (Virtual Extensible LAN) transmission technology in the company's Scalance 5G routers and security appliances.
- Use of a central control system for multiple mobile participants will reduce energy and maintenance costs as Siemens is developing its own 5G ecosystem.

1.3 Use cases – Industrial Products (2/2)

Industrial Products companies are leveraging IOT, 5G and AI to enhance performance and product quality and build safer workplaces

Schneider Electric

(Predictive Machine Maintenance)

What

- **Schneider Electric** and **NTT** collaborated to deliver Private 5G (P5G) - premise private network solution and digitization enabling platform

How

- Schneider Electric's US plants to become Smart Factory site leveraging IoT connectivity, Edge analytics, and predictive analytics.

Benefits

- Solve challenges around equipment availability, machine performance, and product quality. And drive energy efficiency and sustainability goals

1.3 Use cases – Chemicals & Advanced Materials

Chemical companies are building private 5G network to enhance on-premise data transfer applications and remote monitoring and maintenance activities

BASF

(Private 5G network)

What

- **BASF** has partnered with **Cellnex Telecom** to install the first 5G private network in the Spanish chemical industry.

How

- **Cellnex** along with **Masmóvil**, **Nokia** and **Lenovo** will develop a 5G pilot and edge computing solution which will allow autonomous computing of data in BASF's Tarragona facility.

Benefits

- The 5G infrastructure will provide high bandwidth for on-premise applications such as Internet of Things (IoT), implementation of big data, virtual and augmented reality and artificial intelligence

Albemarle Corporation

(Private 5G network)

ALBEMARLE® NTT

- **Albemarle** has partnered with **Nippon Telegraph and Telephone (NTT)** to deploy a private 5G/LTE and Wi-Fi network in its lithium mine facility in North Carolina.
- NTT will deploy a private 5G and Wi-Fi network and help the company transform digitally in the mission-critical environments
- Albemarle will utilize the 5G infrastructure and integrated technology to enhance its hybrid working process and reduce global travel needs by conducting surveys, assists and maintenance activities remotely.

1.3 Use cases – transportation

Transportation companies are leveraging high bandwidth and low latency capabilities of the 5G network to improve operational efficiency and enhance customer experience

Lufthansa Technik

(Private 5G network)

What

- **Lufthansa Technik** has set up two separate industrial grade 5G private wireless networks to test a couple of innovation projects.

How

- Lufthansa Technik will trial inspections of individual engine parts collaboratively over a fast, high-definition video link.

Benefits

- The company's aviation customers can remotely attend the inspection of engine parts and no longer have to travel.

Belfast Harbour

(Private 5G network)

- **Belfast Harbour** and **BT** collaborated to build UK and Ireland's first 5G private network for ports.
- Build a state-of-the-art 5G ecosystem within the port to deliver 5G-led innovations to accelerate the harbour's digital transformation.
- Using virtual reality technology over 5G allowing users to be connected into the same real-time, virtual presentation or training event.

Deutsche Post AG

(Private 5G network)

- **Deutsche Post AG (DHL)** partnered with **BT Group** to technologically transform its connectivity network across 27 operating countries in Europe.
- BT group will design and build a private 5G network and SD-WAN and SD-LAN with Wi-Fi 6 connectivity
- The 5G enabled private network will provide superior flexibility, scalability, security and resilience.

1.3 Use cases – Aerospace and defense

Commercial aerospace companies are moving towards innovative 5G-capable solutions for communications and quick sharing of data

Northrop Grumman

(Private 5G Network)

What

- **Northrop Grumman Corporation** and **AT&T** entered into a collaboration agreement to research and develop a digital battle network to support the US Department of Defence (DoD).

How

- This digital battle network is expected to bring together the high speeds, low latency and cybersecurity protections of private 5G networks.

