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Spectrum availability: the key to Private 5G Networks adoption

Foreword

The allocation of 4G frequencies dedicated to businesses in band 38 (2.6 GHz TDD) in France from 2019 and the arrival of the first private 5G frequencies in the United States and Germany have demonstrated the value of "private" cellular networks in facilitating the development of Industry 4.0.

Although necessary, the allocation of a specific frequency band in a country is nevertheless not enough to see projects emerge if it is not accompanied by a genuine ecosystem to deploy them and prospects for a return on infrastructure investment in the short or medium term. After all, what would be the point of a splendid 5G private radio network if there were no IoT equipment to connect, or if it was too expensive because of the low production volumes involved?

With this in mind, it became clear that it was necessary to have as many users of a frequency as possible, in order to reduce the price of terminals and associated components (chipsets, routers, modems or the radio part of the infrastructure) to competitive levels and thus increase the ROI of projects. It is therefore vital for the industry that this harmonisation of private 5G radio frequencies is achieved quickly.

This is both the ambition and the main purpose of EUWENA (European Users Wireless Enterprise Network Association), which already has 40 members after 2 years in existence. With EUWENA, we are working to broaden and facilitate access to private frequencies for European businesses, enabling them to roll out their own cellular networks.

Without a solid ecosystem and the harmonisation of frequencies at European and global level, many industrial players will not be able to make the transition to digital, limiting their capacity for innovation, recruitment and international growth.

Christian REGNIER
Co-Founder & Chairman of EUWENA

EUWENA

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Introduction

Industries are increasingly depending on connectivity to support the implementation of data driven technologies within their plants, factories, and campuses. However, to fully leverage the benefits of digitization, businesses need reliable connectivity solutions that can support the increasing demand for real-time data, analytics, and automation. Wi-Fi or public cellular networks operated by mobile carriers may not always be the optimal solution for these companies, due to challenges such as coverage or bandwidth limitation, security, and cost.

As a result, many industries are opting to deploy Private 5G Networks which offer several advantages over public cellular networks, as they can be customized to meet the specific needs of industrial environments, providing a robust and reliable foundation for digital solutions. This Private 5G Networks market is rapidly growing, fueled by pioneering countries that have liberalized access to cellular spectrum. Following this trend, more countries are starting to ease restrictions, enabling private players to act as their own network operators. However, two primary challenges remain:

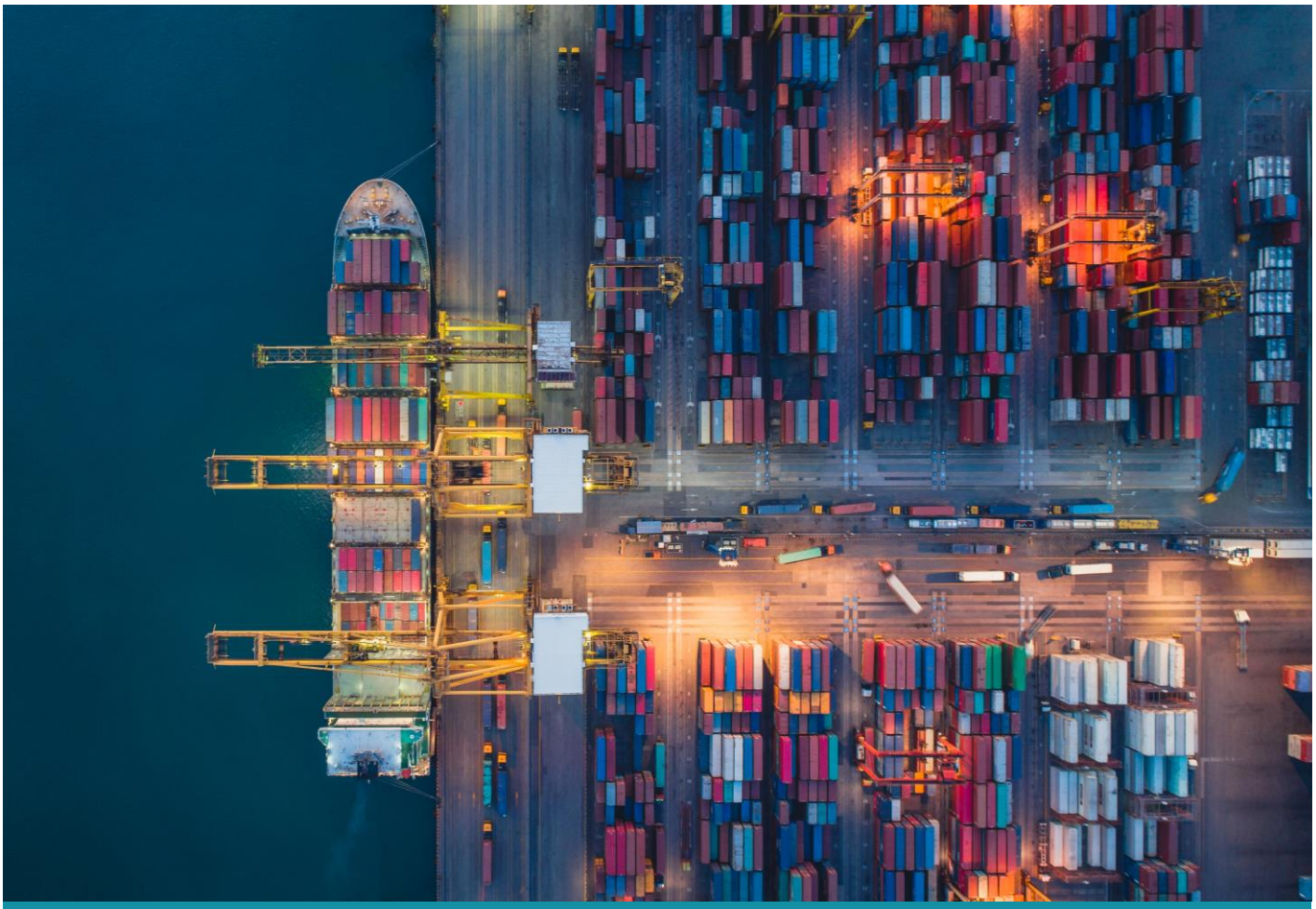
- **Expansion of the trend**: There is a need to encourage more countries worldwide to adopt this approach and open up private spectrum frequencies. The goal is to create a global momentum where private network access becomes a standard option.

