OPEN CALL #1

TECHNICAL GUIDELINES CL2 INFORMATION

Revision: V1

COVER PAGE

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CLUSTER 2: SMART SUSTAINABLE IOT SOLUTIONS (VALENCIA)

1.1 CLUSTER OVERVIEW

Cluster Title	Cluster 2: Smart Sustainable IoT Solutions
Domain	Smart cities, Smart buildings, urban development, environmental monitoring
Locations	Valencia, Spain (City, port, industrial park, UPV campus)
Objective	Implement city-wide IoT platform for real-time urban optimization including traffic, surveillance, environmental monitoring, waste management, and water conservation

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 are 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.

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.

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.

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.

All these characteristics offer the right playground for other parties to enter and improve the ecosystem, by either propose new use cases to test the cluster infrastructure and/or improve the infrastructure with new IoT devices of platform extensions, all within the context of smart cities and collaborative IoT-edge-cloud platforms.

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, as well as different IoT devices. These radars will provide high-precision classification of vehicle types and real-time vehicle counting, supporting data-driven urban mobility strategies. The IoT sensors will provide high-precision measurement of waste and water levels, as well as people detection in smart buildings. Six pilot use cases have been proposed to increase the mobility and optimize transportation and management planning in different situations targeted to be developed within the consortium, by the cluster 2 partners:

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

- UC#2.1B "**FLOOD WARNING AND MITIGATION SYSTEM THROUGH RADAR SENSING**": Because of its location, several areas of Almussafes and the near-by 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 the different locations, the evolution of the flood can be tracked, and decisions can be made in real time, for example, regarding evacuation of personnel.

- UC#2.2 "**SMART RESOURCES MANAGEMENT IN THE UPV CAMPUS**": 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.

- UC#2.3 "**MARITIME TRAFFIC MONITORING AND BERTHING ASSISTANCE**": 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.

- UC#2.4A "**IoT-DRIVEN SMART BUILDING MANAGEMENT**": 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.

- UC#2.4B "**IoT-BASED ENVIRONMENTAL QUALITY MONITORING SYSTEM**": 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.

1.2 AVAILABLE INFRASTRUCTURE & TECHNICAL CAPABILITIES

To operationalize the Cluster2 activities, the COP-PILOT architecture establishes an integrated environment connecting the different domains where the use cases are deployed. As shown in figure 6, the UPV Campus and Valencia Port serve as the two computational domains, each providing computing capabilities and private 5G networks. These domains are interconnected through the Secure Integration Fabric (SIF), ensuring coordinated management and secure data exchange.

Across all Cluster 2 locations (UPV Campus, Valencia Port, Almussafes, and the City), the use cases involve the deployment of sensors and IoT devices. In Almussafes and the City, no local computing infrastructure is available, so the data generated in these scenarios is transferred to the UPV Campus, where the processing takes place.

The architecture also incorporates the Thinking Cities platform from Telefónica as an observability point, providing visibility over the data streams and the behavior of the deployed use cases across the different scenarios.