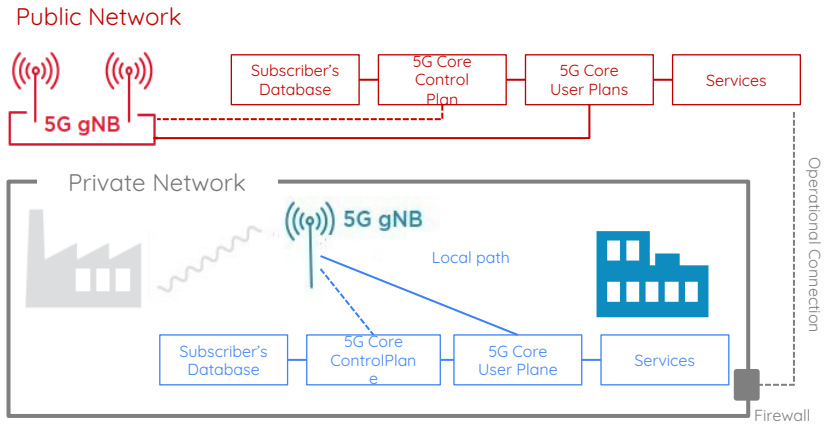
Benefits

- The enhanced connectivity and networking of information that 5G provides are a great advantage in a military environment and will help the DoD in the development of high-performing technologies that quickly share data across lots of secure networks.

