Market Insights

"At the Mobile World Congress (MWC) Barcelona 2024, O-RAN ALLIANCE participants are showcasing advanced solutions to improve RAN (radio access network) performance." [1]

At MWC Barcelona 2024, O-RAN ALLIANCE (Open Radio Access Network) participants presented 41 demonstrations of the latest O-RAN technologies and solutions to improve radio access network (RAN) performance. These smart solutions demonstrate capabilities aimed at improving RAN performance, including enhanced interoperability, security, and efficiency. The growing maturity of the O-RAN ecosystem is reflected in many demonstrations focused on O-RAN1 integration and testing enhancements."

Analysis of the Fundación Valenciaport

The **term 5G** refers to the fifth **generation of mobile telephone technologies**, currently commercially available in many countries. This technology has outstanding features such as **transmission speeds** of up to **10 Gbps**, **latencies below 10 ms**, and a **reliable connection 99.99%** of the **time**. Operating in three regions of the radio spectrum (low, medium and high), 5G performance varies depending on the band used. For example, while the low band offers greater coverage, the high bands provide wider bandwidths and reduced latencies, albeit with limited coverage that requires a greater number of antennas for deployment.

The flexible architecture of the 5G network, known as "slicing", **allows** it to **adapt** to **different applications** by allocating specific resources to particular users, groups of users or services. This flexibility paves the way for the **development** of **private 5G networks**, especially in **industrial environments**, offering an alternative to WiFi networks in unlicensed bands. Despite its potential, industrial **adoption** of 5G is **challenged** by **spectrum availability** and **technology development**. The release of spectrum by the authorities and the evolution towards ***Standalone*** (SA) **architectures** are opening up new opportunities for 5G deployment in the industry, which is expected to significantly transform the technology landscape in the coming years.

- Nowadays, **ports** are **fundamental** for **international trade**, so the **development** and **improvement** of their **infrastructures**, both **physical** and **digital**, are **key** aspects of their strategies. The latest technologies offer opportunities to make shipping and port operations more sustainable, improving their performance and efficiency.

  In this sense, 5G technology plays a crucial role in the logistics-port environment, with various use cases, among which the following stand out:

[1] Original news published by "O-RAN Alliance" and available at: *https://www.o-ran.org/news-and-events*

- **Remote control of autonomous and guided robots (AGVs):** A real-time, low-latency, high-bandwidth wireless connection is required to control these robots, which capture and process video and images.
- **Autonomous operation, monitoring of port vehicles and machinery:** 5G technology offers ultra-reliable real-time connections, enabling precision device positioning and connectivity of up to one million devices per square kilometer.
- **Surveillance and recognition through real-time video processing**: 5G enables real-time, high-quality video and image processing, as well as the use of Machine Learning and Deep Learning algorithms in devices or Edge Computing.
- **Vessel docking assistance:** The combination of 5G technology with UWB radars ensures the safety and accuracy needed to assist ship docking, enabling near real-time collection and processing of location and movement data.
- **Drones:** 5G technology enables beyond line-of-sight operations between the drone and its controller, facilitating high-definition video streaming, real-time fleet management and the incorporation of advanced artificial intelligence algorithms in Edge Computing. It also allows V2X communication between drones and other actors within the port environment. Research is currently being carried out with drones in airspace as well as with semi-submersible and submersible devices, all of them with sonar technology to obtain information underwater.

Without a doubt, these use cases demonstrate the potential of 5G technology to transform port operations, improving efficiency, safety and sustainability in shipping and port logistics.

O-RAN within 5G

Nowadays, the **deployment** of **5G SA networks** is **conditioned** to the **provider** chosen for the **devices** that **compose** it, since both *hardware* and *software* have closed architectures that can hardly be combined with other providers. In order to be able to expand the networks and even improve them, the **concept** of **O-RAN**, the **Open Radio Access Network**, appears. This new concept of access networks **proposes** the **elimination** of the **rigid and closed architectures from the past**, which were linked to the architecture of the providers of infrastructure. O-RAN **opens** the **door** to a world of **possibilities**, where **different providers** can **collaborate**, where ***hardware*** and ***software*** are **harmonized**, and where **innovation advances exponentially**.