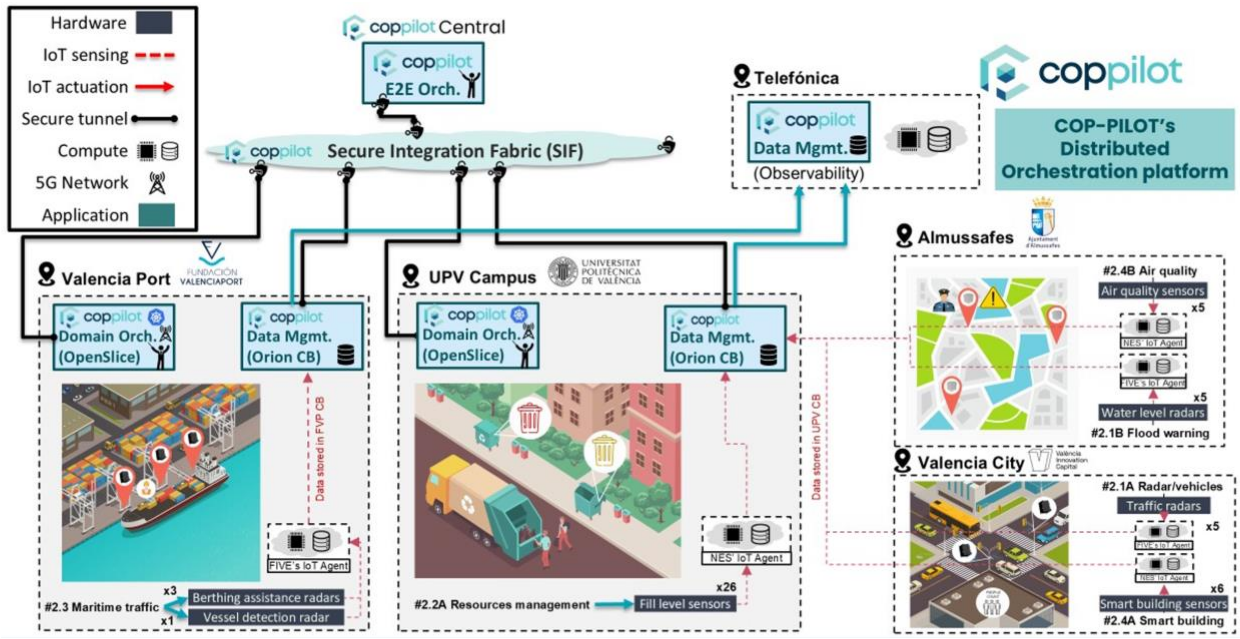

Figure 1- Cluster 2 architecture.

Cluster 2 includes the following domains:

- 1- Universitat Politècnica de València (UPV) Campus
- 2- Valencia Port

For each of the domains, we list below the current infrastructure components and their availability to be utilized by applicants.

Table 1: Infrastructure components provided by the Cluster 2 UPV Campus domain.

Infrastructure type	Description
Physical compute infrastructure	• 1 x HPE ProLiant DL325 Gen10 Plus server with an AMD EPYC 7702P processor (64 cores), 512 GB RAM, 2 x 960 GB SSDs, and 4 x 1.2 TB SAS 10K HDDs
Virtual compute infrastructure	• 1 x VM (to host the OpenZiti Edge Router (COP-PILOT Secure Integration Fabric component)) with: 4 vCPUs 8 GB RAM 32 GB storage 1 x physical network interface • 1 x VM (to host FIWARE Orion Context Broker (COP-PILOT Data Management component)) with: 4 vCPUs 8 GB RAM 32 GB storage 1 x physical network interface • 1 x VM (to host ETSI OpenSlice (COP-PILOT Domain Orchestrator component) which manages a K8s cluster and the private 5G network) with: 8 vCPUs

	16 GB RAM 50 GB storage 1 x physical network interface ● 3 x VM to host a K8s cluster to host the necessary Cluster2 applications for this domain (to be provisioned by the COP-PILOT orchestrators) with: 6 vCPUs 10 GB RAM 80 GB storage 1 x physical network interface
Physical network infrastructure	Dedicated switches/routers: Nokia IXR 7250 Private 5G network: Coverage and deployment: ● The 5G network is deployed across the UPV Vera Campus, providing indoor and outdoor coverage for testing and UC execution. Sites and operating bands: Two outdoor sites: ● 5G SA on n40 ● 5G NSA on n258 with LTE B7 anchoring and the possibility of working in SA mode One indoor site: ● 5G SA on n78, using pico-antennas in the Immersive Communications Lab Spectrum and PLMN configuration: ● Spectrum from Telefónica: B7, n78, n258 (5 + 5 MHz, 100 MHz, 800 MHz) ● UPV owned spectrum: n40 (20 MHz) PLMNs: ● 21438 for n258 and B7 ● 99999 (private) for n40 and n78 Radio units and antennas: ● AWEUD-475168 (n258 mmWave, 2T2R, up to 800 MHz OBW, 32 beams) ● AHHA-474147A (LTE B7, 4T4R, 20 MHz) ● AZNA n40 + Commscope VV-65A-R2 (n40, 4T4R, 80 MHz OBW) ● ASiR-pRRH n78 (indoor, 256QAM, integrated omni antenna) This domain communicates with: ● Almussafes and Valencia City scenarios to receive data generated from IoT sources to be processed by the UPV's FIWARE Orion Context Broker. ● The Data Observability Platform (Thinking Cities from Telefónica) The COP-PILOT Central Platform and E2E Orchestration Management. This communication takes place via COP-PILOT's Secure Integration Fabric via private secure tunnels.
Virtual network infrastructure	Proxmox Virtual Environment (PVE) used as the hypervisor to manage VMs and provide virtual networking