- **Harmonization of frequencies**: It is crucial to standardize these frequencies to streamline deployments. A harmonized approach will prevent the emergence of overly complex, heterogeneous solutions that pose significant challenges for multinational corporations.

The objective of this paper has been to demystify the contemporary landscape of private spectrum allocation, tracing the process from initial attribution to a detailed, country-by-country mapping. It is designed to serve as a valuable resource for:

- **Deployment facilitation**: Assisting stakeholders in deploying international solutions by providing a clear understanding of the global variance in private spectrum accessibility.

- **Advocacy for access**: Offering substantiated rationale for the advocacy of open access to frequencies for private networks, emphasizing the need for a harmonized approach to ensure consistency and efficiency across borders.



1. Spectrum is key to Private 5G Networks growth

The radio spectrum is the network frequency band over which wireless communications take place. As such, it should be considered primarily in any private cellular network projects. To operate a private cellular network, one needs access to a certain width – or quantity – of spectrum bands to transmit and receive data. Each device (modem) is compatible with selected network bands.

Here are different factors impacting the private cellular network deployment:

- **Spectrum bands:** Different bands of the spectrum have different characteristics and can be used for different types of communication. Some bands may be more suitable for private cellular networks based on the required range, capacity, and other factors such as indoor / outdoor usage and considering the targeted devices.

- **Spectrum availability:** The availability of spectrum can vary depending on the location and the type of service being provided. In some cases, there may be a limited spectrum available at a given location, which can impact the feasibility and cost of deploying a private cellular network.

- **Spectrum licensing:** In many countries, spectrum is managed by government agencies and is allocated through a licensing process. This process can be complex and may involve fees or other regulatory requirements. Government agencies most frequently decide to either allocate spectrum ranges for private use cases or to have mobile network operators (MNOs) resell them. However, not every country has allocated a dedicated spectrum for private networks yet.

- **Spectrum costs:** The cost of acquiring and using spectrum can vary depending on the band and location. In some cases, the spectrum may be sold through auctions or other mechanisms, which can impact the overall cost of deploying a private cellular network.

Spectrum is a critical consideration when planning a private cellular network, as it will impact the performance, cost, autonomy, and feasibility of the deployment.

2. Different spectrums allocation

There are several options for spectrum bands that can be used for private cellular networks:

- **Unlicensed spectrum**: Unlicensed spectrum is not allocated by regulatory agencies and is typically used for short-range communication such as Wi-Fi, LoRa, and Bluetooth. License-exempt bands such as 5GHz or 6GHz allow users to access spectrum on a license-exempt basis. Unlicensed spectrum can be less expensive and more flexible than licensed spectrum, but it may not be suitable for all types of private networks due to its limited range and uncontrolled nature thus high potential for interference with other users.

- **Shared spectrum**: Shared spectrum is a type of spectrum that is shared between different users, typically through a dynamic spectrum access (DSA) system, which is a technology that enables multiple users - typically of a geographically confined nature - to share the same radio frequency band simultaneously and dynamically in a coordinated and efficient manner to improve spectrum utilization, reduce the costs and increase the availability of the spectrum. This can include both licensed and unlicensed spectrum and can be used to support a variety of different types of communication. A shared spectrum can be a good option for private networks in certain situations, but it may not be as reliable or predictable as some other spectrum options due to the potential for interference from other users. An example of this is the General Authorized Access (GAA) for the Citizens Broadband Radio Service (CBRS) in the US.

