



## **D2.1: ECOSYSTEM DEFINITION AND REQUIREMENTS**

### **ANNEX 6: CLUSTER 2 DEFINITION AND REQUIREMENTS**

This annex covers Cluster 2 - Smart Sustainable IoT Solutions for Valencia, exploring how COP-PILOT can be deployed across diverse real-life environments including the city, port, industrial park, and university campus to enable real-time data acquisition, monitoring, and AI/ML analysis. It demonstrates how smart IoT platforms and 5G technologies can address scalability, interoperability, and deployment challenges while driving measurable improvements in urban mobility, port operations, safety, and sustainability.

## D2.1: Ecosystem definition and requirements

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<b>Abstract</b>	<p>The COP-PILOT platform is an open collaborative system for managing services across IoT, edge and core computing environments. COP-PILOT is built to enable secure and intelligent operations that connect diverse sectors.</p> <p>This document brings together an ecosystem of technical blueprints and services models across 5 main domains to support the development of these infrastructures. With a focus on seamless cross domain integration, it lays the foundation for private edge deployments and digital ecosystems across Europe.</p> <p>This deliverable sets the direction for building a platform that drives smarter, more secure, and collaborative digital transformations across multiple industries.</p>
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\* R: Document, report (excluding the periodic and final reports)

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

DATA: Data sets, microdata, etc.

DMP: Data management plan

ETHICS: Deliverables related to ethics issues.

SECURITY: Deliverables related to security issues

OTHER: Software, technical diagram, algorithms, models, etc.

## INTRODUCTION TO CLUSTER 2

Valencia was the European Green Capital 2024, and its piloting cluster (PC-ES) focuses on smart sustainable IoT solutions. The cluster brings several real-life environments for use case demonstration and pilots, including (i) the city of Valencia, (ii) the port of Valencia – the fifth-largest port in Europe in terms of traffic volume and the top port in import, export, and transshipment in the West-Mediterranean, (iii) the nearby industrial park of Almussafes, and (iv) UPV campus, a realistic yet controlled smart city environment for use case integration and validation, which aims to become carbon neutral in 2030. The cluster brings different alternatives for implementing smart IoT platforms to make efficient use of devices and their related applications, i.e., the Thinking City smart IoT platform provided by Telefonica based on FIWARE used by the City of Valencia and UPV, and two platforms provided by IoT device integrators. IoT devices will be deployed across key areas in Valencia and integrated into smart IoT platforms to facilitate real-time data acquisition, monitoring, and AI/ML analysis across a distributed IoT-edge-cloud continuum infrastructure.

This cluster handles several challenges in the deployment of smart IoT-based solutions. These include physical and technical constraints in installing devices in dense urban environments and complex infrastructures such as ports and industrial parks. Ensuring secure, privacy-compliant data handling remains an important concern too, as well as achieving seamless integration and interoperability between different platforms. Scalability is also a critical issue, with the need to ensure that solutions can grow efficiently along with urban and operational demands. Additional technical difficulties include potential connectivity losses, sensor misalignment, and power limitations in remote devices. Also, financial challenges related to deployment and maintenance, along with the need for staff training and managing large volumes of real-time data. Finally, gaining public trust and ensuring alignment with regulatory frameworks are essential for widespread acceptance and long-term success.

This cluster demonstrates significant business impact by enabling the deployment of innovative 5G and IoT technologies across critical real-life environments, going from urban city and campus to industrial park, and port. The data-driven solutions applied in these diverse scenarios lead to measurable improvements in operational efficiency, cost reduction, and safety. These use cases help stakeholders validate market-ready technologies, open new application domains, and unlock future commercial opportunities while supporting sustainable development goals and strengthening public-private collaboration.

Cluster 2 plays a crucial role in advancing smart sustainable urban and port environments. Through the selected use cases, it enables smarter urban mobility, improved traffic flow and road safety, supports effective flood mitigation and faster emergency response, optimizes waste management and greater sustainability, and enhances port operations by improving berthing safety and preventing collisions. Collectively, these efforts contribute to more efficient city and port management, increased safety, and better quality of life for citizens and stakeholders.

### Partners and roles

The cluster 2 Smart Buildings/City workforce is composed of participants of 7 different entities, all based in Spain, and mainly in the Valencian region:

- Universitat Politècnica de València (UPV) (Research/Academia) – Leader
- Fundacion de la Comunidad Valenciana para la Investigacion, Promocion y Estudios Comerciales de Valenciaport (VPF) (Research/Academia)

- Telefonica Innovacion Digital SL (TID) (Industry)
- Nespra (NES) (SME)
- 5G Communications for Future Industry Verticals SL (FIVE) (SME)
- Fundacion de la Comunitat Valenciana para la Promocion Estrategica del Desarrollo y la Innovacion Urbana (VCH) (Public Sector)
- Ayuntamiento de Almussafes (ALM) (Public Sector).

The **roles** within the cluster consortium are mainly divided into:

- **Stakeholders:** UPV, VPF, VCH, ALM
- **Technological partners:** TID, NES, FIVE

**Stakeholders** mainly provide testbed facilities, and realistic use cases (UCs) to be tested in operational real-life conditions.

- **UPV** provides the **university Smart campus** as a testbed resembling a small smart city, with UCs focused on **resources management**, i.e. waste, water and space. The UPV campus hosts a wide array of specialized infrastructure to support the development of advanced 5G and IoT-based services. These include a fully operational private 5G network, multiple 5G cores (open-source and commercial), edge-cloud continuum capabilities, and monitoring systems to assess parameters such as energy consumption. In addition, UPV's campus is aligned with the university's goal of reaching carbon neutrality by 2030, providing a unique setting to evaluate the sustainability and environmental impact of smart campus solutions.
- **VPF** provides the **port of Valencia** as testbed, in particular certain key areas where to develop the UCs and pilots, mainly focused on **Maritime traffic monitoring and berthing assistance**. For the UC the area will include the mouth of the port and a container terminal. The mouth of the Port of Valencia has a width of 500 meters and it's the only one to access the container terminals. The container terminal has a quay with several Ship-to-Shore cranes with different sizes that can move along the quay. The terminal has different quays with different depths and can accommodate vessels of different sizes.
- **VCH** provides the **city of Valencia** as testbed, in particular certain key areas where to develop the UCs and pilots, mainly focused on **traffic monitoring** and **intelligent buildings**. Valencia covers 134.65 km<sup>2</sup> and has a population of around 825,000. Its flat terrain makes it especially suitable for walking and cycling. The city has multiple traffic entry points where pedestrians, cyclists, private vehicles and public and logistic transport coexist. In addition, numerous municipal buildings are spread throughout Valencia, providing citizens with access to various public services. Valencia has recently launched an **Urban Sandbox**, providing a controlled environment for testing and validating innovative projects, making it easier for companies to access and carry out real-world trials.

- **ALM** provides the **industrial park of Almussafes** as testbed, in particular certain key areas where to develop the UCs and pilots, mainly focused on **flooding detection**. The ALM site, connected to a major Industrial Park with around 10,000 workers, faces critical challenges related to traffic congestion, flood risk, and environmental safety. Peak-hour mobility and periodic flooding lead to significant delays and increased emissions. The presence of high-risk industries near the protected Albufera Lagoon, and the park's close proximity to the town of Almussafes, heighten the need for robust monitoring and emergency systems. In response, ALM has implemented enhanced security measures, making the area an ideal testbed for Use Cases focused on mobility monitoring, flood detection, and environmental quality. These initiatives aim to improve traffic management and safety in dynamic, high-risk environments.

**Technological partners** mainly provide IoT platforms for the management of IoT sensors data, as well as its deployment and integration to enable the UCs in the different locations.

- **TID** will mainly provide its **Thinking City smart IoT platform** based on FIWARE used by the City of Valencia. This platform enables the integration, processing, and distribution of multiple data sources (e.g., traffic, public transport, waste), allowing real-time tracking on the status through centralized dashboards and control systems. On the other hand, Telefónica can provide access to its commercial network with advanced features such as Network Slicing and Open Gateway APIs to guarantee and prioritize data traffic, or Movistar Intranet service (Private APN) for use cases that require dedicated connectivity.
- **NES** will mainly provide its **Nescloud IoT platform** based on proprietary developments and open IoT standards and will deploy NB-IoT sensors for waste and spaces management in the UPV campus and for air quality measurement in the industrial park of ALM. Additionally, the necessary adaptations will be developed to move towards a FIWARE standard and connect with the COP-PILOT platform.
- **FIVE** will deploy 5G connected radars and NB-IoT sensors to cover use cases for smart mobility, water usage monitoring and port operation. The devices will interface with FIVE's IoT management platform **fivecomm4you**, that will be in charge of parsing the information and forwarding it to the cluster's unified data management platform.

All together the different entities and capabilities offer a broad set of relevant and key UCs and scenarios representing improvement areas of cities and infrastructure to become more efficient towards smart cities.

## Objectives and ambition

The main ambition of the cluster is to dissect the main pain points of cities where improvements can be performed through the inclusion of IoT and smart management. Thus, the cluster structure, partners, use cases and scenarios are carefully selected as to represent a diverse set of daily life dynamic scenarios and situations in which the impact of the proposed improvements can bring enormous benefits to the citizens and make a step forward towards the smart city of Valencia.

To achieve this, the partners, roles and UCs targeted in the cluster fully complement and align together to achieve the cluster 2 main objectives:

- **Obj#2.1:** Evaluate smarter and more sustainable data and mobility solutions for a diverse set of use cases.
- **Obj#2.2:** Integrate and validate smart IoT platforms and devices in large-scale trials across the city of Valencia.
- **Obj#2.3:** Increase sustainability and quality of life in real scenarios by adoption of the proposed solutions.

These objectives fully align with the ambition and objectives of COP-PILOT, as the architecture defined for the cluster and UCs will integrate with the COP-PILOT architecture following common components as well as particularizing other components for cluster 2 specifications.

The expected outcomes of cluster 2 are:

- **EO#2.1:** Implement smart IoT platforms with open interfaces to third parties coming via open calls to develop AI/ML applications for the three considered scenarios.
- **EO#2.2:** Deploy a distributed edge-cloud continuum infrastructure among some of the scenarios the cluster (e.g. port of Valencia and UPV campus), so that distributed real-time AI/ML applications can be implemented.
- **EO#2.3:** Improve the sustainability of UPV campus making progress towards the net zero goal and carbon neutrality.
- **EO#2.4:** Improve both maritime and terrestrial traffic at the Port of Valencia.
- **EO#2.5:** Improve the mobility sustainability in the city of Valencia and also its environmental management.
- **EO#2.6:** Increase security and sustainability of the mobility in the Industrial Park of Almussafes.

Main KPIs and targets at cluster level are the following, which are further detailed and evolved for each of the cluster UCs in the corresponding sections:

- **KPI#2.1:** Improvement in urban traffic control and traffic flow and also at the industrial park
- **KPI#2.2:** Decrease in vessel berthing times and waiting times at the port
- **KPI#2.3:** Increase port's operational efficiency metrics due to better traffic management
- **KPI#2.4:** Improvement in air quality metrics in Valencia due to improved environmental management
- **KPI#2.5:** Increase UPV campus energy efficiency and decrease carbon footprint
- **KPI#2.6:** Overall improvement in sustainability metrics in the different scenarios of the cluster.

## Testbed description

As introduced in the previous section, cluster 2 involves 4 different testbeds composing 4 real smart city scenarios, i.e., the city of Valencia, the industrial park of Almussafes, the campus of UPV and the port of Valencia. Each of these locations intends to focus on different UCs that are the most required for their daily operatives.

### *The City of Valencia*

Valencia is a leading smart and sustainable city, recognized as European Green Capital 2024. It integrates smart technology for efficient public services, including IoT-based waste management, smart grids, and AI-powered water systems. The city promotes sustainable mobility with electric public transport and extensive cycling lanes. It focuses on renewable energy, energy-efficient infrastructure, and climate resilience, with projects like Turia River Park and solar-powered public buildings. Valencia also emphasizes circular economy principles, recycling, and eco-friendly urban planning.

The Smart City Office of València, established in 2018, plays a central role in this transformation. Key projects include the Connecta VLCi initiative, which digitizes 194 municipal buildings with IoT devices and environmental sensors. The technological infrastructure includes:

- **Fiber optic backbone and municipal VPN** connect city buildings and devices.
- **Mobile VPN with private APN** ensures secure communication for IoT devices, using open APIs and NGSI-LD protocols

Related to traffic monitoring:

- **Multi-sensor traffic control system:** Integration of inductive loop detectors, magnetic sensors, radar-based vehicle counters, and computer-vision traffic cameras across urban intersections and arterial roads.
- **City-wide network of over 3,500 IoT sensors** connected to a centralized traffic control system using LPWAN and fiber-optic backhaul. Real-time data from vehicle flow, congestion levels, and parking occupancy.
- **Smart traffic lights** with adaptive signal control powered by edge AI inference. Signal timing dynamically adjusts based on real-time flow and congestion metrics.
- **High-precision parking monitoring sensors**, using radar-magnetic hybrid sensors with LoRaWAN communication and battery autonomy exceeding 7 years.
- **Back-end analytics and monitoring** with Prometheus, Grafana dashboards, and Telegraf data collectors; supports historical trend analysis and live anomaly detection.