This new concept provides unprecedented **flexibility**, in which you can **choose** the **components** that **best suit** your **specific needs**, without being tied to a single supplier. It also enables new networks to be deployed easily and simply, **adapting** the infrastructure to **changing market demands** in **real time**. In terms of **efficiency**, these networks make it possible to **optimize resources**, **reduce costs** and **maximize performance**. On the other hand, they provide **armored security** by protecting the network with multiple layers of security, eliminating dependence on a single provider and securing data in a simple and efficient way. **Vodafone**, **Deutsche Telekom** and **China Mobile** are already adapting their networks to **O-RAN** architectures.

Comparison of 5G with WIFI6 and 4G

When planning the **deployment** of a **5G network**, there are several **mature technologies**, which, together with 5G, emerge as potential candidates to initially address the identified use cases and meet their requirements. These alternative technologies are **4G and WiFi 6**.

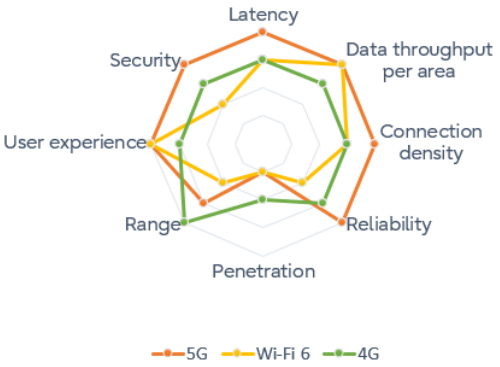
5G has revolutionized mobile communications, offering a number of **significant advantages over** its predecessor, **4G**. Firstly, 5G **download speeds** are **astonishingly fast**, reaching speeds of gigabits per second. This means that **downloads** are practically **instantaneous**, and the **transmission** of **Ultra High Definition (UHD) content** is **smooth** and **uninterrupted**.

In addition, **latency**, known as the delay caused by the propagation delay, is drastically **reduced** with **5G**. While latency in 4G networks is typically around 30 to 50 milliseconds, with 5G it can be as low as **1 millisecond** under ideal conditions. This is **crucial** for **applications** that **require instantaneous responses**, such as **remote control** of **machinery** and **autonomous navigation**.

In terms of **security**, 5G takes **data protection** to a new level. It uses advanced **encryption** and **authentication** technologies to **ensure** that **communications** are **protected** against **cyber threats**. In addition, 5G is designed to be **highly reliable** and **available**. It uses techniques such as **path diversity** and **multiband access** to **ensure stable connectivity** even in densely populated environments or areas with adverse conditions.

The previously mentioned advantages of 5G make it the **ideal choice** for **port logistics environments**, where **instant communications**, **real-time video transmission** and **robust data security** are **required**.

Illustration 1. Comparison between 5G, 4G and WiFi 6



	5G	Wi-Fi 6	4G
Latency	4	3	3
Data thoughput per area	4	4	3
Connection density	4	3	3
Reliability	4	2	3
Penetration	1	1	2
Range	3	2	4
User experience Data rate	4	4	3
Security	4	2	3

1 – low 2 – medium 3 – high 4 – very high

If we contrast 5G with WiFi 6 we can observe how in the Quality of Service (QoS) Model, **WiFi 6 operates** with a **"Best Effort" QoS model**, meaning that there is no guaranteed priority. In contrast, **5G employs** a **"Guaranteed" service model facilitated** by **Network Segmentation**, which **allows** the **creation** of **logical networks tailored** to handle **specific types of traffic** with corresponding capabilities. In addition, private **5G** networks ensure **consistently low latency** and **minimal interference** by operating in licensed

frequency bands. However, **WiFi 6** operates in **unlicensed bands**, making it susceptible to interference from other networks sharing the same frequency. In terms of mobility, **5G** offers **uninterrupted mobility** between its antennas, while **WiFi 6** requires **re-authentication** when switching to a new Access Point (AP) to receive service.

Another key aspect is **security**, **5G** *hardware* provides an **additional layer of protection**, requiring devices to have a SIM card provided in the network core to connect. In addition, 5G offers security at the **device level**, at the **network level** and at the **radio spectrum level**. Finally, the life cycle of **5G** equipment has a **longer life cycle** compared to WiFi 6, although it is true that the value of 5G equipment is higher than the value of WiFi 6.