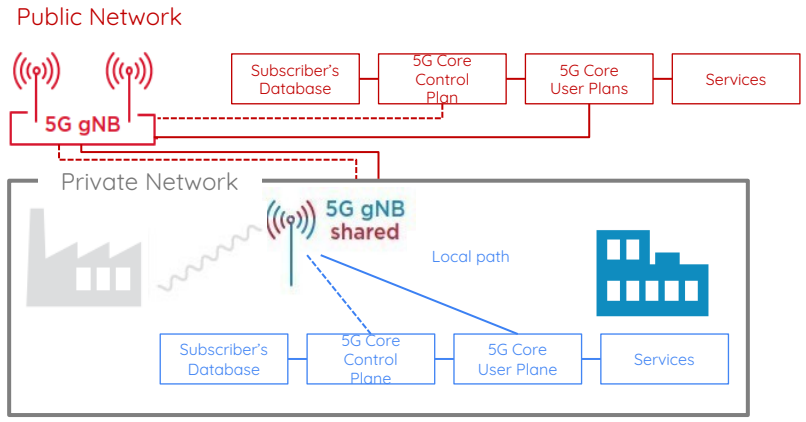
2. Types of 5G private networks

2.1 Types of 5G private networks

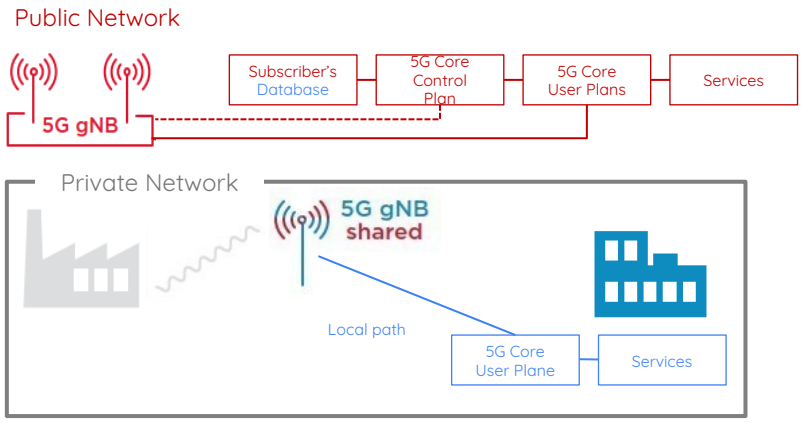
1. Standalone private networks



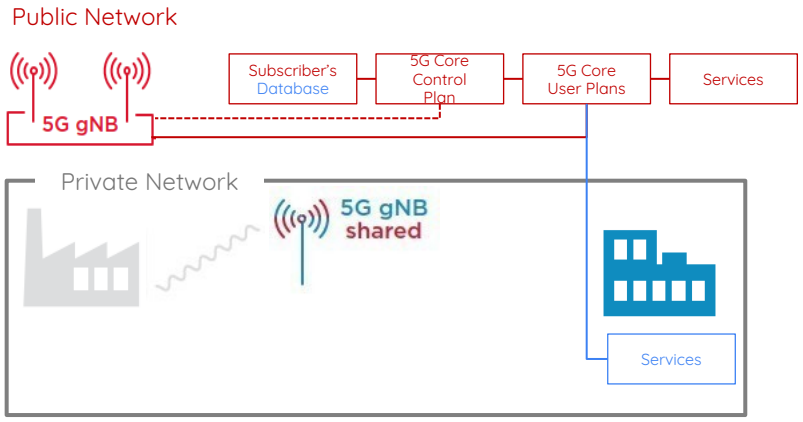
2. Shared RAN



3. Shared RAN and control



4. Virtual slice



There are four main types of 5G private networks:

1) Standalone private networks
2) Standalone private networks with MNO providing shared RAN
3) Public network integrated private networks using RAN and control sharing
4) Public network integrated private networks using end-to-end network slicing

Red icons indicate the system is managed by an MNO and blue icons signify the system is managed by the enterprise. Red and blue colours indicate the component is shared (e.g. shared RAN and database).

Source: 5G – ACIA 5G Non-Public Networks or Industrial Scenarios
GSMA - Private 5G Industrial Networks

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2.2 Comparison of 5G private networks (1/2)

From the point of view of private network users (industry) the standalone private networks gives the most flexibility in network configuration and management however require to maintain the technical competencies and incur higher set-up costs.

Criteria	Standalone private networks	Shared RAN and/or control	Virtual slice
Time to implement	high	low to medium	low
Set up costs for private network user	high	low to medium	low
Competency of private network user	high	medium	low
Data security (ownership)	high	medium	low
Network security	high	high	high
Flexible and adaptable (spatial, capacity, technology)	high	low to medium	low to medium
Configurable for high availability	high	low	low
Configurable for highly time-sensitive applications (TSN)	high	high	low to medium
Monitoring and diagnosis possible for private network user	high	low to medium	low to medium

Source: Federal Ministry for Economic Affairs and Energy - Guidelines for 5G Campus Networks – Orientation for Small and Medium-Sized Businesses, April 2020

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2.2 Comparison of 5G private networks (2/2)

Effort drivers	Standalone private networks	Shared RAN and/or control	Virtual slice
Feasibility study	spatial, legal, organisational requirements	spatial and integration requirements for the MNO and IT	spatial, technical and integration requirements
Legal prerequisites (acquiring a License)	acquiring a frequency License	none	none
Support	direct access to on-site 1st and 2nd level mobile communications and services	2nd level services and 5G core, standard IT support, external service provider	Standard IT support, external service provider
Network planning	radio network, infrastructure, service architecture	integrating and connecting local systems and 5G components, assistance in MNO network planning	integrating local systems, assistance in MNO network planning
Installation and start of operation	Pre-testing and acceptance, installing systems and infrastructure, adopting services	Installing systems and infrastructure, adopting services	adopting services
Integrating into company IT	services and rights management, security	services and rights management, security	rights management, connecting services
Operation	direct access to complete management and service monitoring	SLA monitoring and operating local 5G components	only SLA monitoring

Source: Federal Ministry for Economic Affairs and Energy - Guidelines for 5G Campus Networks – Orientation for Small and Medium-Sized Businesses, April 2020

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3. Frequencies allocation to 5G Private Network

3.1 Frequencies allocation schemes to 5G private network

Approach of providing spectrum to industry users

Dedicated spectrum

- assigning spectrum for exclusive use by industry users
- awarded locally
- license conditions frequently include power restriction and exclusion areas
- “use-it-or-lose-it” terms

Spectrum sharing

- enable several users to access spectrum simultaneously
- enables industry users to access unused (geographically) spectrum allocated to mobile operators, government, military, or satellite operators
- autization and conditions frequently on case-by-case basis