- **Leased spectrum**: Leased spectrum is a type of licensed spectrum that is leased to a user by a party with dedicated spectrum rights such as a mobile operator for a specific period. It can be a good option for private networks that need a guaranteed amount of spectrum temporarily, such as for a special event or temporary coverage area. However, a leased spectrum can be more expensive than a dedicated spectrum and may not be available in all locations.

- **Dedicated spectrum**: Dedicated spectrum is a type of licensed spectrum that is allocated to a specific user or organization on a long-term basis through an application process. It can provide a high level of quality and reliability for private networks, but it can also be expensive to acquire and may require a long-term commitment. It is typically the type of spectrum for enterprises acquired by a Public Network operator.

- **Localised spectrum**: Different from standard dedicated spectrum usually done for the public network operators, the opportunities from private networks are often discussed in terms of the new use cases and applications they enable. To use spectrum efficiently, some regulators are offering spectrum to non-traditional players for private networks to support localized 5G applications.

Overall, the best spectrum allocation solution for a private network will depend on the specific requirements and constraints of the deployment, including the desired range, capacity, and level of quality and reliability.

	Unlicensed spectrum	Shared spectrum	Leased spectrum	Dedicated spectrum
	Spectrum is available on a first-come, first-served basis	Spectrum is shared among multiple entities	Enterprises lease spectrum from public network operators	Awarded to through an application process
Fit for private networks	Partial (interference issue)	Partial (potential interference issue)	Temporary private networks (guaranteed amount of spectrum)	Yes
License	No	Both licensed and unlicensed	Yes	Yes

3.
Private Cellular Networks spectrum in the world

3.1. EUROPE

In Europe, spectrum regulation for private networks is governed by the European Union (EU) and its member states. The EU has established several policies and guidelines for the allocation and use of spectrum, including for private networks.

Mobile operator Transatel NTT joined pan European user association EUWENA, to work together with the private cellular network's ecosystem. EUWENA acts as a catalyst for the wider adoption of feature-rich private mobile networks across Europe, it advocates a sufficient, accessible, affordable, harmonized spectrum and promotes an open, multi-vendor approach to advanced services and applications running in these networks. EUWENA's goal is to make the adoption of such solutions as easy as possible for the widest market, thereby creating enhanced and sustained value for enterprises and the wider society.

Some of the key ongoing trends in spectrum regulation for private networks in Europe include:

- **5G spectrum**: The EU has allocated several spectrum bands for the deployment of 5G networks, including the 700 MHz, 3.6 GHz, 26 GHz, and 70/80 GHz bands. These bands are being made available through a variety of mechanisms, including auctions and administrative allocation.

- **Shared spectrum**: The EU has also encouraged the use of shared spectrum to increase the efficiency and utilization of spectrum resources. This can include the use of dynamic spectrum access (DSA) systems or other mechanisms to allow multiple users to share the same spectrum band.

- **Industrial, scientific, and medical (ISM) bands**: The EU has designated several ISM bands for unlicensed use, including the 2.4 GHz and 5.8 GHz bands, which are commonly used for Wi-Fi and other short-range communication. These bands are available on a first-come, first-served basis and can be used by anyone without the need to acquire a license.

- **Licensed exempt (LE) spectrum**: The EU has also introduced a new category of the spectrum called Licensed Exempt (LE) spectrum, which is designed to be used by low-power devices such as sensors and Internet of Things (IoT) devices. This spectrum is available on a first-come, first-served basis and does not require a license, but it is subject to certain technical and operational rules. An example of this usage is the 868 MHz spectrum intended for LoRa and other IoT protocols.

Overall, the EU is working to ensure that spectrum resources are used efficiently and effectively to support the deployment of private networks and other communication services. EUWENA is trying to harmonize that work to ease deployments across Europe and to provide end users with wider options.
There are several options for spectrum bands that can be used for private cellular networks:

3.2. USA

In the United States, spectrum regulation for private networks is governed by the Federal Communications Commission (FCC), which is responsible for allocating and regulating the use of spectrum.

Some of the key ongoing trends in spectrum regulation for private networks in the United States include:

- **5G spectrum**: The FCC has allocated several spectrum bands for the deployment of 5G networks, including the 600 MHz, 2.5 GHz, and 28 GHz bands. These bands are being made available through a variety of mechanisms, including auctions and administrative allocation.

- **Citizens Broadband Radio Service (CBRS) spectrum**: This spectrum is in the 3.5 GHz band, specifically in the 3,550-3,700 MHz range, is a shared spectrum band that allows for the use of small cells and other wireless devices by both licensed and unlicensed users. It is known as "shared spectrum" and it is managed by a Spectrum Access System (SAS) that ensures that different users do not interfere with each other.

- **Unlicensed spectrum**: The FCC has designated several bands of spectrum for unlicensed use, including the 2.4 GHz and 5.8 GHz bands, which are commonly used for Wi-Fi and other short-range communication. These bands are available on a first-come, first-served basis and can be used by anyone without the need to acquire a license.