Advances in ports

Regarding **examples of 5G use in existing ports**, there are currently many European and international ports that are exploring the integration of the services provided by 5G technology to improve their daily operations. Among the **Spanish ports**, the different **pilots** carried out in the ports of **Algeciras and Barcelona stand out**.

According to the latest press reports, the Port of Algeciras has taken a significant step towards modernization and efficiency with the implementation of a license plate recognition system. This system uses video cameras connected to Vodafone/Huawei's 5G infrastructure to automatically identify license plates of vehicles entering the port. 5G technology enables a fast and reliable connection, ensuring accurate and agile detection. During periods of heavy traffic, such as Operation Crossing the Strait, this system is especially valuable. The cameras capture license plates and, via algorithms, automatically guide vehicles to the appropriate boarding areas. This expedites logistics processes and improves the experience for both drivers and port staff.

In addition, the Port of Algeciras has collaborated with the Guardia Civil to develop a real-time alert application. This application uses facial recognition techniques to identify suspicious people. When someone is detected in the port area, the application generates an alert, enabling a quick and efficient response by the authorities.

As for the Port of Barcelona, the future deployment of the public 5G SA network (Orange) is expected to be strategic for improving efficiency and connectivity in this port. 5G technology will enable greater automation, smarter resource management and faster communication between the different actors involved in port operations.

Valenciaport 5G Projects

The **Port of Valencia** has been **actively involved** in the **pioneering phases** of **5G technology development**, covering **versions 16 and 17**. In fact, all the key capabilities outlined in accordance with **ITU-RM.2083 standards** find justification in the tangible requirements of large ports, exemplified by the Port of Valencia. These types of ports present a multitude of use cases that require high peak data rates, low latency, high mobility, connectivity for a large number of devices, strict reliability and an enriched user experience. Recognizing these needs, the Port of Valencia, under the direct supervision of the Port Authority of Valencia and the Fundación Valenciaport, has proactively addressed these needs.

The port has actively participated in research and development projects, serving as a testing ground for 5G technology through pilots and real use case scenarios. This

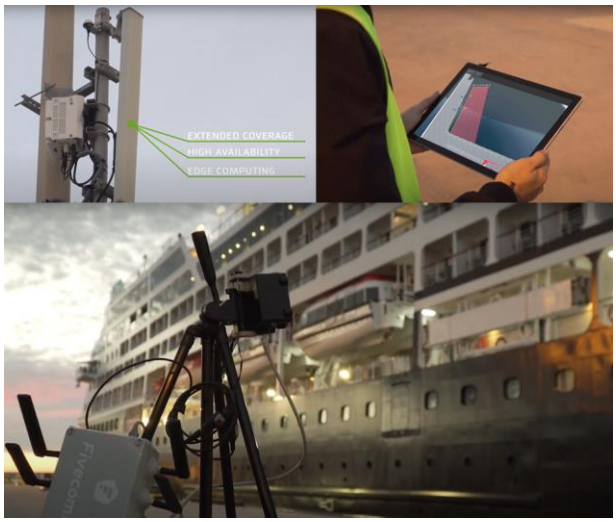
participation has allowed the Port Authority of Valencia to evaluate the effectiveness and feasibility of the technology for its implementation within the port area. Through various use cases covering emergency operations, remote control of machinery and precise monitoring of the ship docking process, the Port Authority of Valencia has leveraged its participation in early-stage 5G development projects. This proactive commitment has been fundamental not only to test the technology, but also to evaluate its practical applicability across a spectrum of critical functionalities within the port environment.

The **RESPOND-A project**, funded by the European Commission's Horizon Europe program, is the first example to be highlighted in this regard. This project demonstrated the **practical application of 5G** in **emergency scenarios**, achieving efficient coordination and reducing operational time in rescue missions. During the demonstration, a 5G SA portable base station was used to provide connectivity to a drone in charge of recording the incident and sending the images in real time to the advanced control center. This center shared images with rescue units to improve coordination of operations. Additionally, 5G technology provided coverage for the different body sensors installed on the affected persons, allowing the transmission of vital signs data, among others.