These technologies feed into the city's smart IoT platform, Thinking City, provided by Telefónica and based on FIWARE, which serves as the integration layer for all urban data and services. With international certifications like ISO 37120, València stands as a benchmark for smart, sustainable, and citizen-centered urban innovation.

### *The industrial park of Almussafes*

The Almussafes Industrial Park, located near Valencia, is a key hub for the automotive and manufacturing industries, home to the Ford Spain plant and a network of over 100 suppliers. It plays a crucial role in Spain's automotive sector, driving innovation, sustainability, and economic growth. The park focuses on smart manufacturing, automation, and green energy solutions, integrating renewable energy, energy-efficient logistics, and circular economy practices. Efforts in carbon footprint reduction, waste management, and sustainable mobility make it a model for eco-friendly industrial zones.

ALM aims to improve and increase the integration of different systems for digitalization, unifying models so they can provide adequate information for smooth, fluid, and easily accessible mobility, and to optimally resolve any situations that may arise (traffic jams, floods, accidents in companies). Adjust and improve vehicle traffic management mobility to: (i) Avoid congestion, (ii) Reduce fuel consumption, (iii) Offer the most appropriate and safe exits in the event of floods and accidents, (iv) Offer maximum safety for the benefit of people, which directly impacts companies. Preemptively prevent potential flooding and gas releases in high-risk companies, facilitating the actions planned and indicated in the corresponding Emergency Plans. Improved real-time information based on relevant knowledge of the information provided by device data, helping to improve decision-making based on data or suggestions proposed by analytics, which aids coordination and communication among the various stakeholders in the Industrial Park and the town.

All of this with the mission of achieving a more sustainable Industrial Park, where environmental symbiosis can be achieved, while also impacting the citizens of Almussafes.

In the industrial park there is currently the following infrastructure:

- 8 boxes, each consisting of: Access control camera and environmental management camera. Real-time control of the different work areas. The system allows real-time monitoring of traffic density and can generate alarms if conditions exceed previously established thresholds.
- 9 boxes, each consisting of: Parking access control camera and environmental management camera. The system allows defining the direction of travel of vehicles, counting or subtracting them from the total capacity of each parking lot. Alarms can be generated if parking occupancy levels exceed pre-established thresholds.
- 5 Information panels. These provide the necessary information on parking spaces in the different parking lots. The objective of the information screen system is to inform the estate's users about the status of the parking lots, thus avoiding unnecessary trips, thereby saving resources and CO2 emissions.
- 6 Acoustic warning devices. These devices emit acoustic signals and announcements that alert residents, workers, and drivers in the affected area.
- 10 Panels indicating the speed of passing vehicles. These devices are autonomous; there is no connection to the central office.
- In the locality, there is:
  - 9 Control panels in each panel, consisting of: Access control camera and environmental management camera. Real-time monitoring of the different work areas. The system allows

real-time monitoring of traffic density and can generate alarms if conditions exceed pre-established thresholds.

- 1 Panel indicating the speed of passing vehicles. These devices are autonomous; there is no connection to the control center.
- 4 Acoustic warning devices. These devices emit acoustic signals and announcements that alert citizens, workers, and drivers in the affected area.

Additionally, the infrastructure is completed with a control center consisting of information and management switchboard. Management center, real-time image observation from the different devices, with data analytics software, compatible with the Provincial Council's "Connecta" platform. Processing and preparation of studies aimed at improving mobility. The cameras and information panels are connected through a 4G router, and the power supply is supplied through street lighting.

### ***UPV Smart Campus***

The UPV campus provides a realistic yet controlled smart city environment for use case integration and validation, with a strong commitment to achieving carbon neutrality by 2030. As a key stakeholder in the cluster, UPV offers a fully equipped and self-managed private 5G Advanced testbed, which extends across both indoor and outdoor areas of the UPV's Vera campus, enabling large-scale experimentation in real-world conditions.

This testbed integrates the Thinking City smart IoT platform based on FIWARE, used as the central integration layer for real-time monitoring and data management of smart services. The 5G network infrastructure, deployed and operated by the iTEAM-UPV institute, comprises three sites: two outdoor nodes operating in 5G standalone and non-standalone modes with n40 and n258 bands (the latter anchored on LTE B7, but also capable of operating in standalone mode), and one indoor node providing standalone coverage in the n78 band through pico-antennas located in an immersive laboratory.

The infrastructure includes five 5G cores (open-source and commercial solutions), which enable full E2E slicing and customized QoS per slice using proprietary SIM cards. The platform also integrates advanced monitoring, measurement and testing tools, such as instruments from Keysight Technologies, Rohde & Schwarz, as well as widely used open-source tools like Telegraf and Grafana.

In line with UPV's sustainability goals, the 5G testbed also includes energy monitoring systems and weather stations, interconnected with MEC-based platforms deployed at different campus locations. These features allow for the assessment of both network performance and energy efficiency under real usage conditions. Altogether, the UPV Smart Campus offers a comprehensive setting for the validation of innovative services and applications, particularly those targeting resource optimization, smart mobility, and sustainable infrastructure within a smart city framework.

### ***The port of Valencia***

The Port of Valencia is Spain's busiest container port and the 4<sup>th</sup> in Europe. The port is a key hub for Mediterranean and global trade as the main routes between North Europe and the Far East use Valencia as the first of last call in the Mediterranean.

The port has been working on innovative sustainability projects for more than 25 years, being a pioneer in Europe and worldwide. In recent years it has worked on projects on environmental management, air quality, water quality and environmental noise. Here that are being executed:

- Electrification of docks, to reduce emissions from ships in port,
- Use of new fuels in port equipment, such as hydrogen,
- Generation of electricity from renewable sources in the port.
- Improved maritime traffic management to reduce fuel consumption.
- Improved road traffic management to avoid congestion
- Improved internal communications to enhance coordination of the different port actors.

All this leads the Port Authority of Valencia to propose the zero emissions plan, with the goal of being a carbon-neutral port by 2030, implementing smart logistics, digitalization, and circular economy initiatives. With automated terminals, AI-driven operations, and green corridors, it is a model for eco-friendly and efficient maritime transport.

The Fundacion Valencia port 5G network infrastructure includes a single outdoor node operating in standalone mode on band n40, strategically positioned at the center of the port. This setup allows for a variety of tests to be conducted across different areas of the port, including the RoRo terminal, cargo container terminals, and other zones.

The infrastructure features 5G core networks (open-source solution) which support full end-to-end slicing and customized Quality of Service (QoS) per slice using proprietary SIM cards. The platform also incorporates advanced monitoring, measurement, and testing tools, including instruments from Keysight Technologies, among others.

Within the context of previous projects, four berthing assistance radars have already been installed. However, being a novel technology, validation is still pending, and work needs to be done regarding processing measuring to achieving the desired accuracy and reliability. Moreover, two maritime traffic monitoring radars have been installed but connected via ethernet. It is desirable and a goal to be achieved withing COP-PILOT to move the connectivity to 5G and install additional radars of both types to expand the solution to additional docks.

## ANNEX 6.A: UC 2.1A - UC 5G-CONNECTED RADARS FOR TRAFFIC CLASSIFICATION AND VEHICLE COUNTING

### Description Short Description

Urban mobility management faces growing challenges due to traffic congestion, lack of real-time monitoring, and inefficient resource allocation. Cities need accurate data on the type and number of vehicles using key routes to optimize transportation planning, reduce environmental impact, and enhance road safety. To address this issue, the project proposes the deployment of multiple 5G-connected radar units across strategic urban locations. These radars will provide high-precision classification of vehicle types and real-time vehicle counting, supporting data-driven urban mobility strategies.

**Use case overview Diagram:** In the following figure, the overview diagram can be seen. In it, the deployment of connected radars at different locations in the city of Valencia is illustrated. The radars will use the mobile network to transmit their readings to the data management platform in which statistics about vehicle counting and classification, velocity, and lane detection will be collected. With the data, statistics can be drawn to detect traffic congestion patterns and enable smart traffic management.



Figure 6.1 City of Valencia use case overview diagram

### Complete Description

Currently, Valencia monitors vehicle flow at its entry points using sensors that provide data on speed and direction. The goal is to **validate this data** by incorporating a different radar and, at the same time, **introduce a new metric: the type of vehicles** entering the city. So far, this metric has not been measured. This limitation makes it difficult to accurately determine how many cars,

motorcycles/bicycles, and trucks are accessing the city, which in turn hinders effective decision-making in urban mobility and planning. It is proposed to implement a vehicle classification system using radar, integrated into the VLCi platform. This would enable more efficient traffic management and provide richer data to support policies, one of those related to urban logistics.

The use case involves the following steps:

### **Step 1: Site Selection and Feasibility Assessment**

In a first instance, the desired locations for monitoring should be determined, and the feasibility of installation at each site should be assessed. The number of radars to be used at each location will be determined based on street characteristics and traffic conditions. Once the locations and the number of radars are determined, and the installation feasibility is ensured, a first batch of units will be deployed and validated in the field.

### **Step 2: Firmware Adaptation and Additional Metrics Analysis**

In parallel with the location scouting, Fivecomm will work on adapting the 5GRadar's firmware to meet the needs of the project's data management platform. Additionally, the need for the 5GRadars to include additional metrics in the set of measurements will be evaluated.

### **Step 3: Real-Time Data Collection and Processing**

Radar units continuously scan the area, detecting and classifying vehicles based on size, speed, and direction. The collected data is transmitted via 5G networks to a central urban mobility management platform. Advanced AI algorithms process the data in real time, identifying traffic patterns and congestion points.

### **Step 4: Deployment of Remaining Units and Data-Driven Optimization**

After on-field validation of the initial batch, the rest of the radar units will be deployed. A first data collection stage will allow for a better assessment of the need for additional devices. The analysis of collected data will enable a data-driven approach for authorities to improve traffic management, infrastructure planning, and road safety.

### **Step 5: Continuous Monitoring and Optimization**

The urban mobility platform continuously refines its models based on historical and real-time data. Authorities receive automated reports highlighting trends, inefficiencies, and areas for improvement. Ongoing system updates ensure radar units adapt to evolving urban mobility challenges.

### **Interactions Between Key Stakeholders**

- City Traffic Management Authorities oversee the deployment of radar systems and utilize the collected data for policy-making. Their role is crucial in ensuring the effectiveness of traffic monitoring and implementing necessary regulations to improve urban mobility.
- Transportation Planners leverage these insights to enhance urban mobility infrastructure. By analyzing real-time traffic patterns, they can design more efficient road networks, alleviate congestion, and optimize transportation systems for growing urban populations.

- Emergency Services benefit from access to real-time traffic data, enabling faster response times to incidents. The ability to reroute emergency vehicles based on live traffic conditions significantly improves public safety and emergency preparedness.
- Environmental Agencies use vehicle emissions data to support sustainability goals. By monitoring pollution levels and identifying high-emission areas, they can develop strategies to reduce urban air pollution and promote environmentally friendly transportation policies.
- Public Transportation Operators optimize routes and schedules using traffic insights. By incorporating real-time data into their operations, they can improve service efficiency, reduce delays, and enhance the overall commuting experience for passengers.
- Reduced traffic congestion is achieved through data-driven optimizations, allowing for smoother traffic flow and reduced travel times. Real-time alerts and insights also contribute to enhanced road safety by helping to lower accident rates and improve overall driver awareness.
- Data-backed decisions enable more informed urban planning, leading to better transportation policies that align with current and future mobility demands. Additionally, the reduction in emissions resulting from optimized traffic movements supports environmental sustainability initiatives.
- Public transport efficiency improves as dynamic route adjustments are made based on real-time demand. By responding to traffic conditions and passenger needs, transit systems can operate more effectively and provide a higher level of service.
- The implementation of 5G-connected radar units represents a significant advancement in urban mobility management. By leveraging real-time data collection, AI-powered analytics, and seamless integration with smart city infrastructure, this solution enhances transportation efficiency, reduces congestion, and contributes to sustainable urban development.

#### Expected Outcomes

- Reduced Traffic Congestion: Improved traffic flow through data-driven optimizations.
- Enhanced Road Safety: Real-time alerts and insights help reduce accident rates.
- Informed Urban Planning: Data-backed decisions for better transportation policies.
- Environmental Benefits: Reduction in emissions due to optimized traffic movements.
- Improved Public Transport Efficiency: Dynamic route adjustments based on real-time demand.