Sub-licencing from mobile operators

- assigning spectrum to mobile operators includig conditions to deliver deliver private networks
- deploy private networks using their network and trought network slicing
- deploy private networks using separate spectrum assets
- lease spectrum to industry users wishing to deploy their own networks

3.2 Mid-band spectrum allocation (1/4)

5G spectrum for local industrial networks

European countries

#	Country	Spectrum (MHz)	LTE/NR band	Bandwidth	Comments
1.	Belgium	3800-4200	n77	TBD	• Considering allocation
2.	Croatia	2570-2620 3400-3480	B38 n78	50 MHz 80 MHz	• Available 2022 • Allocated in 2021 with a licensing/leasing option
3.	Czech Republic	3400-3480 3640-3700	B42/B43/n78	2*20 MHz	• Allocated in 2020 to two MNOs with a leasing option
4.	Denmark	3740-3800	B43/n78	60 MHz	• Allocated in 2021 to MNOs with a leasing option
5.	Finland	2300-2320 3410-3800	B40 B42/B43/n78	20 MHz TBD	• Available 2020 - local access licenses • Allocated in 2018 to MNOs with a leasing option
6.	France	2575-2615 3490-3800 3800-4200	B38 B42/B43/n78 n77	40 MHz 4x50 MHz 100 MHz	• Available 2019 • Allocated in 2020 to four MNOs with a leasing option • Local licenses available on a trial basis from 2019. Trial extended to December 2023
7.	Germany	3700-3800	B43/n78	100 MHz	• Available 2019 - local access licenses

Source: Ericsson White Paper - 5G spectrum for local industrial networks, April 2023
EY research

3.2 Mid-band spectrum allocation (2/4)

5G spectrum for local industrial networks

European countries

No.	Country	Spectrum (MHz)	LTE/NR band	Bandwidth	Comments
8.	Greece	3410-3800	B42/B43/n78	TBD	• Allocated in 2021 to MNOs with a leasing possibility
9.	Netherlands	3410-3450 3750-3800	B42/B43/n78	40+50 MHz	• Available with restrictions. New regulation by 2026.
10.	Norway	3400-3800 3800-4200	B42/B43/n78 n77	TBD	• Allocated in 2021 to MNOs with a leasing option • Available 2022 - local access licenses
11.	Poland	3800-4200	B42/n78	70 MHz	• Available 2023 - local access licenses
12.	Spain	2370-2390 3800-4200	B40 n77	20 MHz TBD	• Available • Considering allocation
13.	Sweden	3720-3800	B43/n78	80 MHz	• Available 2021 - local and regional licenses
14.	UK	1781.7-1785/ 1876.7-1880, 2390-2400, 3800-4200	B3, B40, n77	3+3, 10, 400 MHz	• Available 2019 - local access licenses

Source: Ericsson White Paper - 5G spectrum for local industrial networks, April 2023

3.2 Mid-band spectrum allocation (3/4)

5G spectrum for local industrial networks

Other countries

No.	Country	Spectrum (MHz)	LTE/NR band	Bandwidth	Comments
1.	Brazil	3700-3800	B43/n78	100 MHz	• Allocated in 2022 with a local licensing option
2.	Chile	3750-3800	B43/n78	50 MHz	• Allocation postponed
3.	China	5925-7125	TBD	TBD	• Under investigation
4.	Japan	2575-2595 4600-4900	B41 n79	20 MHz 300 MHz	• Available 2019 • Available 2020
5.	Republic of Korea	4720-4820	n79	100 MHz	• Available 2021
6.	Taiwan	4800-4900	n79	100 MHz	• Considering allocation
7.	US	3550-3700	B48/n48	<150 MHz	• Available 2020
8.	Canada	3800-3980	n/d	n/d	• For commercial MNO operations

Source: Ericsson White Paper - 5G spectrum for local industrial networks, April 2023