Illustration 2. Drone flight using 5G for reconnaissance in the RESPOND-A project

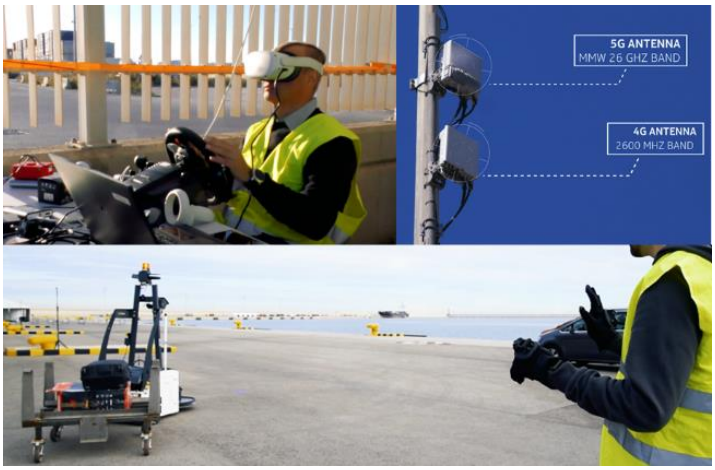
In the **PORTWIN project**, funded by regional funds, a **private 5G SA** test **network** was used to **provide connectivity** to **millimeter-accurate radar sensors on the docks**, enabling real-time monitoring of the docking process. These sensors sent data regarding the distance between the ship and the dock, as well as the ship's speed from different angles. This data was transmitted to the digital twin of the docking process, allowing the agents involved to monitor the process at all times via a Tablet. This approach was aimed at strengthening safety in this operation in the Port of Valencia.

Illustration 3. Digital twin of the docking process enabled by 5G and radar technology



Alternatively, the **iNGENIOUS** project successfully demonstrated the **use of 5G millimeter wave technology** to **operate machinery remotely** in the port, improving operator safety through mixed reality and haptic solutions. During the demonstration, it was shown how, through a private 5G network in the millimeter band, it was possible to remotely control an AGV in a demanding environment surrounded by containers. This was achieved through the use of virtual reality goggles and haptic gloves, which enabled the seamless transmission of telemetry, video and sensor data, with minimal latency and zero interruptions.

Illustration 4. Remote control of an AGV using 5G in the millimetric band



Currently, the port continues its **participation** in **projects related** to **5G technology**, with the aim of evaluating the advances offered in the new versions of this technology, with a view to an **eventual transition to 6G**. A prime example is the **IMAGINE-B5G project**, an initiative of the Horizon Europe program, which has allowed testing the capabilities of 5G on a large scale, demonstrating its benefits in safety, security and rescue scenarios. This project contemplates the execution of two pilots in this specific context. In one of these pilots, it will be explored the use of a dedicated 5G slice of a commercial network to provide connectivity to a drone in autonomous perimeter surveillance and intrusion tracking operations. Meanwhile, the other pilot will use a

private 5G SA test network, managed by an O-RAN backbone, to facilitate the remote control of a vessel from an emergency control center, as part of inspection and rescue work during a simulated accident in port waters.

These projects collectively validate and exemplify the varied and significant applications of 5G technology in real-world port operations. The tests conducted in these projects have demonstrated the suitability of 5G technology to facilitate use cases in an environment as complex as the port of Valencia, where advanced connectivity capabilities are required. As a conclusion, and undoubtedly, the arrival of the fifth generation of mobile technologies, known as **5G**, has gone from being a mere expectation to a **tangible reality** around the world. This evolution stands as a **transformative factor** in the age of **digitalization**. In this sense, the integration of this technology acquires an extraordinary relevance in the **logistics-port field**, since it plays a **fundamental role** in the **adaptation** and **modernization** of **ports** in the face of **digital challenges** and new demands arising in the field of international trade. It is not only a matter of cost reduction, but also opens the door to innovation at port nodes, enabling **data capture** and **analysis** on an **unprecedented scale**. Consequently, although there is still a long way to go, an increasing number of ports, both in Europe and globally, are exploring the possibilities offered by 5G technology to optimize their day-to-day operations.