Physical IoT infrastructure (or data sources)	Traffic monitoring radars (next deployments tbd). The radars have 5G/LTE connectivity and report detected vehicles' velocity, direction, classification according to size and lane. Water level radars, with NBIoT/CAT-M connectivity, that report on the detected level of water on the deployed location by comparing a live measurement of distance to ground with a reference value. 5G radars near the UPV Campus Air quality sensors: 5 LoRaWAN devices located in Almussafes providing formaldehyde levels. Smart building sensors: 6 LoRaWAN devices installed at La Harinera reporting people flow (people in and people out) at different building locations. Fill level sensors: 26 NB-IoT devices in UPV that monitor container waste accumulation through ultrasonic level measurements. Percentage level is reported.
Virtual IoT infrastructure (or data sources)	N/A
Infrastructure Availability for COP-PILOT and Open Calls	• This infrastructure is fully available for COP-PILOT to deploy necessary platform and application component for the validation of Cluster2 and potential Open Call projects to be integrated with this cluster in the near future. • Open Call projects may bring and deploy a new domain within Cluster 2, introducing complementary technologies, datasets, or services; or they may host and validate their solution within one of the existing Cluster 2 domains, leveraging its infrastructure, data environment, and demonstration use cases.

Table 2: Infrastructure components provided by the Cluster 2 FVP domain.

Infrastructure type	Description
Physical compute infrastructure	• 1 x Dell Inc. PowerEdge R740xd - 14 CPUs x Intel(R) Xeon(R) Gold 5120 CPU @ 2.20GHz 127.49 GB RAM 8T hard solid disk (RAID 5)

Virtual compute infrastructure	• 1 x VM (to host ETSI OpenSlice (COP-PILOT Domain Orchestrator component) which manages the private 5G network) with:
	  ◦ 8 vCPUs
	  ◦ 16 GB RAM
	  ◦ 50 GB storage
	  ◦ 1 x physical network interface
	• 1 x VM (to host FIWARE Orion Context Broker (COP-PILOT Data Management component)) with:
	  ◦ 4 vCPUs
	  ◦ 8 GB RAM
	  ◦ 32 GB storage
	  ◦ 1 x physical network interface
	• 1 x VM (to host ETSI OpenSlice (COP-PILOT Domain Orchestrator component) which manages a K8s cluster) with:
	  ◦ 8 vCPUs
	  ◦ 16 GB RAM
	  ◦ 50 GB storage
	  ◦ 1 x physical network interface

	• 1 x VM to host a K8s cluster to host the necessary Cluster2 applications for this domain (to be provisioned by the COP-PILOT orchestrators) with:
	  • 6 vCPUs
	  • 10 GB RAM
	  • 50 GB storage
	  • 1 x physical network interface