3.2 Mid-band spectrum allocation (4/4)

5G spectrum for local industrial networks

Other countries

No.	Country	Spectrum (MHz)	LTE/NR band	Bandwidth	Comments
9.	 UAE	3800-4200	n/d	n/d	• Consultation in August 2021
10.	 Saudi Arabia	3800-4000	n/d	n/d	• MNOs in 2022 4.0-4.2 light licensing; coexistence with FSS
11.	 Egypt	3400-4200	n/d	n/d	• Under consideration
12.	 Laos	3700-4200	n/d	n/d	• Potentially if FSS below is protected
13.	 Vietnam	3800-4200 4400-4500	n/d	n/d	• Not before 2024
14.	 Philippines	3800-4200	n/d	n/d	• In long-term if MNO backhaul migration is done

Source: Ericsson White Paper - 5G spectrum for local industrial networks, April 2023

3.3 High-band spectrum allocation (1/2)

5G spectrum for local industrial networks

European countries

No.	Country	Spectrum (GHz)	NR Band	Bandwidth	Comments
1.	Denmark	24.25-24.65	n258	400 MHz	• Available 2021
2.	Finland	24.25-25.1	n258	850 MHz	• Available 2020
3.	Germany	24.5-27.5	n258	800 MHz	• Available 2021
4.	Greece	26.5-27.5	n258	TBD	• Allocated in 2021 to CSPs with a leasing possibility
6.	Norway	24.25-25.1	n258	850 MHz	• Considering allocation
7.	Spain	24.25 - 24.70	n258	TBD	• Considering allocation
8.	Sweden	24.25-25.1	n258	850 MHz	• Available 2021
9.	UK	24.25-26.5	n258	<2.25 GHz	• Available 2019

Source: Ericsson White Paper - 5G spectrum for local industrial networks, April 2023

3.3 High-band spectrum allocation

5G spectrum for local industrial networks

Other countries

No.	Country	Spectrum (GHz)	NR Band	Bandwidth	Comments
10.	Australia	24.25-27.5 27.5-29.5	n258 n257	50 MHz channels	• Available 2020
11.	Brazil	27.5-27.9	n257	TBD	• Allocated in 2022 with a local licensing option
12.	Hong Kong	27.95-28.35	n257/n261	400 MHz	• Available 2021
13.	Japan	28.2-28.3 28.3-29.1	n257/n261	100MHz 800 MHz	• Available 2019 • Available 2020
14.	Republic of Korea	28.9-29.5	n257	600 MHz	• Available 2021

Source: Ericsson White Paper - 5G spectrum for local industrial networks, April 2023

3.4 European cases (1/8)

Germany

Frequency band

3.3 GHz – 3.4 GHz

Approach of providing spectrum to industry users

Dedicated to industry users - local access Licenses

License terms

- Licenses for the spectrum are allocated based on an application process, where only the owner or leaseholder of the respective premise is entitled to apply
- Licenses could be granted for up to 10 years, with the possibility of renewal until December 2040 at the latest.
- Licenses is granted using 'use-it-or-lose-it' - spectrum must be used within one year of assignment and any transfers must be approved by regulator
- Users must ensure interference-free use, including by coordinating with other geographically near local users and protecting existing users in the band (e.g. FSS earth stations).

License fee

- The License cost is calculated through a simple formula considering the applied-for bandwidth, License duration and coverage area
- A License fee = €1000 + B · t · 5 · (6 · a1 + a2),
- "B" is the bandwidth in MHz - between 10 MHz and 100 MHz in intervals of 10MHz,
- "t" is term of the contract in years;
- "a" is the Surface in km2, whereby there is a difference between residential and traffic areas (a1) and other areas (a2)

Source: GSMA - The Impact of Spectrum Set-Asides on 5G, June 2023
EY research

3.4 European cases (2/8)

UK

Frequency band

3.8– 4.2 GHz band as well as frequencies not assigned to national mobile operators in the 1800 MHz, 2300MHz, and 26 GHz bands.