The FCC is working to ensure that spectrum resources are used efficiently and effectively to support the deployment of private networks and other communication services in the United States.

3.3. ASIA

Spectrum regulation for private networks in Asia varies depending on the country and the specific spectrum bands being used. In general, most countries in Asia have established regulatory agencies that are responsible for allocating and regulating the use of spectrum, including private networks.

Some of the key ongoing trends in spectrum regulation for private networks in Asia include:

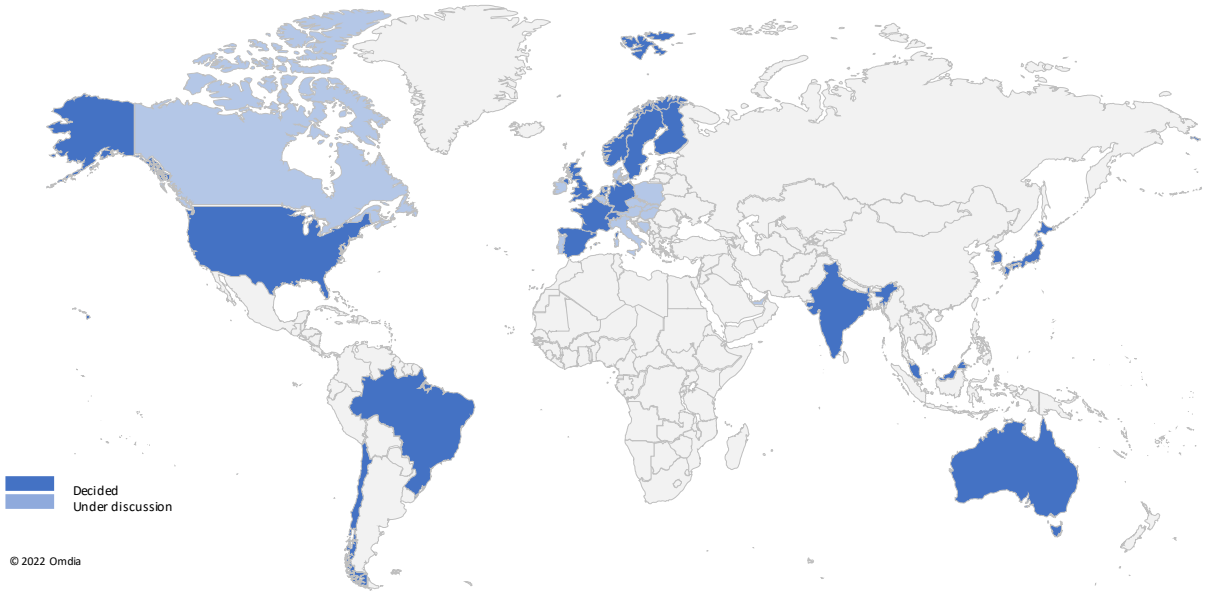
- **5G spectrum**: Many countries in Asia have allocated several bands for the deployment of 5G networks, including the 3.5 GHz, 4.9 GHz, and 28 GHz bands. These bands are being made available through a variety of mechanisms, including auctions and administrative allocation.

- **Shared spectrum**: Some Asian countries have also encouraged the use of shared spectrum to increase the efficiency and utilization of spectrum resources. This can include the use of dynamic spectrum access (DSA) systems or other mechanisms to allow multiple users to share the same spectrum band. Among the largest country to implement such a solution is India.

- **Unlicensed spectrum**: Many countries in Asia have designated several bands of spectrum for unlicensed use, including the 2.4 GHz and 5.8 GHz bands, which are commonly used for Wi-Fi and other short-range communication. These bands are available on a first-come, first-served basis and can be used by anyone without the need to acquire a license.

Overall, regulatory agencies in Asia are working to ensure that spectrum resources are used efficiently and effectively to support the deployment of private networks and other communication services.