#### Conclusion

The implementation of 5G-connected radar units represents a significant advancement in urban mobility management. By leveraging real-time data collection, AI-powered analytics, and seamless integration with smart city infrastructure, this solution enhances transportation efficiency, reduces congestion, and contributes to sustainable urban development.

By feeding mobility data into COP-PILOT, Valencia will be able to explore **synergies between transportation and other critical infrastructures**, enabling more holistic and resilient urban planning. This integration supports advanced data correlation, cross-domain insights, and a unified decision-making framework that enhances sustainability and operational efficiency across sectors.

## Main actors and roles

Table 6.1 Main actors and roles

Actor name	Actor type	Actor Description and Role
València Innovation Capital (VCH)	Use case provider / user	Public entity that facilitates the testing environment and interactions with public institutions.
Fivecomm (FIVE)	Tech provider	Will provide connected radars and assist in the integration with the data management platform
Valencia city council	Test environment owner / user	Carry out the installation according to the tech provider's specifications.
Telefónica Innovación Digital (TID)	Tech provider	Will provide the global platform, enabling integration with other platforms and data sources, and offering a visualization and alerting layer.

## Ambition, Motivation and Objectives

The main ambition behind this use case is to leverage 5G connectivity and AI-driven analytics to enhance urban mobility management. The motivation lies in improving traffic flow, increasing road safety, optimizing urban planning, and reducing environmental impact. The objective is to deploy a robust, scalable, and efficient system that allows authorities to make data-driven decisions for better mobility outcomes.

## Challenges addressed

- Traffic congestion and inefficient mobility management.
- Lack of accurate, real-time vehicle classification and counting.
- Limited integration of smart technologies in traffic monitoring.
- High environmental impact due to traffic emissions.

## Expected outcomes

- Reduced Traffic Congestion: Improved traffic flow through data-driven optimizations.
- Enhanced Road Safety: Real-time alerts and insights help reduce accident rates.
- Informed Urban Planning: Data-backed decisions for better transportation policies.
- Environmental Benefits: Reduction in emissions due to optimized traffic movements.
- Improved Public Transport Efficiency: Dynamic route adjustments based on real-time demand.

## Key pain points

**Infrastructure limitations:** Challenges related to the installation of radar units in highly congested or structurally complex urban areas.

**Data privacy and security:** Ensuring that collected data is handled securely and in compliance with regulations.

**Integration with existing systems:** The need for seamless interoperability with existing urban mobility management platforms.

**Cost of deployment and maintenance:** High costs associated with installing and maintaining a widespread radar network.

**Scalability concerns:** Ensuring the system can be expanded efficiently as cities grow and traffic conditions evolve.

**Public acceptance and policy compliance:** Addressing concerns from citizens and policymakers regarding the use of AI-driven traffic monitoring.

## ANNEX 6.B: UC 2.1B - FLOOD WARNING AND MITIGATION SYSTEM THROUGH RADAR SENSING

### Description

#### Short Description

Because of its location, several areas of Almussafes and the nearby Industrial Zone are prone to floods, which can cause considerable material and human loss if adequate measures are not taken in a timely fashion. This use case intends to implement a flood warning system throughout the deployment of connected radar units WIOTRAD at vulnerable locations of Almussafes and the Industrial Park. The radars will constantly monitor the water level at the sensed locations and report when it surpasses the pre-defined thresholds. By mapping the water levels at different locations, the evolution of the flood can be tracked, and decisions can be made in real time, for example, regarding evacuation of personnel.

The following figure presents the Use case overview Diagram. In it, the deployment of water level sensing units is shown, both in the town of Almussafes and in the Industrial Area. The radars will send the collected measurements to the data management platform to make this data available to the relevant authorities to act under a flood event.



Figure 6.2 Almussafes Industrial Park use case diagram

## Complete Description

The Industrial Park is a site characterized by several distinctive operational and environmental factors. One of the most significant is the high concentration of workers — approximately 10,000 individuals — which results in elevated and concentrated levels of mobility, particularly during entry and exit hours.

A specific area within the park is subject to frequent flooding due to the nature of local torrential rainfall. The combination of high traffic flow and periodic inundation leads to severe congestion during peak times, which in turn contributes to a notable increase in greenhouse gas emissions.

Additionally, the park houses several companies classified as high-risk in terms of safety, both for personnel and the surrounding environment. These risks are magnified by the proximity of a protected natural area, the Albufera Lagoon, which could be adversely affected by any industrial incidents.

Another critical aspect is the park's location — just 1 kilometre from the town of Almussafes. This geographical closeness means that any events occurring within the Industrial Park, such as traffic disturbances or industrial accidents, can have direct repercussions on the nearby population.

In response to these challenges, a series of security and risk mitigation measures have been implemented in recent years. These include the deployment of surveillance systems and the enhancement of emergency management protocols.

Given these conditions, the ALM represents a strategic environment for the development and testing of advanced Use Cases (UCs), particularly those focused on the monitoring of: High-density mobility patterns, Flood-prone zones, and Environmental quality indicators.

These efforts aim to support more efficient and resilient traffic and mobility management systems in the face of potential disruptions.

Currently, Almussafes has data from a weather station which provides rainfall monitoring, temperature, wind speed and atmospheric pressure measurements. Additionally, cameras are in place which allow operating personnel to get a visualization of the field situation in case of flood. However, cameras are known to not provide a reliable solution on adverse weather conditions that can cause lens obstruction or poor visibility. Additionally, a more automated and distributed monitoring system would allow real-time data during a flood event, speeding up the decision-making to mitigate human and material damages.

Fivecomm has developed a product that allows water-level measurement via radar technology. While initially intended for sewage monitoring, the COP-PILOT project has opened the possibility to test it for flood monitoring purposes. Starting from a high TRL product, firmware modifications and calibration will be completed to adapt to this new application scenario.

The execution of the use case can be divided into clear steps which will be detailed below. As a summary, the deployment of WIOTRAD devices will follow a four-step process. First, initial locations will be selected based on criticality and feasibility, ensuring that supporting structures can withstand adverse conditions due to the devices' autonomous power capabilities. Next, devices will be installed at these sites, with key reference data such as ground distance recorded to enable flood detection. During this phase, which is expected to be executed throughout the first year of the project, operational validation will be carried out, including transmission frequency and adaptability. Following successful field validation, a second deployment phase to be carried out during the second year of COP-PILOT will identify additional locations to cover remaining vulnerable areas and evacuation routes, assessing any further installation requirements. Finally, throughout the third year of the project, the system will undergo continuous monitoring and data analysis to determine the need for more units and to optimize flood response strategies.

The solution to the proposed use case will be provided according to the following steps:

#### **Step 1:** Selection of initial deployment locations

Attending to the information gathered, a set of initial locations will be identified for the first deployment phase. The locations must meet relevant criteria such as their criticality and feasibility of deployment. Due to the power autonomy of the devices, the remaining condition that needs to be assessed per location is the potential of the supporting structure to resist adverse conditions, ensuring that the WIOTRAD will remain operating during critical events.

#### **Step 2:** Initial deployment of devices and field validation

Once suitable locations are identified, the devices will be deployed. At each installation it is paramount to register the reference distance to ground since this value will be compared to measurements to detect flood events.

After their installation, the WIOTRAD units will commence their reporting to the data management platform. Operational aspects such as the periodic transmission of measurements and adaptability to working conditions will be validated.

**Step 3:** Evaluation of needs for second deployment

Once the initial deployment has been validated, additional needed locations will be identified to complete covering the intended vulnerable points and relevant evacuation routes. Assessing the possible locations, it will be necessary to determine if additional installation activities are necessary to ensure WIOTRAD units can be installed.

**Step 4:** Analysis and Monitorization

The collected data will be analysed to determine if additional units are required and to evaluate the optimal response to future flooding events based on observed patterns. Additionally, the operation of the devices will be constantly monitored to ensure full operability and maximize the reliability of gathered data.

**Main actors and roles**

*Table 6.2 Main actors and roles*

Actor name	Actor type	Actor Description and Role
Almussafes	Test environment owner / user	Provide information that will guide the locations for deployment. Assist on the deployment.
Fivecomm	Tech provider	Provide the water level radars and integrate the measurements with the data management platform.
Telefónica Innovación Digital (TID)	Tech provider	Will provide the global platform, enabling integration with other platforms and data sources, and offering a visualization and alerting layer.

**Ambition, Motivation and Objectives**

The ambition of this Use Case is to demonstrate an advanced, connected and autonomous flood monitoring and early-warning system that leverages radar sensing and IoT connectivity to enhance safety and resilience in flood-prone areas. By developing and validating the WIOTRAD radar technology in real-life conditions within Almussafes and its Industrial Park, the project seeks to move beyond traditional flood detection methods based on visual inspection or manual data collection, towards a fully digital and automated decision-support framework. This initiative aims to establish Almussafes as a reference site for smart and sustainable risk management, integrating real-time environmental data into broader urban and industrial safety operations.

Floods represent one of the most recurrent and disruptive natural events in Almussafes and the surrounding industrial zone, posing serious threats to human safety, infrastructure and environmental assets such as the nearby Albufera Lagoon. Existing monitoring methods, mainly weather stations and cameras, provide limited reliability under adverse conditions, lack automation and delay critical decision-making. The motivation behind this Use Case is therefore to enhance preparedness, responsiveness and coordination among local authorities and industrial stakeholders by providing continuous, reliable and data-driven situational awareness. Furthermore, the project builds upon existing high-TRL radar technology, fostering innovation through adaptation to a new context (flood management), contributing to both technological progress and societal resilience.

The specific objectives of this Use Case are:

1. To deploy and validate WIOTRAD radar units at selected vulnerable sites in Almussafes and its Industrial Park, ensuring stable operation and reliable data transmission under real environmental conditions.
2. To integrate radar-based water level data into a centralized data management platform, enabling visualization, alert generation, and interoperability with other environmental and mobility data sources.
3. To enable early warning capabilities for flood events, supporting real-time decision-making by authorities and improving the coordination of evacuation or mitigation actions.
4. To analyze the performance and scalability of the deployed solution, assessing the potential for wider replication in similar industrial or urban environments.
5. To contribute to environmental sustainability and safety, reducing greenhouse gas emissions caused by flood-related traffic congestion and minimizing risks to nearby natural areas and populations.

### Challenges addressed

This use case addresses the challenge of gathering real time information of flooding events and sending them to a platform that allows for relevant actors to send alerts to vulnerable areas and organize the evacuation routes in a safe and optimized manner if needed.

### Expected outcomes

The expected outcome of this use case is to provide a platform that will provide critical information for relevant actors to make decisions under the occurrence of a flood event. Hence, the main goal is to reduce the impact of floods, and to decrease risks of human and material losses.

### Key pain points

The identified key pain points are:

- Losses in connectivity: The potential for loss in the connection from the WIOTRAD devices to the data platform could cause measurement losses. As it is projected to use a commercial network for this deployment, the coverage at the deployed locations must be checked, considering signal levels and support for NB-IOT or similar connectivity technologies.
- Radar orientation displacement: While this might be a rare occurrence, the displacement of the radars would lead to incorrect readings. To prevent this, in addition to taking measurements during the installation, the reported measurements will be monitored to detect possible issues.
- Radar battery exhaustion: In the long term, the batteries of the deployed radars will be exhausted. The battery life will be strongly influenced by the configured measuring and reporting periods. WIOTRADs will report their battery level to prevent unforeseen exhaustion.

## ANNEX 6.C: UC 2.2 - SMART RESOURCES MANAGEMENT IN THE UPV CAMPUS

### Description Short Description

Currently, UPV is not fully in control of its resource management due to several reasons. For waste management, the waste collection is managed by the Valencia City Council, making it complicated to know the exact waste generation data, relying instead on sector-wide estimates. To ensure accurate monitoring and assessment of the environmental impact of campus waste, it is crucial to obtain precise data on the quantities generated. For this, an IoT-based solution is proposed as a piloting activity on the campus. Fill-level sensors will be installed in containers across the campus, enabling more accurate estimations of waste generation. This data will also allow the optimization of number and distribution of containers, contributing to a more efficient and environmentally responsible waste management system.