Approach of providing spectrum to industry users

Dedicated to industry users - local access Licenses

License terms

- Licenses for the spectrum are allocated based on an application process on first-come-first-served basis
- Licenses is granted using 'use-it-or-lose-it'
- Licenses allow for the deployment multiple low-power base stations in a 50m radius, or a single medium-power base station in an outdoor non-urban area.
- Geographical restrictions for medium-power base station

License fee

License fees at £80 / 10 MHz / year

Source: GSMA - The Impact of Spectrum Set-Asides on 5G, June 2023
EY research

3.4 European cases (3/8)

UK

Frequency band

Unused operator-held frequencies

Approach of providing spectrum to industry users

Shared access - local access licenses

License terms

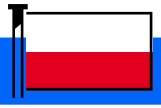
- Local access licenses grant access to licensed mobile spectrum in areas where operators have not deployed it and have no plans
- 3-year license term
- Operators can ask Ofcom to refuse licenses for reasonable objections and their rights to deploy are unaffected, but they must coordinate with the licensee to mitigate disruption

License fee

One-off fee £950 per band and cover a single location or area

Source: GSMA - The Impact of Spectrum Set-Asides on 5G, June 2023
EY research

3.4 European cases (4/8)



Poland

Frequency band

3.8– 4.2 GHz band (where 3800-3900 is reserved for local government units)

Approach of providing spectrum to industry users

Dedicated to industry users - local access

License terms

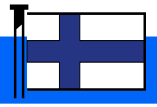
- Each entity may apply for blocks with a width ensuring a multiple of 10 MHz, but not more than 100 MHz in total
- One entity may apply for bandwidth in a maximum of 20 communitie
- Licenses for the spectrum are allocated based on an application process on first-come-first-served basis
- Licenses is granted using ‘use-it-or-lose-it’
- Licenses allow for the deployment of multiple low-power base stations in a 50m radius, or a single medium-power base station in an outdoor non-urban area.
- Geographical restrictions

License fee

- One-off fee – 18 EUR (own-use) / 435 EUR (operators)
- Monthly fees – 22 EUR / 10 MHz / month (urban) – 561 EUR / 10 MHz / month (rural)

Source: GSMA - The Impact of Spectrum Set-Asides on 5G, June 2023
EY research

3.4 European cases (5/8)



Finland

Frequency band

3.4 GHz – 3.8 GHz

Approach of providing spectrum to industry users

- Sub-licencing from mobile operators

License terms

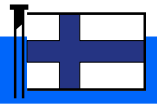
- Obligation for 3500 MHz License holders to:
  a) negotiate private network contracts to deploy a private network that meets the specified customer needs
  b) sub-License 3500 MHz spectrum within the specified area

License fee

Operators can charge reasonable, non- discriminatory fees for these deployments

Source: GSMA - The Impact of Spectrum Set-Asides on 5G, June 2023
EY research

3.4 European cases (6/8)



Finland

Frequency band

20 MHz in the 2300 MHz band and 850 MHz in the 26 GHz band

Approach of providing spectrum to industry users

Dedicated to industry users

License terms

- Licenses dedicated to enterprises as well as research and educational facilities (or the operators providing services for such users)
- 6-year License
- Granted to applicants on a case-by-case basis

License fee

Fees depend on the requested bandwidth and population coverage

Source: GSMA - The Impact of Spectrum Set-Asides on 5G, June 2023
EY research

3.4 European cases (7/8)

3800 MHz – 4200 MHz technical conditions for low power stations

Technical License conditions for low power Shared Access License		
Condition	**UK**	**PL**
Permitted deployment	Indoor and outdoor Outdoor antennas limited to 10m height above ground	Indoor and outdoor Outdoor antennas limited to 10m height above ground
Authorised bandwidth	10, 20, 30, 40, 50, 60, 80 and 100 MHz	10, 20, 30, 40, 50, 60, 80 and 100 MHz
Maximum base station power (EIRP)	24 dBm / carrier for carriers ≤ 20 MHz; or 18 dBm / 5 MHz for carriers > 20 MHz	21 dBm - 10 MHz, 24 dBm – 20MHz, 26 dBm – 30MHz, 27 dBm – 40 MHz, 28 dBm – 50MHz, 29 dBm – 60/70 MHz, 30 dBm – 80 MHz, 31 dBm – 90/100 MHz
Maximum terminal station (TRP for mobile/nomadic; EIRP for fixed	28 dBm	28 dBm