Private Network Spectrum allocated per local regulator



4.
Key spectrum takeaways

4 Key Spectrum takeaways

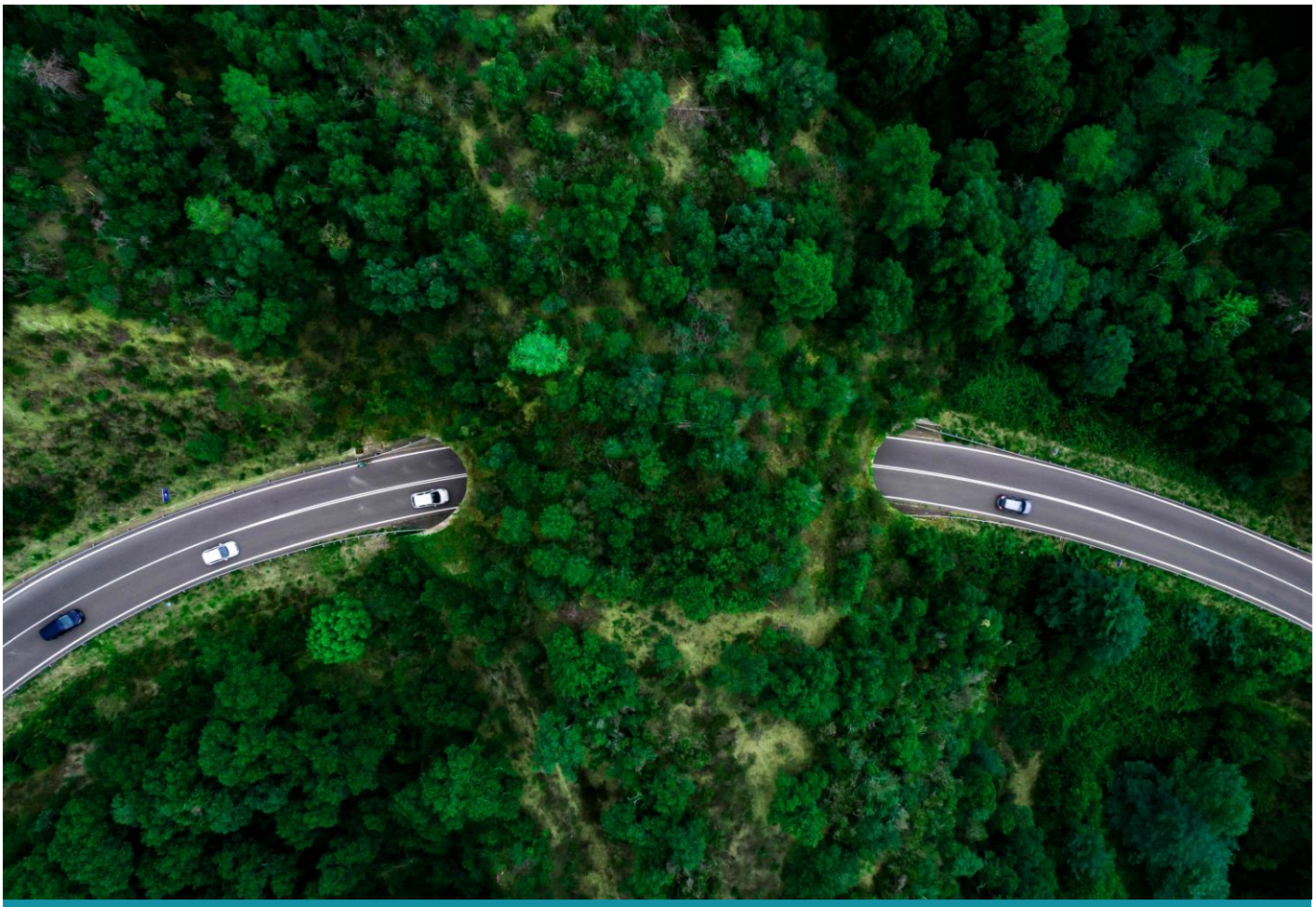
1. Spectrum is the frequency band over which wireless communications take place. It is a critical consideration when planning a private network, as it will impact the performance, cost, autonomy, and feasibility of the deployment.

2. There are several options for spectrum bands that can be used for private networks, including licensed spectrum, unlicensed spectrum, shared spectrum, and leased spectrum. The best option will depend on the specific requirements and constraints of the deployment.

3. Spectrum regulation for private networks can vary depending on the location and the type of spectrum being used. In many countries, spectrum is managed by government regulatory agencies, which are responsible for allocating spectrum to different users and enforcing compliance with spectrum rules and regulations. Private spectrum is not harmonised across countries other than the homogeneous CBRS band in the USA, which calls for caution when deploying

4. Several ongoing trends in spectrum regulation may impact private networks, including the allocation of spectrum for 5G networks, the use of shared spectrum, and the expansion of unlicensed and ISM bands.

It is important for enterprises planning to deploy a private network to be aware of the spectrum options and regulatory considerations that may impact their deployment, in order to make informed decisions about the best spectrum solution for their needs.



5. Bridging the gap between Private & Public 5G Networks

85% **of large enterprises see roaming with the public network as "important" or "very important" ("OMDIA - 2022 - Private LTE and 5G Network Enterprise Survey Insight 2022 – Drivers, Technologies, and Applications").** This should not come as a surprise given the higher number of sites and larger size of the workforce (likely more dispersed compared to smaller enterprises). A seamless continuity of service between private networks and public connectivity is essential, particularly in scenarios where mobility transcends the bounds of isolated private network coverage.

Mobility solutions ensure continuity of service and maximize operational efficiency in several key areas:

- **Workforce Mobility**: Employees often require uninterrupted access to communication and data services as they transition from areas covered by the private network to those served by public networks. The ability to utilize public services "on the go" is crucial for maintaining productivity and ensuring constant communication.
- **Connected Vehicles and Commodities**: The increasing integration of connectivity within vehicles and transported goods necessitates a reliable public network connection when these assets move beyond the private network's coverage, such as when leaving the assembly line. This connectivity is vital for real-time monitoring and the delivery of telematics data.
- **Logistical Coordination**: Logistics personnel rely on public networks to track the movement of goods during transit. The vast quantities of data generated and transmitted by these assets, once they return to the private network's coverage area, can offer valuable insights for inventory management, route optimization, and overall supply chain efficiency.