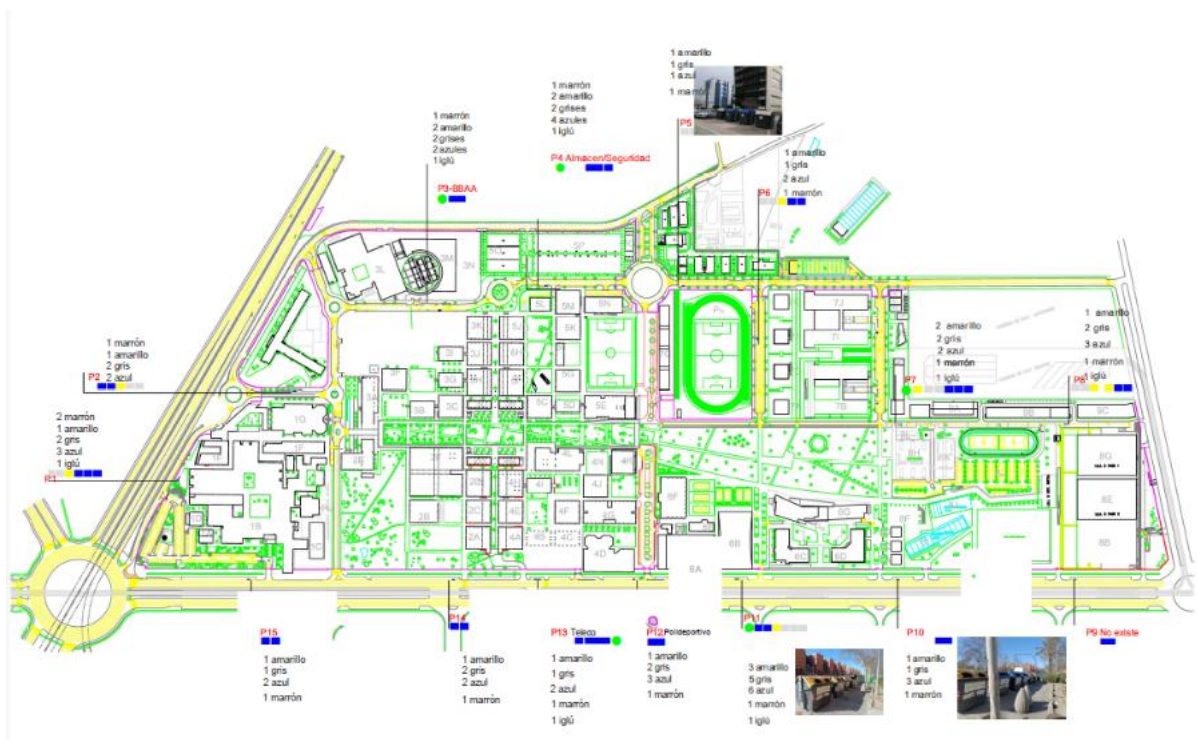


Figure 6.3 UC2.2 overview Diagram: Waste containers' location.

### Complete Description

The Universitat Politècnica de València (UPV) has implemented a waste management system comprising four types of waste containers distributed across the campus: organic waste, paper, plastic, and general waste. Currently, waste collection is managed by the Valencia City Council, so UPV does not have exact data on the amounts generated on campus. Instead, they rely on estimates based on the data from all containers in the sector. Additionally, all resources of the campus are not integrated in a centralized platform where to monitor the situation in real time to detect possible inefficiencies of the current system.

The Sensor-Based Measurement System to be developed will ensure accurate monitoring and assessment of the environmental impact of campus waste, which is crucial to obtain precise data on the quantities generated. While weight sensors ideally provide direct measurements in kilograms, their installation is not feasible due to its physical characteristics. Instead, fill-level sensors will be deployed to measure container capacity in real time, providing valuable data on usage patterns. To improve estimation accuracy and system efficiency, adjustments to the number and distribution of containers across the campus will be also made.

The solution to the proposed use case will be provided according to the following steps:

To enhance waste management efficiency and sustainability, the Universitat Politècnica de València (UPV) has developed a three-phase strategy spanning from 2025 to 2027. This plan focuses on real-time monitoring, data analysis, and the implementation of optimized waste collection processes.

### **Phase 1: Monitoring (Year 2025)**

The first phase aims to establish a comprehensive waste monitoring system across campus by deploying sensor-based technologies and integrating them into a centralized platform. Key initiatives include:

- Implementation of fill-level sensors in containers: Sensors will be installed to monitor waste accumulation in real time, allowing for more accurate tracking of container usage.
- Development and deployment of fill-level sensors: Fill-level sensors will provide precise estimations of the waste generated, addressing the current reliance on external estimations.
- Integration with Nespra's IoT platform: The collected data will be integrated into Nespra's IoT system, ensuring seamless connectivity and centralized monitoring.
- Real-time data collection: Continuous monitoring will enable immediate insights into waste disposal patterns, facilitating better decision-making.
- Data validation with UPV: The data gathered will be cross verified with UPV's internal records to ensure accuracy and reliability.

### **Phase 2: Analysis (Year 2026)**

Once the monitoring infrastructure is in place, the focus will shift towards analyzing collected data to optimize waste management processes as well as integrating with the Smart Thinking platform of Telefónica, and ultimately with the COP-PILOT platform. Key actions include:

- Integration with the Smart Thinking and COP-PILOT platforms: Nespra's IoT system will be integrated into the Smart Thinking and COP-PILOT systems ensuring seamless connectivity and the collected data will be enabled with a centralized monitoring through the Smart Thinking platform to have the overview of the whole cluster in the same place.
- Development of data analysis tools: Advanced analytical tools will be designed to process and interpret waste collection data.
- Evaluation of the impact of waste collection on carbon footprint: The environmental impact of current collection methods will be assessed, identifying areas for improvement.

- Data visualization and report generation in the IoT platform: Results will be displayed through interactive dashboards, providing stakeholders with clear insights and facilitating data-driven decision-making.

### Phase 3: Proposals (Year 2027)

The final phase will focus on translating insights into actionable improvements for a more sustainable and efficient waste management system. Key objectives include:

- Generation of data-based recommendations: Using the findings from Phase 2, strategic recommendations will be formulated to enhance waste collection efficiency.
- Optimization of collection frequency and routes: Data-driven adjustments will be made to reduce unnecessary collections, lower costs, and minimize environmental impact.
- Reduction of environmental impact and Improvement in waste management: The implementation of optimized waste management practices will contribute to a more sustainable campus.
- Presentation of results and roadmap for future improvements: The findings and proposed enhancements will be compiled into a comprehensive report and roadmap, ensuring continuous improvement in UPV's waste management strategy.

Through this structured approach, UPV aims to establish a smart, data-driven waste management system that promotes efficiency, sustainability, and environmental responsibility.

### Main actors and roles

Table 6.3 Main actors and roles

Actor name	Actor type	Actor Description and Role
UPV	Test environment owner Use case provider / user	Public entity that facilitates the testing environment and interactions with public institutions.
Nespra	Tech provider	Will provide the IoT devices and assist in the integration with the data management platform.
Telefónica Innovación Digital (TID)	Tech provider	Will provide the global platform, enabling integration with other platforms and data sources, and offering a visualization and alerting layer.

### Ambition, Motivation and Objectives

Efficient waste management is a key challenge for sustainability in urban and university environments. At UPV's campus, waste collection is managed by the Valencia City Council, making it difficult to access accurate data on waste generation and management. This project aims to improve waste collection monitoring, optimization, and sustainability through IoT technologies and artificial intelligence.

## Challenges addressed

This use case addresses the challenge of gathering accurate real time information of the waste quantities and type generated in the campus, in order to propose improvements in the location of containers as well as the frequencies of collection and the recycling within the campus areas. For example, organic waste could be transformed into soil for the campus gardens in the appropriate unit, which is not possible to be done without knowing the quantities generated.

## Expected outcomes

- Obtain accurate data on waste generation by type and container.
- Reduce environmental impact through collection optimization.
- Implement tools to improve collection routes.
- Enhance traceability and sustainability of the carbon footprint.

## Key pain points

- Infrastructure limitations: Challenges related to the installation of IoT devices.
- Data privacy and security: Ensuring that collected data is handled securely and in compliance with regulations.
- Integration with existing systems: The need for seamless interoperability between the Thinking Smart IoT platform of Telefónica and the Nespra IoT platform.
- Scalability concerns: Ensuring the system can be expanded efficiently to be expanded to the city level.

## ANNEX 6.D: UC 2.3 - MARITIME TRAFFIC MONITORING AND BERTHING ASSISTANCE

### Description Short Description

The increasing traffic of large vessels in the Port of Valencia requires precise monitoring for efficient and safe operations. Traditional tracking systems like GPS and AIS lack accuracy in vessel orientation and positioning. The proposed solution involves installing radars at key port locations to provide real-time data on vessel direction, position, and docking conditions. This system enhances safety, prevents costly accidents, and optimizes port operations for shipping companies and terminals.

**Use case overview Diagram:** The following figure shows the overview diagram for the use case. It illustrates the possible locations for the different types of 5G Radars, their connection to the Port of Valencia Private 5G Network, and the real-time transmission of measurements to the data management platform. The data includes the location of the sensed ships, the positions of the monitored cranes, and the berthing assistance measurements.



Figure 6.4: Port of Valencia use case overview diagram

### Complete Description

In the Port of Valencia, the traffic of large vessels has been steadily increasing over the years. It is becoming more common to receive larger ships with greater cargo capacity, which presents a significant challenge for management and operations in such a busy environment as a commercial port of this magnitude. Due to their massive size, these vessels require precise control throughout all stages of their stay in the port, from approach and entry to docking, unloading, and departure.

To ensure efficient and safe management of these processes, it is essential to have a real-time tracking system for container ships. Currently, location systems such as GPS and AIS (Automatic Identification System) allow ships to be tracked. However, these methods have limitations as they can only indicate a specific point where the ship's antenna is located, without providing precise information about its orientation or the exact space it occupies within the port. This lack of accuracy

can pose significant risks during entry and docking maneuvers, making it necessary to implement more advanced solutions.

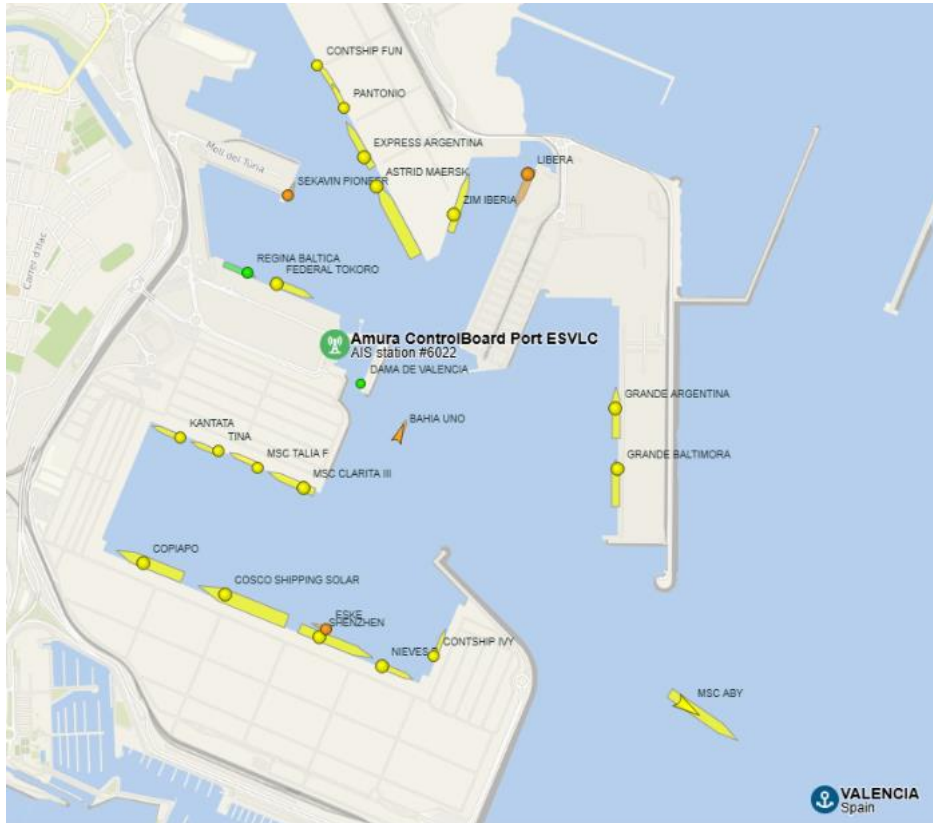


Figure 6.5: Mismatch between vessel's actual position and the position reported by the GPS and AIS



Figure 6.6: Detail of the mismatch between the vessel position and the GPS/AIS-reported position.

The proposed solution in this use case involves installing radars at the main entrances of the Port of Valencia, as well as in several of its inner docks. These radars will not only allow the correlation between AIS information and the vessel's actual position but will also provide precise data on its direction, exact location, and orientation at all times.

Additionally, a set of radars strategically placed along the dock will enable precise tracking of the relative position between the vessel and the dock, providing valuable information to ship pilots, mooring personnel, and tugboats.

All the data collected during this process will not only improve the safety and efficiency of port maneuvers but will also be highly beneficial for shipping companies and terminals. Thanks to this information, every operation—entry, mooring, loading, unloading, and departure—can be optimized more efficiently, reducing operational times and increasing the profitability of port activities.

**Phase 1: Study of the location and installation of the radars**

- Finish fabrication of radars
- Confirm locations for installation of radars
- Install and collect radar measurements
- Validate integration of data with TID's platform
- KPIs definition

**Phase 2: Setting up the system and continuous development of**

- System integration with port data sources.
- KPIs evaluation (uptime, latency, jitter, measurements accuracy, ...).