Physical network infrastructure	Radio Access Network (RAN): • Standalone 5G network. • N40 TDD band • Bandwidth 30 MHz • 32T32R MIMO • Coverage in more than 80% of the port area. RAN Capacity and Performance: • Max. Capacity: >4.3 Gbps • TDD frames: 3/7 semi-static to maximize Uplink • UL > 45Mbps; DL > 135Mbps Core Network: • Deployment Model: Georedundant distributed core • Supported Subscribers > 25000 • Private Network Tenant: Portable latest-generation 5G node (Fundación Valenciaport).
Virtual network infrastructure	N/A
Physical IoT infrastructure (or data sources)	4 deployed berthing assistance radars, 1 maritime traffic monitoring radar to be integrated Berthing assistance radars, deployed on a dock, with 5G connectivity. The radars detect and report the distance to a berthing ship providing real time updates on the docking process. Maritim traffic radars, deployed at the entry of the port, with 5G connectivity, that detect the passing of a ship and its direction.
Virtual IoT infrastructure (or data sources)	N/A
Infrastructure Availability for COP-PILOT and Open Calls	This infrastructure is fully accessible for COP-PILOT to deploy the required platform and application components for the validation activities of Cluster 2. It also prepares the ecosystem for future Open Call projects that may integrate their solutions into this cluster. Open Call participants will have the option to either introduce a new domain within Cluster 2 (adding complementary technologies, datasets, or services) or to integrate directly within one of the existing Cluster 2 domains. In both cases, they will be able to leverage the available network infrastructure, data capabilities, and operational demonstration scenarios for validating their solutions. Network Integration and Mobility Features: • Multi-network operation: Support for two independent private 5G networks to ensure continuity of service. • Seamless coverage: Connectivity guaranteed along the full operational route, from the port's main entrance to the internal terminal areas. • Network slicing: Advanced prioritization of critical telemetry and remote-control traffic.

	• Cross-site interconnection: Dedicated fiber infrastructure linking the UPV Lab and the Fundación Valenciaport 5G Lab, enabling flexible component deployment and execution across locations.

Thinking Cities platform

Thinking Cities, is an IoT management platform by Telefónica. The platform is designed as an end-to-end middleware solution, targeting integrators, developers, data providers, and end users in smart-city scenarios. The Thinking Cities platform presents a layered architecture in accordance with the UNE 178104:2017 standard defined by AENOR. Each layer groups related capabilities in a clear way to ensure systems work together and allow smooth integration of apps and services.

Platform Architecture

The platform is based on the standards and interfaces developed within the framework of the European FIWARE project, and the following image shows its modules and interfaces at a high level:

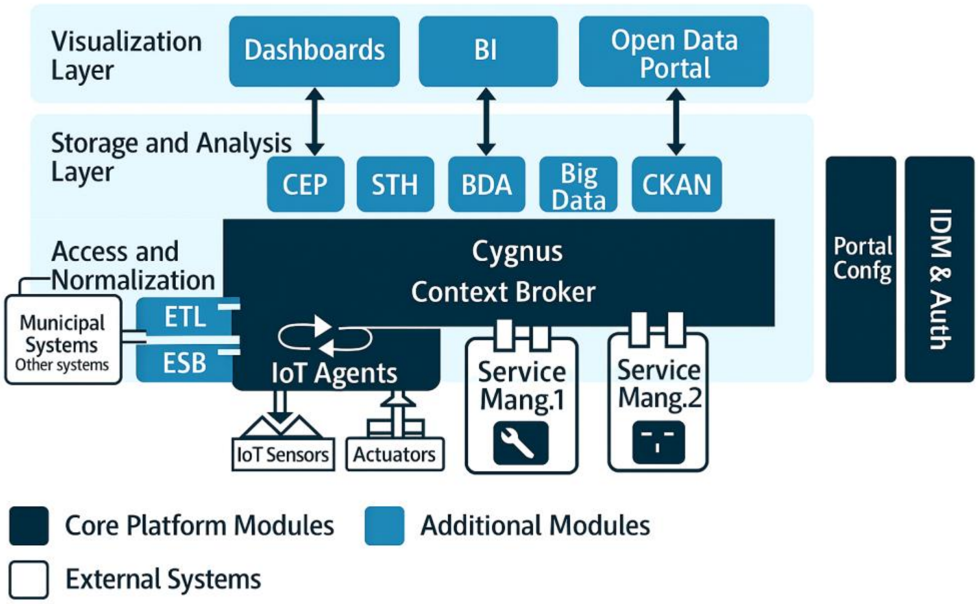

Figure 2- Cluster 2 Thinking Cities Platform.

The Core Modules of the platform are the components required to provide the platform's basic functionalities. These modules are mainly based on FIWARE components and in-house developments. They are essential for deploying the platform.

The Additional Modules are platform components that provide extra functionality and are mainly based on integrations with third-party products. These components are not essential for the platform to operate and may or may not be included in a platform deployment.