3.8-4.2 GHz base station out of channel emission limits	
Frequency offset	**Maximum mean EIRP density**
-5 to 0 MHz offset from lower channel edge 0 to 5 MHz offset from upper channel edge	(Pmax - 40) dBm / 5 MHz EIRP per antenna
-10 to -5 MHz offset from lower channel edge 5 to 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Out of block baseline power limit (BS) < -10 MHz offset from lower channel edge > 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna

3.8-4.2 GHz base station out of band emission limits	
Frequency offset	**Maximum mean EIRP density**
3795 MHz-3800 MHz 4200 MHz-4205 MHz	(Pmax - 40) dBm / 5 MHz EIRP per antenna
3760 MHz-3795 MHz 4205 MHz-4240 MHz	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Below 3760 MHz Above 4240 MHz	-2 dBm / 5 MHz EIRP per antenna

Source: EY research

3.4 European cases (8/8)

3800 MHz – 4200 MHz technical conditions for mid power stations

Technical License conditions for low power Shared Access License		
Condition	**UK**	**PL**
Permitted deployment	Rural areas	Indoor and outdoor Outdoor antennas limited to 20m height above ground
Authorised bandwidth	10, 20, 30, 40, 50, 60, 80 and 100 MHz	10, 20, 30, 40, 50, 60, 80 and 100 MHz
Maximum base station power (EIRP)	42 dBm / carrier for carriers ≤20 MHz; or 36 dBm/5 MHz for carriers > 20 MHz	39 dBm - 10 MHz, 42 dBm – 20MHz, 44 dBm – 30MHz, 45 dBm – 40 MHz, 46 dBm – 50MHz, 47 dBm – 60/70 MHz, 48 dBm – 80 MHz, 49 dBm – 90/100 MHz
Maximum terminal station (TRP for mobile/nomadic; EIRP for fixed	28 dBm TRP 35 dBm / 5 MHz EIRP	28 dBm
Geographical restrictions	Yes	Yes

3.8-4.2 GHz base station out of channel emission limits	
Frequency offset	**Maximum mean EIRP density**
-5 to 0 MHz offset from lower channel edge 0 to 5 MHz offset from upper channel edge	(Pmax - 40) dBm / 5 MHz EIRP per antenna
-10 to -5 MHz offset from lower channel edge 5 to 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Out of block baseline power limit (BS) < -10 MHz offset from lower channel edge > 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna

3.8-4.2 GHz base station out of band emission limits	
Frequency offset	**Maximum mean EIRP density**
3795 MHz-3800 MHz 4200 MHz-4205 MHz	(Pmax - 40) dBm / 5 MHz EIRP per antenna
3760 MHz-3795 MHz 4205 MHz-4240 MHz	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Below 3760 MHz Above 4240 MHz	-2 dBm / 5 MHz EIRP per antenna

Source: EY research

4. 5G Private Networks frequency standardisation at EU level

4.1 Feasibility and the shared use of 3.8-4.2 GHz band

The 5G represents a great opportunity for increasing the income and will connect millions of devices worldwide at high speed and low latency, allowing the realization of advanced projects such as connected cars, the Internet of Things, Smart Cities and Smart Homes of new generation.

Two Tasks under the EC mandate

Task 1:

- Feasibility and sharing studies on the shared use of the band - **February 2024**
  - Agree on parameters for studies – April 2023
  - Preliminary study results – September 2023
  - Preliminary study results – February 2024

Task 2

- Harmonised technical conditions for the shared use of the band – **November 2024**

Technical conditions should consider sharing solutions, including innovative features for:

- **Protection** and **future evolution** of incumbents (FSS, FL)
- **Coexistence with 5G** in 3.4-3.8GHz and radio altimeters in 4.2-4.4 GHz