**Phase 3: Integration with port/terminal systems**

- Continuous integration with TOS.
- Evaluation of custom views for on-field personnel operation.

**Main actors and roles**

*Table 6.4 Main actors and roles*

Actor name	Actor type	Actor Description and Role
VPF	Use case provider / user	Provide a description of the actor related to UC. Provide next the actor's role or involvement in this particular use case.
Fivecomm	Tech provider	Will provide the connected radars and assist in the integration with the data management platform
Port Terminal	Stakeholder	TBC
Telefónica Innovación Digital (TID)	Tech provider	Will provide the global platform, enabling integration with other platforms and data sources, and offering a visualization and alerting layer.

**Ambition, Motivation and Objectives**

The increasing traffic of large vessels in the Port of Valencia presents a significant challenge for port management. The arrival of bigger ships with higher cargo capacity increases the complexity of

entry, docking, and departure maneuvers, requiring advanced solutions to ensure operational safety and efficiency. Traditional systems such as GPS and AIS have limitations, as they do not provide precise information on vessel orientation or space occupation within the port.

The main scenario involves installing radars at strategic locations within the port to enhance accuracy in detecting vessel position and orientation. This will enable better coordination of maneuvers, prevent incidents, and optimize port logistics.

The orchestration platform plays a crucial role in this process, as it integrates radar data with AIS and other existing systems. This centralizes and processes real-time information, ensuring better coordination among shipping companies, port operators, and terminals. The platform optimizes resource allocation and improves operational planning, aligning with the project's objectives to enhance safety, reduce operational times, and increase efficiency.

### Challenges addressed:

- Increasing traffic of large vessels and the difficulty of maneuvering in a highly congested port.
- Limitations of GPS and AIS systems in identifying the exact position and orientation of vessels.
- Risk of accidents during docking, especially due to collisions with improperly positioned ship-to-shore cranes.
- Lack of integration between different vessel tracking systems.
- Need to optimize coordination between shipping companies, terminals, and port operators.

### Expected outcomes:

- Greater accuracy in detecting and tracking vessels in real-time.
- Reduced risk of accidents and damage to port infrastructure.
- Optimization of docking, loading, unloading, and departure times.
- Improved operational planning and more efficient resource allocation.
- Reduced operational costs due to better port traffic management.

### Key pain points

- Integration of radars with existing port information systems.
- Ensuring interoperability between different technologies and platforms.
- Installation and maintenance costs of the radar system.
- Need for staff training to operate the new technology.
- Efficient management of the high volume of real-time data generated.

## ANNEX 6.E: UC 2.4A - IOT-DRIVEN SMART BUILDING MANAGEMENT

### Description

#### Short Description

València Innovation Capital optimizes the management and comfort of La Harinera, a multipurpose public building, through the deployment of Nespra's IoT platform. The use case proposes a hybrid IoT architecture that integrates existing sensors connected to local BMS systems with a modern cloud-based platform, enabling centralized real-time monitoring of occupancy, environmental conditions, and space usage. In addition, a complete IoT solution will be deployed in a pilot building to validate automation and remote-control capabilities, supporting data-driven decisions that enhance operational efficiency and sustainability.

#### Complete Description

The City Council of València manages a diverse network of public buildings (sports centers, museums, libraries, etc.), many of which already have Building Management Systems (BMS) that allow local control of HVAC, lighting, and ventilation. These systems operate autonomously through programmed logic and are connected to proprietary IoT nodes, such as Siemens devices.

Additionally, before implementing the IoT solution, the management of La Harinera faced challenges due to the lack of objective, real-time data about how spaces were being used and the level of environmental comfort. As a multipurpose building hosting various activities, it was difficult to plan for occupancy, anticipate climate control needs, or design energy-efficient operations without reliable measurements.

Decisions were based largely on estimates or past experiences, which often led to suboptimal use of the facilities, unnecessary energy consumption, and difficulties in anticipating user needs. The absence of sensorized monitoring limited the ability to improve operational planning or prepare long-term strategies for sustainability and comfort optimization.

The project proposes a hybrid architecture in two complementary scenarios:

#### Scenario 1: Integration of Existing IoT Nodes with Cloud Platform

In this scenario, a data replication mechanism will be enabled from Siemens nodes to the Nespra cloud IoT platform. This integration will allow real-time synchronization of locally generated data, without modifying the existing control logic. The goal is to validate interoperability between on-premise and cloud systems and facilitate centralized visualization of parameters such as temperature, humidity, energy consumption, etc.

Additionally, the possibility of extending this integration to other buildings with similar BMS systems will be evaluated, establishing a scalable and replicable architecture. Communication protocols used by BMS will be analyzed and adapters or connectors will be developed to enable smooth integration with the cloud platform. Security mechanisms will be established to ensure data integrity and confidentiality, including end-to-end encryption and robust authentication.

Custom dashboards will be implemented to allow municipal operators to visualize the status of multiple buildings from a single interface, facilitating data-driven decision-making. Integration with other urban platforms such as energy management, mobility, or environmental quality systems will also be explored, promoting a holistic smart city vision.

### Scenario 2: Deployment of Complete IoT Solution in Pilot Building

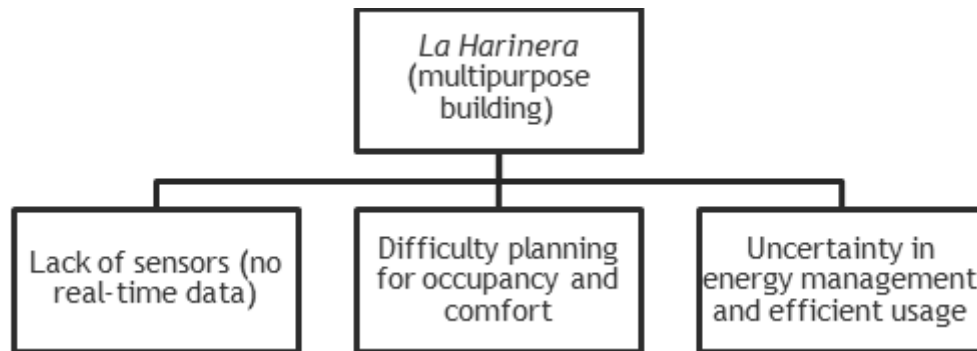


Figure 6.7 Pre-solution overview.

In this second scenario, a complete IoT solution will be deployed in La Harinera through the installation of diverse sensors managed by the Nespra platform and a proprietary IoT node with edge computing capabilities. The deployed sensors will rely primarily on LoRaWAN connectivity (low power, wide coverage), complemented by NB-IoT where LoRaWAN coverage is insufficient, leveraging cellular infrastructure to ensure reliable data transmission.

This architecture will enable monitoring, automation, and remote control while supporting fast local decision-making without relying solely on the cloud.

The pilot building will serve as an end-to-end validation environment, where interoperability, latency, communication reliability, and responsiveness to critical events will be tested. Metrics on energy efficiency, comfort, and reduction of operational incidents will be collected.

This scenario represents a step toward the digitalization of municipal infrastructure, aligned with the COP-PILOT project’s goals of efficiency, sustainability, and improved user experience. The proposed architecture is scalable to other municipal buildings and interoperable with broader urban platforms (mobility, lighting, environmental quality). Training for City Council staff and the creation of best-practice guides will ensure long-term adoption.



Figure 6.8: Final solution overview

The execution of this use case will follow a structured workflow to integrate IoT technology into La Harinera:

- Sensor deployment and configuration: Installation of non-invasive IoT sensors with LoRaWAN and NB-IoT connectivity options, strategically placed and connected to the cloud-based Nespra platform.

- Data collection and real-time monitoring: Continuous gathering of occupancy and environmental data (temperature, humidity, CO<sub>2</sub>) visualized through customizable dashboards.
- Operational optimization and analysis: Use of data insights to adjust HVAC systems, lighting, and space scheduling, while supporting evidence-based strategies for long-term energy efficiency.

### Main actors and roles

Actor Name	Actor Type	Actor Description and Role
VCH / València City Council	Public Operator	Provides municipal buildings as test environments and facilitates access to BMS systems. Through València Innovation Capital, it is responsible for the management and optimization of <i>La Harinera</i> , coordinating the implementation of the IoT platform and using the generated data to support decision-making.
NESPRA (NES)	IoT Technology Provider	Supplies IoT sensors with LoRaWAN and NB-IoT connectivity options, proprietary IoT nodes, and a cloud-based platform to ingest data from both existing BMS-connected devices and new deployments in pilot buildings. Responsible for deployment, integration, technical support, and remote device management through a secure and user-friendly interface.
Building Users	End Users	Provides the Thinking City platform, enabling integration with other municipal and urban platforms, interoperability with diverse data sources, and advanced functionalities for visualization, alerting, and analysis.
Telefónica Innovación Digital (TID)	Tech provider	Individuals and organizations that occupy and use the spaces within <i>La Harinera</i> . Their comfort, safety, and overall experience are directly improved by the monitoring, optimization, and automation capabilities enabled by the IoT solution.

### Ambition, Motivation and Objectives

One of the main motivations for this use case was the need to obtain objective, real-time data about the usage and environmental conditions of La Harinera, a multipurpose building managed by VCH. Prior to the deployment of the IoT platform, the team lacked tools to measure occupancy, indoor air quality, and comfort indicators, which limited their ability to make informed decisions and operate the building efficiently.

Furthermore, the building's multifunctional nature—used for coworking, events, and public activities—required a dynamic and responsive system capable of adapting to changing occupancy patterns. The absence of such data not only affected user experience but also hindered the implementation of energy-saving strategies and proactive space management.

The ambition of this use case is to transform La Harinera into a smart, data-driven public facility, where decisions about energy usage, comfort, and space management are guided by real-time

insights. By integrating Nespra's IoT platform, the project aims to demonstrate the value of plug-and-play sensor technology in public administration contexts.

At a broader level, this use case aspires to scale this smart building model to other municipal or regional facilities, reinforcing the city's position as a reference in urban innovation and sustainability. The experience and data collected in La Harinera serve as a foundation for shaping future digital infrastructure policies and optimizing public assets across Valencia.

This use case makes a direct contribution to the overall goals of the COP-PILOT project through the following aspects:

- It supports data-driven decision-making in urban building management, enabling a shift from reactive to proactive operations.
- It enhances energy efficiency and sustainability by using real-time data to optimize HVAC systems and occupancy strategies.

This implementation also plays a significant role in validating key technological innovations of the project:

- It demonstrates the deployment of a flexible and secure IoT orchestration platform within public infrastructure.
- It leverages customizable dashboards that allow various stakeholders to access and act on real-time data, improving responsiveness and coordination.
- The choice of the COP-PILOT platform is strategic and responds to both technical and governance needs:
- It enables scalable and modular architecture, suitable for replication across other public buildings and urban spaces.
- It ensures data traceability, security, and interoperability, which are essential for public sector compliance and trust.

### Challenges addressed

One of the main motivations for this use case was the lack of objective, real-time data about the usage and environmental conditions of La Harinera, a multipurpose building managed by VCH. Before the deployment of the IoT platform, the team had no tools to measure occupancy, indoor air quality, or comfort indicators, limiting their ability to make informed decisions and operate the building efficiently.

The multifunctional nature of the building, used for coworking, events, and public activities, required a dynamic system capable of adapting to changing occupancy patterns. The absence of centralized and interoperable monitoring not only affected user experience but also hindered the implementation of energy-saving strategies and proactive management practices.

The main challenges addressed by this use case can be summarized as follows:

- Fragmented operational data across municipal buildings hindering comprehensive oversight.
- Proprietary systems limiting interoperability with modern, open platforms.
- Reliance on reactive management approaches rather than proactive strategies.
- Limited automation and remote-control capabilities in outdated infrastructures.
- Insufficient centralized analytics to support data-driven decision-making.
- Difficulty in aligning building operations with broader sustainability and climate goals.

### Expected outcomes

The ambition of this use case is to transform La Harinera into a smart, data-driven public facility where energy use, comfort, and space management are guided by real-time insights. By integrating Nespra's IoT platform, the use case demonstrates the value of plug-and-play sensor technology in public administration contexts, while laying the foundation for predictive analytics and intelligent decision-making tools.

Expected outcomes include:

- Validation of a hybrid IoT architecture that integrates legacy BMS systems with cloud-based platforms.
- Improved operational efficiency, energy performance, and user comfort through centralized monitoring and adaptive management.
- Reduction of manual interventions via automation and remote control, lowering maintenance costs.
- Establishment of a scalable and replicable smart building model, adaptable to diverse building types and varying levels of technological maturity across municipalities.
- Enhanced transparency and accountability in building operations, supported by unified dashboards and reporting tools.
- Contribution to broader urban innovation and climate strategies by aligning building operations with sustainability objectives.