Components description

IoT Agents

IoT Agents serve as the bridge between physical devices and the platform's context management core. They support multiple protocols (UL2.0, JSON over HTTP, and MQTT) and transform raw sensor observations into standardized **NGSI** updates. Configuration is handled via attribute-mapping rules defined in the Administration Portal or via REST APIs. In addition to ingesting data, IoT Agents also enable bidirectional communication, allowing commands from the Context Broker to be routed back to devices.

Context Broker (Orion)

The Orion Context Broker is the heart of Thinking Cities' real-time data management. It implements the OMA NGSIv2 interface for creating, updating, and querying entities, and it manages subscriptions that trigger notifications whenever an entity's state changes. This ensures that all downstream modules receive timely context updates without polling.

NGSI Data Adapter (Cygnus)

Cygnus listens for notifications from the Context Broker and persists those notifications to a variety of storage backends. It can operate in "row" or "column" mode depending on whether dynamic attribute storage or a pre-provisioned schema is in use. Supported sinks include MongoDB, MySQL, PostgreSQL, Hadoop HDFS, and CKAN.

Short-Term Historic Storage (STH)

The STH component uses MongoDB to store recent time-series data for fast retrieval. It exposes an NGSI-compatible REST API that supports both raw data queries and aggregated computations (mean, max, min, and standard deviation), making it ideal for powering near-real-time dashboards.

Analytical Database (BDA)

For longer-term and more complex analyses, data is also stored in a relational analytical database (MySQL or PostgreSQL). Each NGSI entity type maps to a table containing standardized metadata (recvTime, service path, entityId, entityType) alongside attribute columns. This optimized schema ensures minimal latency for BI tools querying large volumes of historical data.

Complex Event Processing (CEP)

Built on the Esper engine, the CEP module subscribes to context changes and evaluates complex event patterns in real time. When defined conditions are met—such as a threshold breach or sequence of events—CEP can generate alerts via email, SMS, or additional NGSI callbacks into the platform.

Big Data Stack

At the core of the Big Data layer is the Apache Hadoop ecosystem. HDFS provides scalable storage of historical datasets, while YARN and MapReduce enable distributed batch processing. This environment supports advanced analytics, including machine learning model training on city-scale data.

Open Data Portal (CKAN)

CKAN offers a public-facing portal for publishing curated datasets. It provides search, preview (maps, charts, tables), and a REST API for automated data ingestion and retrieval. This fosters transparency and allows developers, researchers, and citizens to build their own applications on top of platform data.

IDM & Access Management

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Security is enforced via Keystone for identity management, PEP proxies for API protection, and KeyPass implementing XACML policies for fine-grained access control. Tokens issued by Keystone govern who can read, write, or administer each microservice.

Administration & Configuration Portal

A web-based portal consolidates management of all platform entities—services, subservices, users, devices, subscriptions, and CEP rules.

Role-based access (ServiceAdmin, SubserviceAdmin, SubserviceCustomer) ensures that each stakeholder has the appropriate level of control over their domain.

Integration Capabilities

IoT Agents act as the entry point for all sensor data (called devices) into the Thinking Cities platform, translating raw observations into NGSI updates. They support UL2.0 and JSON payloads over HTTP or MQTT, with extensibility to any other protocol via custom agent development.