Two technical families of solutions exist :

- **Roaming interconnection**: standard solution to interconnect public networks. Solution not always appropriate to Private Network
- **SIM based solutions**: ease to benefits from the connectivity of public operator once traveling outside the coverage of the Private Networks without making any concession on the private network side.

" Service continuity across private and public networks is essential for large businesses. It's crucial to find a method that maintains this continuity, breaking through the typical restrictions of private cellular networks for corporate users. Transatel offers a significant innovation in this area with its SIM-based solution, facilitating seamless connectivity. "

Florian VALTER
Private 4G/5G Networks Business Manager
Transatel | NTT

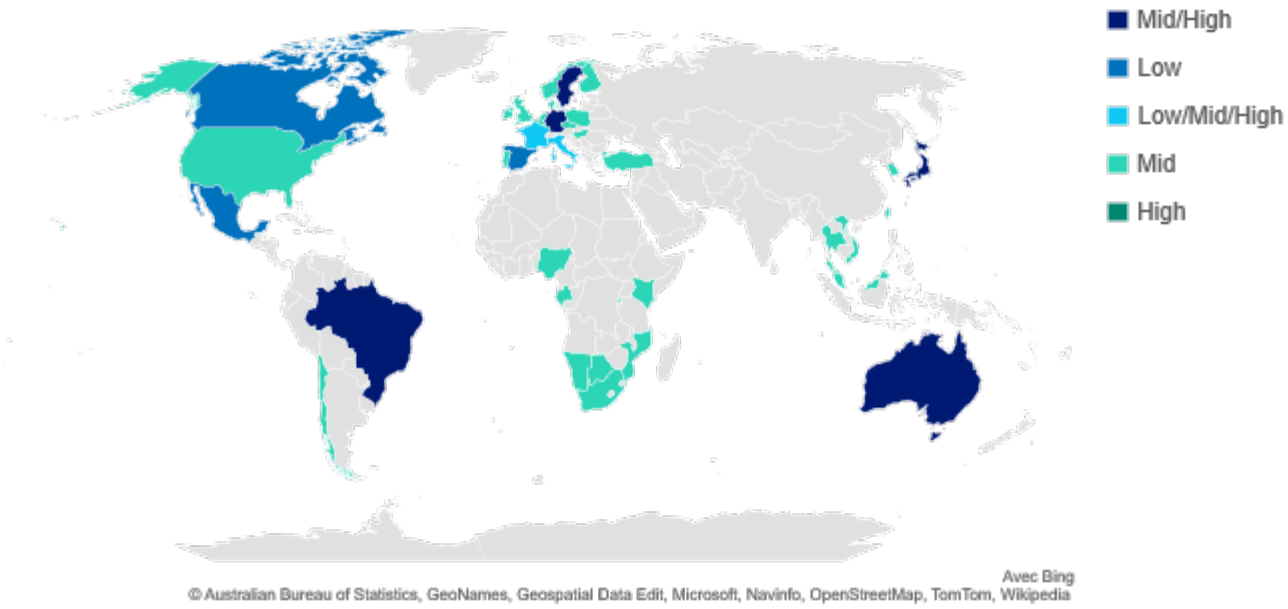
6.
How to choose your device: what bands in which country?

For every country, the regulators can distribute spectrum range for the private networks at the different levels inside the table of wavelengths. Usually, the 5G ranges are divided into these subranges' groups:

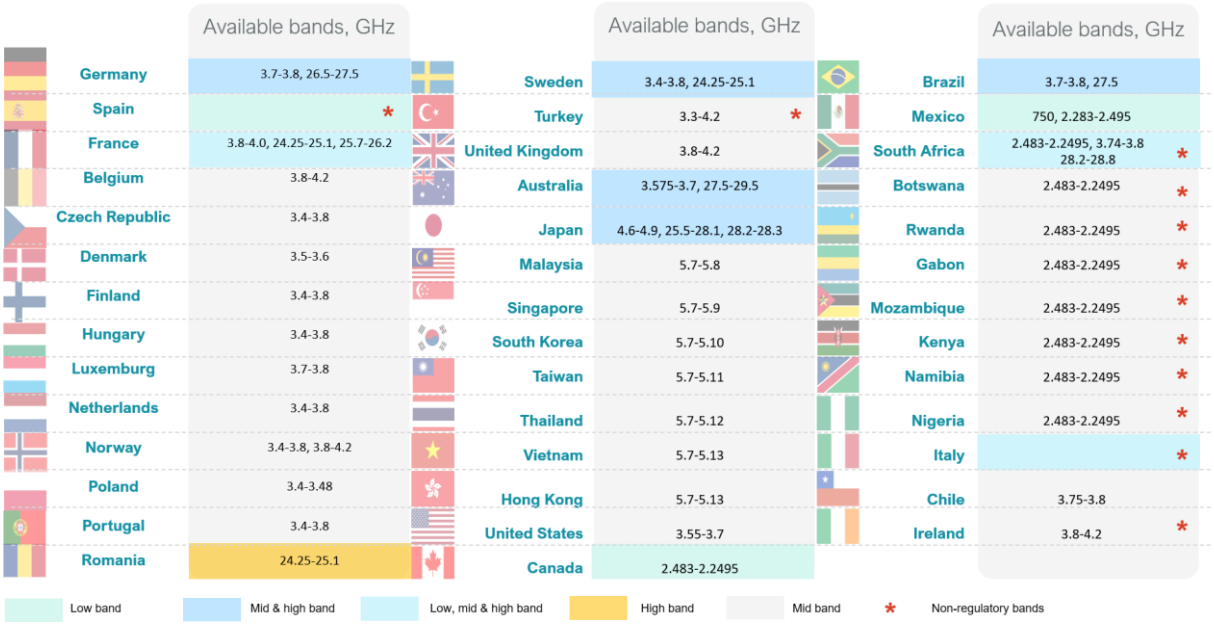
- **Low Band (MHz)**: Band is usually subdivided between 700MHz (B28/n28), 2483MHz (B53), and 2570MHz (B38).
- **Mid Band (GHz)**: Band is usually subdivided between 3.55-3.7GHz (n48), 3.3-3.8GHz (n78) , 3.3-4.2GHz (n77), 4.6-4.9GHz (n79), 5.7-5.8GHz (unlicensed).
- **High Band (GHz)**: Band is usually subdivided between 24-27GHz (n258), 26-29GHz (n257), 27-28GHz (n261).

The device characteristics are taken into consideration to ensure connectivity: there is the need to have an exact match between the frequency band broadcasted by the private core network and the supported frequency of the modem within a device. Mobile phone frequencies are usually within the RF spectrum between 600MHz and 39GHz.