### Key pain points

Despite the progress made, the use case still presents several pain points that COP-PILOT is designed to mitigate:

- High technical complexity in integrating proprietary systems with open and standardized platforms.

- Connectivity challenges in older buildings that affect reliable data transmission and control.
- The need to ensure security, privacy, and integrity of operational data in compliance with regulations.
- Scalability of the architecture across diverse building types and municipalities with different technological maturity.
- The challenge of ensuring long-term adoption through adequate training, governance models, and cross-department coordination.

## ANNEX 6.F: UC 2.4B - IOT-BASED ENVIRONMENTAL QUALITY MONITORING SYSTEM

### Description

#### Short Description

This use case focuses on the deployment of a LoRaWAN-based sensor network in the Juan Carlos I Industrial Park (Almussafes) to enable real-time monitoring of formaldehyde levels. The solution integrates Nespra's IoT platform with CO-PILOT and includes a solar-powered gateway and five formaldehyde sensors. It enhances industrial safety by detecting abnormal gas concentrations, enabling alert management, and supporting emergency response protocols in a transparent and environmentally responsible manner.

#### Complete Description

This use case involves the deployment of an environmental monitoring infrastructure consisting of five LoRaWAN HCHO (formaldehyde) sensors and a solar-powered outdoor gateway within the Juan Carlos I industrial park in Almussafes. The primary objective is to enable real-time monitoring of air quality in critical zones, specifically targeting abnormal levels of formaldehyde, a potentially toxic volatile compound.

Sensor data is transmitted via LoRaWAN and integrated into Nespra's IoT platform, which is then connected to the CO-PILOT system. Users of the Nespra platform are enabled to configure custom alerts and notifications (via email/SMS) for critical events such as threshold breaches, low battery status or device disconnections.

This system enhances industrial safety and supports existing emergency response plans by providing real-time environmental data that can facilitate timely and coordinated evacuation procedures, optimize vehicle circulation, and reduce health risks. Furthermore, it promotes transparency, environmental responsibility, and builds trust among workers, companies, and public authorities.

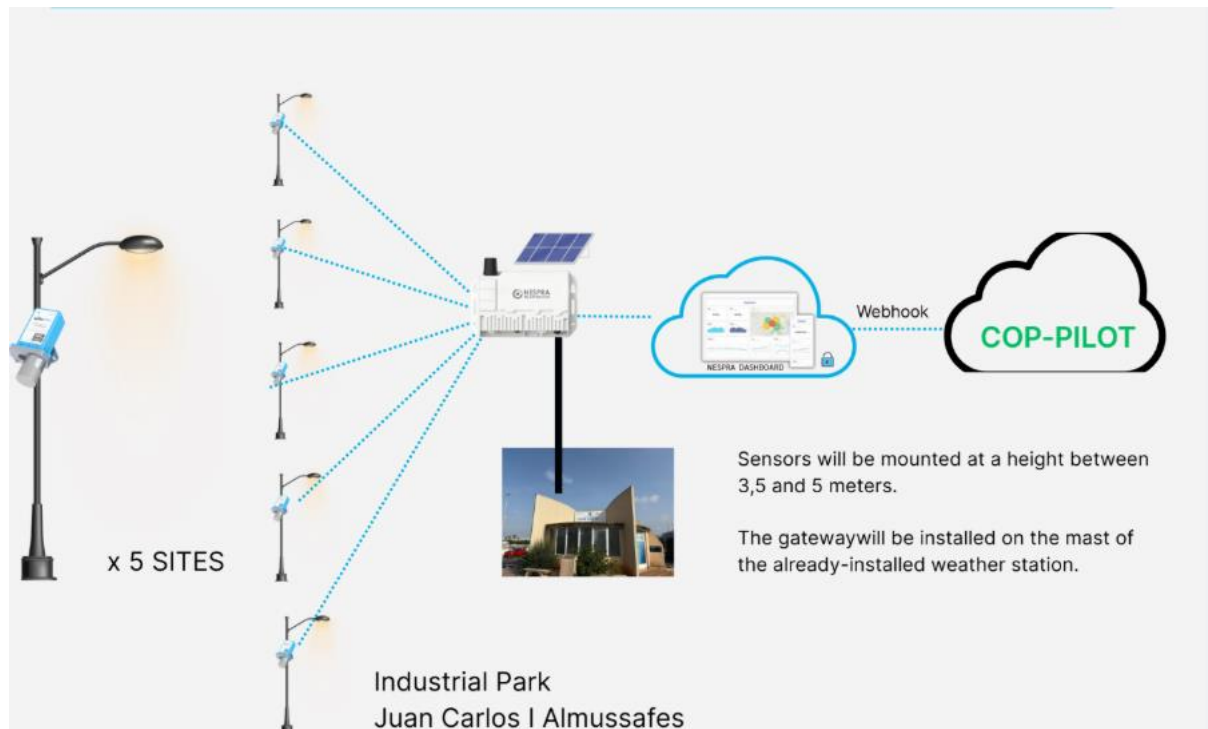


Figure 6.9 Use Case overview diagram.

## Main actors and roles

Table 6.5 Main actors and roles

Actor Name	Actor Type	Actor Description and Role
ALM	Public Operator	Entity responsible for the management of the industrial park. They use the data for decision-making.
NESPRA (NES)	IoT Technology Provider	Supplier of the IoT sensors and cloud platform. Responsible for the deployment, integration and technical support of the real-time monitoring system.
Companies and Industrial Park Users	End Users	Organizations and individuals operating within the industrial park. Their operational experience are directly influenced by the real-time monitoring of air quality.
Telefónica Innovación Digital (TID)	Tech provider	Will provide the global platform, enabling integration with other platforms and data sources, and offering a visualization and alerting layer.

## Ambition, Motivation and Objectives

Air quality monitoring is a critical challenge for ensuring safety and sustainability in industrial environments. At the Juan Carlos I industrial park in Almussafes, the presence of volatile compounds such as formaldehyde poses potential health and safety risks. In the absence of real-time environmental data, it becomes difficult to respond efficiently to chemical incidents or to implement proactive safety measures. This use case aims to address these challenges by developing IoT-based formaldehyde sensors and integrating them with digital platforms to enable continuous monitoring, alert management, and improved emergency response capabilities.

## Challenges addressed

- The absence of real-time toxic gas detection infrastructure in industrial zones.
- Limited capabilities for early warning and rapid response to chemical incidents.
- Need for enhanced coordination during emergency evacuation scenarios.
- Ensuring continuous environmental surveillance and operational safety in a high-risk setting.

## Expected outcomes

- Continuous, real-time air quality monitoring with precise formaldehyde concentration data.
- Improved emergency preparedness and faster decision-making in hazardous situations.
- Enhanced worker safety through proactive incident detection.
- Reinforced trust among stakeholders through transparent environmental practices.

## Key pain points

- Connecting to municipal systems, citizen alert applications, and analytics platforms requires protocol compatibility, robust security, and scalable infrastructure.
- Gas sensors require periodic calibration and may suffer measurement drift due to environmental factors such as humidity, temperature, or dust, compromising accuracy.
- Battery autonomy in LoRaWAN sensors is critical for sustainable deployment, particularly in hard-to-reach locations where replacement or maintenance is costly and logistically complex.
- Transmission of critical data must ensure end-to-end encryption and strong authentication to prevent data manipulation or network sabotage.
- As new industries or sensors are added, the network infrastructure must support expansion without degrading latency or service reliability.
- Deploying sensors in public or private spaces may require municipal, industrial, or environmental approvals that can delay implementation.

- The need to detect hazardous leaks and issue immediate alerts demands a network and platform architecture capable of processing high data volumes with low latency.

## USE CASE SYSTEM DIAGRAMS

The Use Case System Diagrams for the different UCs of Cluster 2 follow a similar structure, with particularities for each of them considering the IoT devices used and the platforms collecting the data at first stage. Thus, the following figure represents the generic use case/cluster diagram. It shows the path followed by the measured data from the connected devices through the mobile network until reaching the data management platform, where it will be put to the disposition of operators. The data will be available in real time and will be stored to draw statistics that could enable the application of AI agents for thorough analysis and optimization of traffic management. Then, these first platforms integrate with the Telefonica’s Smart Thinking platform sending the data through the public network of Telefonica or in the case of the UPV campus will also make use of the 5G private network.

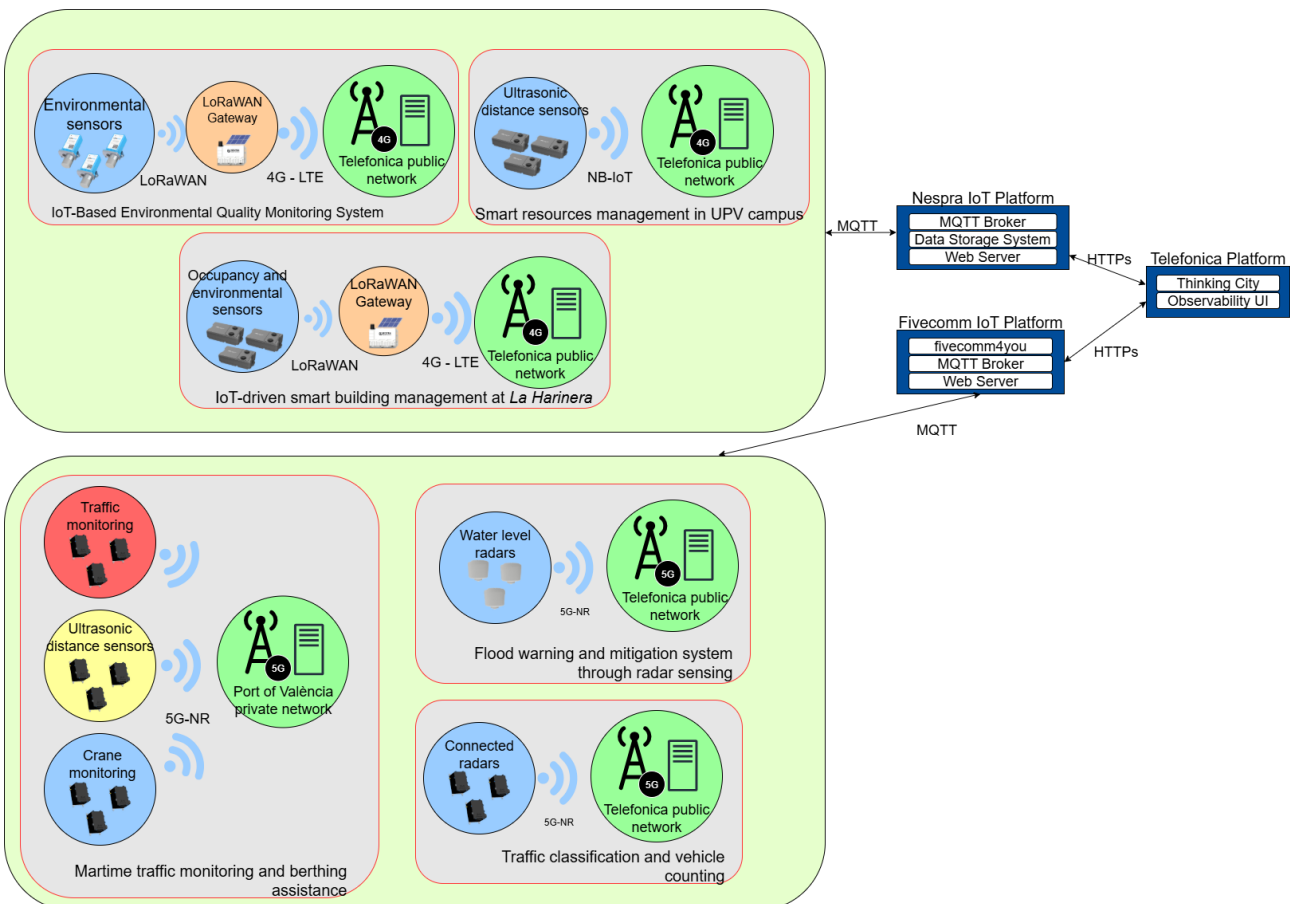


Figure 6.10 Cluster-level user case system diagram

In Valencia, the 5G Radars’ and IoT sensors’ connectivity will be provided through Telefonica’s public network. In an initial stage, the feasibility of using a commercial APN for the solution will be assessed.

The monitorization of the KPIs will determine the need for a private APN or slice for the optimization of latency and reliability.

For Almussafes, the figure portrays the relevant components of the solution, from infrastructure components that are the radars, which communicate via LTE network with the data management platform, to the observability UI where operators will be able to make decisions based on field conditions. For the connectivity, the WIOTRAD devices can use LTE CAT-M or NB-IoT. The public network from Telefonica will be used with the available option. For the Environmental Quality Monitoring System, sensors connect via LoRaWAN and then transmit data through Telefonica’s Public Network to Nespra’s IoT Platform, Nescloud. Nescloud manages the operation, configuration, and communication, and forwards the collected data in real time via a webhook to the platform developed by Telefónica.