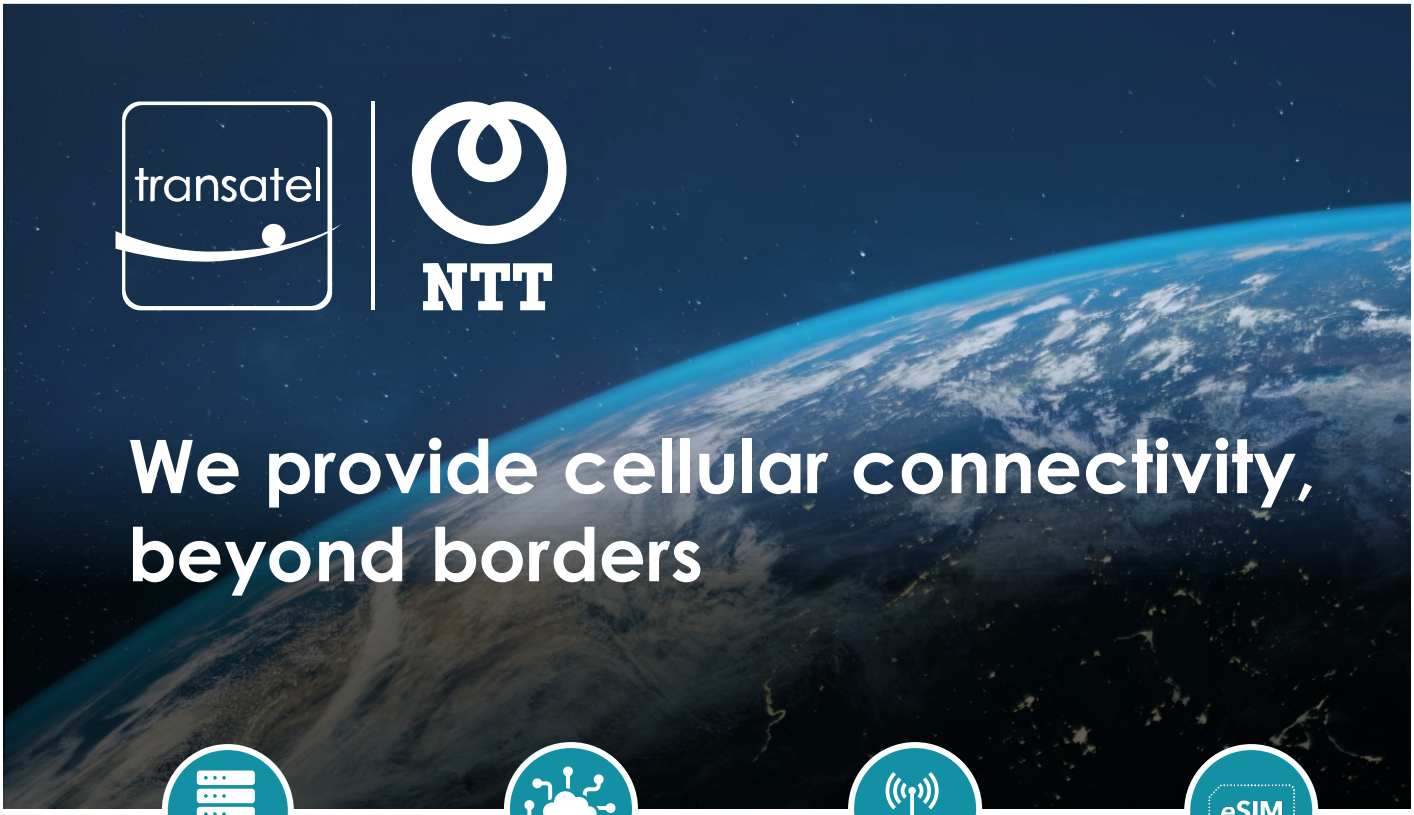
Private Network bands around the world



Devices need to be selected carefully to allow connectivity onto the corresponding range of the spectrum. Device availability for a particular band tends to lag behind the availability of network equipment. For international projects, devices need to fit with multiple frequency ranges to connect to different local networks with different regulations and frequency ranges.



Simplified map of frequency bands available around the world. It highlights the diversity of frequencies and associate countries having allocated a low-frequency band / Mid frequency / High frequency in the spectrum table for private 5G. The frequency ranges need to be selected carefully device per device depending on geographical objectives.



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Transatel (a subsidiary of NTT and member of EUWENA) is a global cellular connectivity solutions provider and a leading Mobile Virtual Network Operators Enabler with over 100 MVNOs managed on its own full core network. Pioneer of M2M connectivity, Transatel simplifies worldwide IoT deployments through a single integration to its connectivity management platform by leveraging LTE-M, 3G, 4G, and 5G network access agreements with hundreds of international mobile carriers and regional infrastructures. Today, Transatel global SIM / eSIM securely connects millions of vehicles, industrial and consumer devices to public and private cellular networks across the world for clients such as Airbus, Stellantis, and Jaguar Land Rover. Transatel also provides global cellular data connectivity for international travelers and distributed workforce through its Ubigi eSIM solution.

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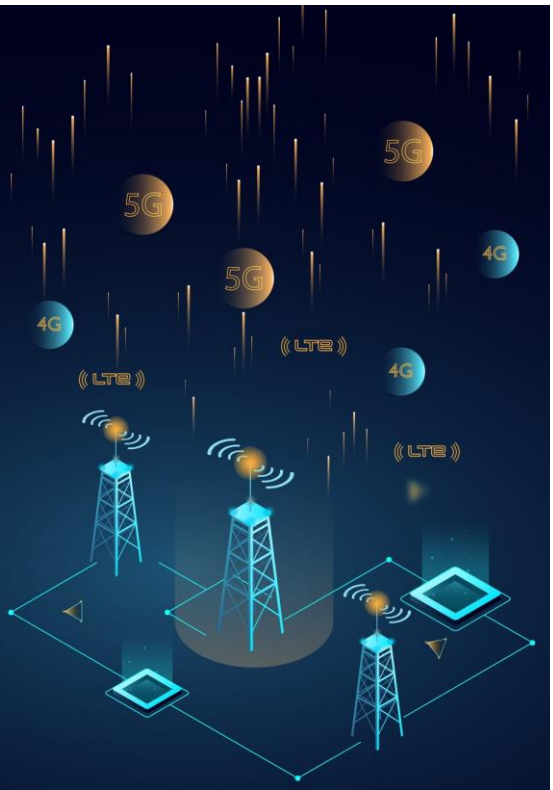
EUWENA

EUROPEAN USERS WIRELESS ENTERPRISE NETWORK ASSOCIATION



EUWENA (European Users Wireless Enterprise Network Association) was set up in April 2021, following a series of parallel conversations during early 2021 between private mobile networks pioneer, Christian Regnier, and critical communications industry experts, Peter Clemons and Koen Mioulet, who recognised the urgent need for a European-level initiative to promote the greater uptake of 3GPP-based private mobile networks. Christian, Peter and Koen were joined from the beginning by Antoine van der Sijs, Christopher Gehlen, Kerim Agdaci, Shaun McGinley and Thomas Hervieu, with the support and attendance of Tony Boyle and Johann Schmid at the inaugural meeting in March 2021. The founding members all share EUWENA's common values and goals and represent companies from across Europe: AirFrance, Privinnet, Transatel and LD expertise (France), Quixoticity (United Kingdom), ULWIMO and Strict (Netherlands), Sigma Wireless (Ireland), Opticoms (Germany) and Neutroon (Spain), as well as industry associations, AGURRE (France) and KMBG (Netherlands). It is expected that many more companies and associations will become a part of EUWENA over the coming months and years.

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