At the UPV campus, Nespra's solution is based on an IoT system where various waste container level sensors transmit data via NB-IoT to Nescloud. This platform manages the operation, configuration, and communication of the sensors. As data is received from the sensors, it is forwarded in real time via a webhook to the platform developed by Telefónica.

In the port of Valencia, the diagram illustrates the different layers involved in the use case, from the infrastructure layer with the 5G Radars, the data management platform as part of the Distributed Domain Orchestration Layer (DDO-L), and the Observability UI from the Business Management Layer (BM-L). Connectivity for the 5G Radars in this use case will be obtained directly from the Port’s own private 5G network.

## Requirements

This section gathers the requirements of the different UCs of Cluster 2.

Table 6.6 Functional requirements

Req. ID	Subject (+ Condition)	Commitment	Action + Object + {Constraint and/or Value}	UC
FR1	5G Radar	Must	Correctly count, classify, measure speed, and identify lane of passing vehicles in their installed location.	UC#2.1a
FR2	5G Radar	Must	Send the collected information to the data management platform applying the correct formatting.	UC#2.1a, UC#2.3
FR3	Fivecomm4you	Must	Parse and forward the received information to the Thinking City Smart Platform.	UC#2.1a, UC#2.1b, UC#2.3
FR4	Thinking City	Must	Receive information from the Fivecomm4you platform and present it for end user consumption.	UC#2.1a, UC#2.1b
FR5	WIOTRAD	Must	Correctly measure the water level at the deployed locations using the floor level as reference.	UC#2.1b
FR6	WIOTRAD	Must	Send the measurements to the data management platform.	UC#2.1b

FR7	WIOTRAD	Must	Be able to modify the periodicity of readings according to the operating conditions.	UC#2.1b
FR8	Sensors	Must/Could	Fill-level sensors connected to an IoT network.	UC#2.2
FR9	Nespra's IoT Platform	Must/Could	Real-time data management	UC#2.2, UC#2.4a. UC#2.4b
FR10	Security Infrastructure	Must	Data protection and regulatory compliance.	UC#2.2
FR11	Interoperability	Must	API development for platform integration.	UC#2.2
FR12	5G Radars	Must	Accurately detect ships that enter the monitored location	UC#2.3
FR13	5G Radars	Must	Detect the position of the targeted crane(s)	UC#2.3
FR14	5G Radars	Must	Collect the relevant parameters for berthing assistance	UC#2.3
FR15	IoT Sensors	Must	Collect and transmit occupancy and environmental data	UC#2.4a
FR16	IoT Sensors	Must	Measure formaldehyde concentration in industrial park	UC#2.4b

Table 6.7 Non-functional requirements

Req. ID	Subject (+ Condition)	Commitment	Action + Object + {Constraint and/or Value}	UC
NFR1	5G Radar	Must	Operate with minimum downtime, except for circumstances such as power interruption and network side connectivity outages.	UC#2.1a, UC#2.3
NFR2	5G Radar	Must	Stand adverse weather conditions.	UC#2.1a, UC#2.3
NFR3	Fivecomm4you	Must	Operate continuously, maintain connectivity with 5Radars and Thinking City platform, and keep the received data during the timeframe of the project.	UC#2.1a, UC#2.1b
NFR4	WIOTRAD	Must	Maintain operation during adverse weather conditions.	UC#2.1b
NFR5	WIOTRAD	Must	Ensure battery durability according to the designed life cycle	UC#2.1b
NFR6	Almussafes Council	Must	Assist with the identification of relevant deployment locations and in the installation	UC#2.1b, UC#2.4b
NFR7	UPV	Must	Assist with the identification of relevant deployment locations and in the installation	UC#2.2

NFR8	NesCloud platform	Must	Operate continuously, maintain connectivity with IoT devices and Thinking City platform, and keep the received data during the timeframe of the project.	UC#2.2, UC#2.4a, UC#2.4b
NFR9	IoT sensors and gateways	Must	Maintain operation in outdoor conditions	UC#2.4b

### Business requirements

Table 6.8 Sustainability business requirements

Req. ID	Subject (+Condition)	Commitment	Action + Object + {Constraint and/or Value}	Quantifiable measures for assessment	UC
SR1	Waste collection routes must be optimized when fill levels are below threshold	Good to have	Collection routes will be optimized by proposing collection only when container fill level exceeds 80%	% reduction in kilometers travelled obtained from route reports	UC2.2a
SR2	Sensors must operate with low energy consumption	Compulsory	NB-IoT sensors with battery life over 3 years will be deployed to minimize energy usage	Average battery lifespan of sensors obtained by database logs	UC2.2a, UC2.1b, UC2.4a, UC2.4b
SR3	Truck movements should be minimized to lower emissions	Good to have	The system will reduce truck trips by using real-time fill data to avoid unnecessary collections	Estimated CO <sub>2</sub> reduction (kg/year) obtained from route reports	UC2.2a
SR4	The system must support easy scalability to new zones or locations	Compulsory	New containers and sensors can be added to the system without requiring infrastructure changes	# of new containers integrated per year tracked by database logs	UC2.2a

### Societal business requirements

Cluster 2 stakeholders aim to ensure that technology investments directly support Valencia’s and region strategic mobility and digital transformation objectives. As the city advances toward becoming a smart and connected urban space, priority is given to innovative, interoperable, and scalable solutions that have been validated in real-world environments.

To reduce investment risks, all technologies must undergo thorough testing and demonstrate clear added value before procurement. Special attention is given to new radar technologies that enhance traffic monitoring, integrate with the VLCi platform, and support data-driven improvements in traffic planning, logistics, and environmental strategies.

As a key innovation enabler, the integration of tested solutions is promoted into existing infrastructure while fostering cross-domain collaboration (e.g., linking mobility data with other public services). Technologies must also align with EU policy and sustainability goals, ensuring long-term public value.

Before any acquisition, stakeholders require complete clarity on the technology being evaluated — including its purpose, benefits, and potential for scaling. This involves exploring emerging devices and confirming their technical robustness and relevance to public needs.

Cluster 2 stakeholders play a central role in connecting technology providers, public institutions, and regulators, offering an open, real-world sandbox for experimentation. Solutions must demonstrate excellence and provide clear paths to interoperability, citizen benefit, and integration within public systems. Transparency, modularity, and replicability are essential values, reinforcing Valencia’s position as a reference for sustainable, data-driven urban innovation.

Based on this, the following economic and business KPIs and KVIs have been extracted:

Req. ID	Subject (+Condition)	Commitment	Action + Object + {Constraint and/or Value}	Quantifiable measures for assessment	UC
SC1	Data deviation rate (%)	Good to have	Comparison between data from existing sensors and newly deployed, validated against on-field measurements.	Difference between the new radar data and existing sensor data (e.g., vehicle count, speed) obtained from logs.	UC#2.1a, UC#2.1b UC#2.22a, UC#2.3, UC#2.4a, UC#2.4b
SC2	User satisfaction rate (%)	Compulsory	Launch surveys among stakeholders to assess satisfaction and receive feedback for possible solution improvements	Percentage of stakeholders (e.g., city technicians, planners), measured by surveys, who rate the new radar system as satisfactory or highly satisfactory based on usability, reliability, and value added.	UC#2.1a, UC#2.1b UC#2.22a, UC#2.3

### Market business requirements

For FIVE the execution of the use case presents a very valuable opportunity to validate products with a high TRL in demanding environments. While the devices that FIVE intends to provide are in an advanced development phase, chances for deployment beyond a small scale have not been presented before, since they are new solutions that need to compete with well-established alternatives. The data collected from FIVE’s connected sensors will be used to optimize the operation of the devices in aspects such as energy consumption, resource usage and management strategies, which will enable improving product value. Moreover, from the use-case proposals, potential opportunities for adapting pre-existing products to new applications have been identified, which could result in new market opportunities. In addition to validating the hardware and firmware on an individual level, their integration and interoperability with a broader IoT platform like the one provided

by Telefonica is another expected result that would open new market prospects. Based on this, the following economic and business KPIs and KVI have been extracted:

Req. ID	Subject (+Condition)	Commitment	Action + Object + {Constraint and/or Value}	Quantifiable measures for assessment	UC
BR1	Validation success rate (%)	<i>Compulsory</i>	Keep statistics of deployment.	Percentage of deployed devices that pass the integration tests, considering cost per device and overall costs.	UC#2.1a UC#2.1b UC#2.2a UC#2.3
BR2	Market readiness	<i>Compulsory</i>	Assess TRL achieved based on accepted metrics.	TRL achieved by the end of the project.	UC#2.1a UC#2.1b UC#2.2U C#2.3
BR3	Projected product growth	<i>Good to have</i>	Study results obtained from the project to draw estimations on market potential.	Projected units to be sold as a result of the validation of the product and dissemination of the outcomes. Measured by sales reports.	UC#2.1a UC#2.1b UC#2.2 UC#2.3 UC#2.4a UC#2.4b
BR4	New applications found	<i>Good to have</i>	Analyse gathered experiences to identify potential new applications for the deployed devices.	New applications found for existing products based on results reports	UC#2.1 UC#2.3, UC#2.4a UC#2.4b

## KPIs and KVI

### UC/vertical Specific

The UC#2.1a specific KPIs are:

- Vehicle counting accuracy (%): Number of correctly counted vehicles / the number of total vehicles
- Classification accuracy (%): Correctly classified vehicles / Total classified vehicles
- False positive rate (%): Incorrect detections / Total detections
- Lane detection accuracy (%): Correct lane classification / Total vehicles

Other KPIs related to the accuracy of the radar such as the velocity accuracy are hard to validate on deployment conditions, but it could be considered using alternative measurement tools to contrast the radar's readings. Distance accuracy is secondary in this use case, so it will not be assessed.

The UC#2.1a specific KPIs are:

- Public transportation efficiency insight index: measure and report route efficiency improvements based on real-time traffic data from the radar system, to support decision-making on route optimization.

The UC#2.1b specific KPI in this case is the measurement accuracy which can be obtained as an absolute difference between the reported distance to ground and the real measurement. This KPI can be given in centimeters.

The UC#2.1b specific KPIs are:

- Flood detection time: average time gained between the radar detecting threshold-exceeding water levels and the actual start of flooding conditions.
- Reduction in flood-related material damage costs: estimated monetary value of property and infrastructure damage prevented or reduced due to the flood warnings enabled by the radar system.

UC#2.2 represents a significant advancement in smart waste management through the application of IoT technologies and artificial intelligence. Its three-phase development will optimize waste collection processes, improve environmental sustainability, and reduce operational costs.

- Waste monitoring accuracy (%):  $\frac{\text{correctly measured waste (fill-level)}}{\text{estimated waste generated}}$ .
- Sensor data uptime (%): percentage of time the sensors are operation and transmitting valid data.
- Container usage efficiency (%):  $\frac{\text{number of containers that reach } >80\% \text{ capacity before collection}}{\text{Total number of containers}}$ .

The UC#2.2 specific KPIs are:

- Contributions to UPV sustainability objectives: assessment of how the system supports UPV's environmental and sustainability goals by correlating project outcomes with UPV's environmental targets.

The UC#2.3 specific KPIs are:

- Ship detection accuracy (%):  $\frac{\text{Number of correctly detected}}{\text{total number of ships}}$
- Ship distance estimation accuracy (m/%): Can be obtained as absolute or relative error. Applies to the traffic monitoring and berthing assistance radars

- Ship velocity accuracy (m/s or %): Applies to both maritime traffic monitoring and berthing assistance radars
- Detection range (m): Range at which the radars can monitor the ship for berthing assistance

The UC2.3 specific KVIs are:

- Security – Preventing Collisions Between the Ship-to-Shore Cranes and the Vessel: The implementation of radar-based tracking systems will enhance situational awareness and precision during vessel docking. By providing real-time positioning and orientation data, the system will help prevent dangerous collisions between vessels and port infrastructure, such as ship-to-shore cranes and dock structures. Avoiding such incidents is critical, as collisions can cause severe financial losses, operational downtime, and significant safety risks for port workers.

#### Reducing Engine Running Time by Preventing Mooring Errors

Inefficient or delayed mooring can lead to extended periods where a vessel’s engines remain running, consuming excessive fuel and increasing emissions. By improving the accuracy of mooring operations through real-time radar tracking, vessels can secure their docking position faster, reducing unnecessary fuel consumption and lowering environmental impact. This also contributes to cost savings for shipping companies by minimizing operational inefficiencies.

- Efficiency in Vessel Entry and Exit Logistics – Reducing Time and Avoiding Delays

A well-orchestrated system that integrates radar technology with AIS and other tracking tools will optimize vessel traffic flow within the port. By providing real-time data on vessel movements, port authorities can better plan and execute docking, unloading, and departure operations, minimizing turnaround times. This increased efficiency helps avoid unnecessary delays, ensuring that schedules remain on track and reducing overall port congestion.

- Reducing Truck Congestion Within the Port: Port congestion is a major challenge, especially when large volumes of containers need to be transported to and from ships. By improving the accuracy of vessel tracking and optimizing unloading times, port authorities can better coordinate the movement of trucks entering and exiting the terminal. This leads to a smoother flow of goods, prevents bottlenecks, and enhances overall supply chain efficiency, benefiting both port operators and logistics companies.

### Sustainability

The sustainability KPIs focus on the environmental and economic impact of the use case implementation.

Table 6.9: Sustainability KPIs

KPI ID	KPI	Description	Target	UC
KPI1	Energy efficiency	Evaluation of power consumption (%) of radar units/IoT devices.	>30 %	UC#2.1a, UC#2.1b, UC#2.3,

				UC#2.4a, UC#2.4b
KPI2	Lifecycle sustainability	Evaluation of the long-term sustainability of radar units/IoT devices, including their durability, maintenance needs, and recyclability	>3 years	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3, UC#2.4a, UC#2.4b
KPI3	Collection efficiency assesment	Evaluation of the frequency of unnecessary container emptying events to quantify potential optimization opportunities.	15 %	UC#2.2
KPI4	Waste Monitoring Accuracy	Correctly measured fill-level / estimated waste generated (%)	>70%	UC#2.2
KPI5	Reduced Engine Running Time	Minimize mooring delays, reducing fuel use and emissions	5-10 %	UC#2.3

### Environmental

Traffic noise is a significant contributor to urban pollution, affecting both quality of life and public health. The deployment of smart traffic management solutions aims to mitigate this issue by optimizing vehicle flow and reducing unnecessary idling. Furthermore, the implementation of fill-level sensors will provide real-time data on the amount of waste generated at UPV’s campus, improving planning and collection efficiency. AI-based route optimization will reduce unnecessary collections, decreasing vehicle usage and environmental impact.

Table 6.10 Environmental KPIs

KPI ID	KPI	Description	Target	UC
KPI6	Reduction in noise pollution	Assessment of noise levels (dB) before and after radar deployment to quantify the impact of smoother traffic flow.	1.5 dB	UC#2.1a
KPI7	Cleanliness awareness index	Evaluation of employees’ perception of cleanliness and satisfaction levels before and after solution implementation.	>20 %	UC#2.2
KPI8	Environmental pollution prevention	Helps detecting abnormal gas concentrations	>10 %	UC2.4b

## Societal

Better understanding of the region situation and real-time monitoring in an integrated and interoperable infrastructure will result in faster decision-making and action, which in turn will impact in the population lifestyle.

Table 6.11 Societal KPIs

KPI ID	KPI	Description	Target	UC
KPI8	Reduction in traffic accidents	Comparison of accident rates before and after radar deployment to assess improvements in road safety (%).	5-10 %	UC#2.1a
KPI9	Population covered by flood alerts	People in flood-prone areas receiving alerts and safety instructions (%).	75 %	UC#2.1b
KPI10	Response Time to Flood Events	Average time between alert generation and action taken (min).	< 10 min	UC#2.1b
KPI11	Cleanliness index	Survey/visual index of waste presence pre and post-implementation	>20 %	UC#2.2
KPI12	Worker Safety Incidents	Number of reported safety incidents involving port workers in berthing and docking operations	>30 %	UC#2.3
KPI13	Collision Prevention	Reduces risk of vessel-crane and dock collisions, increasing safety	>70 %	UC#2.3

## Operational and Efficiency

The operational and efficiency KPIs are:

Table 6.12 Operational and Efficiency KPIs

KPI ID	KPI	Description	UC
KPI14	Reliability	Minimize the downtime of the solution, including minimization of power and connectivity related outages. Downtime should be kept below 0.1%.	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3, UC#2.4a, UC#2.4b
KPI15	Latency	Minimize the time it takes for the measurements to reach the data platform to ensure real-time monitoring. Latency should be lower than 100ms	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
KPI16	Durability	Ensure the solution keeps its operability for the intended time span. Battery powered solutions	UC#2.1a, UC#2.1b,

		are expected to have an autonomy of over 3 years (depending on data reporting rates).	UC#2.2, UC#2.3, UC#2.4a
KPI17	Vehicle Counting Accuracy	Correctly counted vehicles / total number of vehicles (%).	UC#2.1a
KPI18	Classification Accuracy	Correctly classified vehicles / total classified vehicle (%).	UC#2.1a
KPI19	False Positive Rate	Incorrect detections / total detections (%).	UC#2.1a
KPI20	Lane Detection Accuracy	Correct lane classification / total vehicles (%).	UC#2.1a
KPI21	Measurement Accuracy	Absolute error between radar-reported and actual water level (cm).	UC#2.1b
KPI22	Sensor Data Uptime	Percentage of time sensors are operational and sending valid data (%).	UC#2.2, UC#2.4a, UC#2.4b
KPI23	Ship Detection Accuracy	Correct ship detections / total ships (m/s or %).	UC#2.3
KPI24	Ship Distance Estimation Accuracy	Absolute or relative error in ship distance estimation (%).	UC#2.3
KPI25	Ship Velocity Accuracy	Accuracy of ship speed measurement (%).	UC#2.3
KPI26	Detection Range	Maximum radar range for monitoring ships during berthing (m).	UC#2.3

### Economic and business

Optimizing waste collection will not only positively impact campus sustainability but also generate significant economic savings in the medium and long term. Reduced use of collection trucks, lower fossil fuel consumption, and better resource planning will contribute to more efficient and cost-effective management. Additionally, the reduction in CO<sub>2</sub> emissions and recycling optimization will strengthen UPV's commitment to environmental sustainability.

This project proposal will not only improve waste management at UPV's campus but also serve as a benchmark for technological innovation in sustainability, with potential for expansion to other environments seeking more efficient and eco-friendly waste management solutions.

Table 6.13 Economic and business KPIs

KPI ID	KPI	Description	Target	UC
KPI27	Cost-Benefit ratio	Assessment of the economic efficiency of the radar/sensor system compared to traditional monitoring solutions		UC#2.1a, UC#2.1b, UC#2.2, UC#2.3

KPI28	Return on Investment (ROI)	Calculation of the financial returns generated from improved traffic management and reduced congestion costs (%).	15% in 3 years	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
KPI29	Operational cost saving	Reduction in costs from fuel, labor, and vehicle maintenance	>10 %	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
KPI30	Resource allocation efficiency	Measure the optimal use of personnel and vehicles	>20 %	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
KPI31	Improved vessel logistics	Optimizes docking and unloading to reduce turnaround and delays.	>10 %	UC#2.3
KPI32	Reduced truck congestion	Enhances truck coordination in port to improve cargo flow and logistics.	>10 %	UC#2.3

### Scalability and EU Sovereignty

The scalability and sovereignty KPIs ensure that the system can be expanded efficiently while complying with European regulations:

Table 6.14 Scalability and EU Sovereignty KPIs

KPI ID	KPI	Description	Target	UC
KPI3 3	Scalability index	Evaluation of the ease with which the system can be expanded to new locations and integrated with other smart city solutions, on different deployment scales, e.g small (<10 devices), medium (10<devices<100), large (>100 devices)	Small: <10 devices, Medium: 10<devices<100 Large: >100 devices	UC#2.1a UC#2.1b UC#2.2, UC#2.3, UC#2.4a UC#2.4b
KPI3 4	Interoperability compliance	Assessment of the system's capability to integrate with existing and future smart city technologies (%).	>90%	UC#2.1a UC#2.1b UC#2.2, UC#2.3, UC#2.4a UC#2.4b
KPI3 5	EU data privacy compliance	Measurement of adherence to GDPR and other EU data protection regulations (%)	>95%	UC#2.1a UC#2.1b UC#2.2, UC#2.3, UC#2.4a UC#2.4b

KPI3 6	Long-Term viability	Projection of the system's sustainability, considering technological advancements and policy changes. Need to assess costs of the solutions (production and operational), results obtained and devices durability. Approaches such as the Balanced Scoreboard (BSC) and Environmental Social and Governance (ESG) will be considered.	>70%	UC#2.1a UC#2.1b UC#2.2, UC#2.3
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The model developed at the different testbeds of Cluster 2 can be replicated and scaled to other urban, industrial, and university environments. Cities and companies managing large waste volumes could benefit from this solution to enhance their sustainability and waste management strategies. Additionally, integration with European environmental regulations will facilitate funding for similar projects in other contexts.

### Datasets and open data

The datasets gathered in UC#2.1a will include data on radar localization and orientation, vehicle counts for the targeted street of each radar, including timestamped classifications, velocities and lanes.

The expected dataset from the UC#2.1b consists of a record of timestamped water levels at the measured locations.

The expected dataset from the UC#2.2 consists of a record of timestamped waste levels at the measured locations.

Whenever possible datasets will be anonymized and published in open repositories.

### Legal and Ethics Requirements

Legal and ethics compliance need to be continuously addressed throughout the entire project lifecycle, also, due to the changing EU Policy and Regulatory Landscape captured in the recently published Competitiveness Compass which underlines the importance of edge computing in digital competitiveness. Considering the early stage of the project, the present initial high-level overview of the most relevant legal and ethical considerations will be revisited in light –both– of the aforementioned developments and the actual technical work. Accordingly, both the content of the questions and format can be subject to further changes in the later stages of the project.

### Involvement of Volunteers

No volunteers involvement is foreseen out of the involved partners of the Cluster, and in case it is detected the need to involve further people, information and permission will be properly asked.

### Data Related Activities

The datasets gathered in UC#2.1a will include data on radar localization and orientation, vehicle counts for the targeted street of each radar, including timestamped classifications, velocities and lanes.

The expected dataset from the UC#2.1b consists of a record of timestamped water levels at the measured locations.

The expected dataset from the UC#2.2 consists of a record of timestamped waste levels at the measured locations.

Whenever possible datasets will be anonymized and published in open repositories.

## IPR

Intellectual Property Rights (IPR) considerations are essential in ensuring the proper management, ownership, and licensing of the technologies involved in this use case. The key IPR-related aspects to be addressed include:

- **Patent Protection:** Identification of proprietary technologies used in the 5G radar system, including AI algorithms for traffic classification and data processing.
- **Licensing Agreements:** Establishment of agreements for the use of radar technology, 5G connectivity, and AI-based traffic management solutions.
- **Data Ownership and Access:** Defining policies on who owns the collected traffic data and under what conditions it can be shared or monetized.
- **Regulatory Compliance:** Ensuring adherence to EU laws on data protection, cybersecurity, and telecommunications standards.
- **Open Innovation & Collaboration:** Evaluating opportunities for open-source contributions or collaborative research to improve system capabilities.

## Risk Identification and Assessment

A comprehensive risk assessment ensures the identification and mitigation of potential challenges that may arise during the implementation of 5G-connected radar systems. The table below outlines key risks, their likelihood, impact, and corresponding mitigation measures.

Table 6.15 Risk Identification and Assessment

Risks	Likelihood (L / M / H)	Impact (L / M / H)	Mitigation	UC
<b>Connectivity failures:</b> 5G network disruptions affecting data transmission.	M	H	Implement redundant communication channels and network failover mechanisms.	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
<b>Data privacy &amp; Security breaches:</b> Unauthorized access or misuse of collected traffic data.	H	H	Apply end-to-end encryption, strict access control, and GDPR compliance policies.	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
<b>Integration challenges:</b> Difficulties in integrating with existing urban mobility platforms.	M	M	Conduct compatibility assessments and use standardized data formats.	UC#2.1a

<b>High deployment &amp; maintenance costs:</b> Financial burden of large-scale implementation.	M	H	Optimize cost-efficiency through phased deployments and public-private partnerships.	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3, UC#2.4a,
<b>Environmental factors:</b> Weather conditions impacting radar functionality.	L	M	Use weather-resistant materials and conduct regular system resilience testing.	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
<b>Technology obsolescence:</b> Rapid advancements in technology making current systems outdated.	M	M	Ensure modular design and allow for software updates and hardware upgrades and/or deployed equipment will have an expected lifecycle longer than the project duration	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
<b>Loss of connectivity</b>	L	H	Ensure proper coverage at deployed locations	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
<b>Radar displacement</b>	L	H	Take measures to prevent it during installation and monitor reported measurements to detect anomalies	UC#2.1a, UC#2.1b, UC#2.3
<b>Battery exhaustion</b>	L	H	Monitor battery level to prevent it	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3
<b>IoT device displacement</b>	L	H	Take measures to prevent it during installation and monitor reported measurements to detect anomalies	UC#2.1a, UC#2.1b, UC#2.2, UC#2.3, UC#2.4a, UC#2.4b