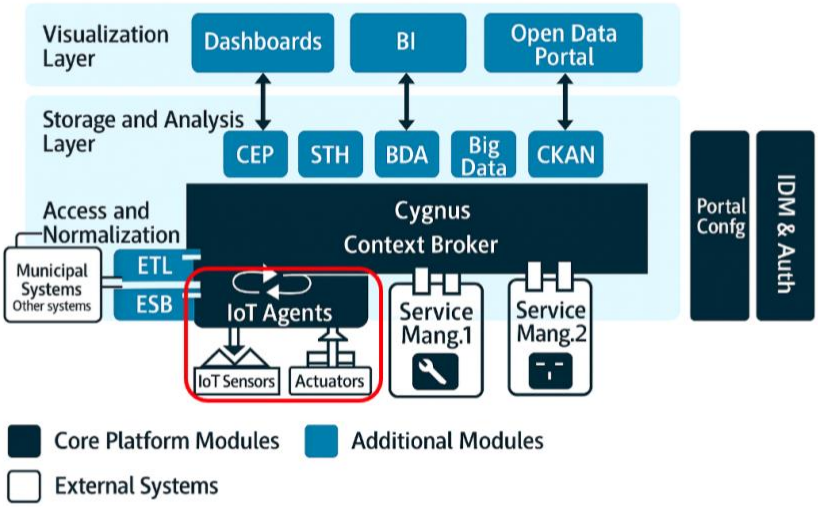

Figure 3- Cluster 2 Integration Capabilities

In this case, sensor data is stored in the platform through IoT Agents. By default, an IoT Agent does not need prior knowledge of the devices it serves, it will accept any incoming UL2.0 or JSON message over HTTP/MQTT and forward it as NGSI context updates.

However, when specific transformations or mappings of device data are required, such as publishing parameter X sent via protocol P under attribute A, the device must be provisioned in the agent. Provisioning lets you define attribute-mapping rules, static metadata (for example, device colour or fixed location), and the Context Broker entity name that will aggregate all device information. While provisioning is only strictly necessary for such customized behaviours, it is generally recommended to pre-provision devices for greater control and consistency.

What Applicants Can Access:

✓ Testbed infrastructure and equipment
✓ Edge computing resources
✓ Connectivity (5G/6G or LoRaWAN)
✓ Sensor networks and IoT devices

✓ Data collection and storage
✓ Technical mentoring and support
✓ Integration with COP-PILOT platform
✓ Documentation and APIs
✓ Training and workshops
✓ Community collaboration opportunities

Applicant solutions must be compatible with:

✓ Open standards and protocols
✓ COP-PILOT platform APIs
✓ Edge-to-cloud architecture
✓ Data governance frameworks
✓ Security and compliance requirements
✓ Interoperability specifications
✓ Container deployment (Docker, Kubernetes)
✓ Real-time data processing
✓ GDPR and data protection regulations

1.3 CLUSTER 2 TECHNOLOGIES, STANDARDS, AND (OPEN-SOURCE) COMMUNITIES

To support the use cases of Cluster 2, a set of different software components has been developed. This table enumerates the different components, and provides information on their open-source status, relevant standards, and underlying technologies.

Table 3: Cluster 2 Technologies, Standards and (Open-Source) Communities

Component	Open Source	Standard / Reference Framework	Main Technologies
IoT Agents	Yes	FIWARE IoT Agents	NGSI-LD, MQTT, HTTP
Context Broker	Yes	FIWARE Orion-LD Context Broker	NGSI-LD
Identity & Authorization Management	Yes	OAuth 2.0 Authorization protocol (RFC 6749)	Keycloak
Secure Context APIs	Yes	NGSI-LD + OAuth 2.0	REST APIs
Data Models	Yes	Smart Data Models	NGSI-LD, JSON
Domain Orchestrator	Yes	ETSI OpenSlice (SDG), TMF633/641/638	Kubernetes, OpenSlice
Secure Integration Fabric (SIF)	Yes	CNCF SPIFFE, OAuth 2.0, mTLS	OpenZiti
E2E Orchestrator (ESO)	Yes	ETSI ZSM, TMF Service/Resource Mgmt	OpenSlice HypO

In addition to this, Thinking Cities Platform is also part of Cluster 2 architecture. Thinking Cities Platform is based on a FIWARE NGSI-v2 based architecture with proprietary extensions.

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Table 4: Thinking cities platform principal components

Component	Open Source	Standard / Reference Framework	Main Technologies
IoT Agents	Yes	FIWARE IoT Agents	NGSI, MQTT, HTTP, AMQP
Context Broker	Yes	FIWARE Orion Context Broker	NGSI v2
Context Data Storage	Yes	FIWARE Orion	MongoDB
Data Ingestion & ETL	Yes	FIWARE Cygnus	Apache Flume, NGSI v2
Short-Term Historic Storage (STH)	Yes	FIWARE STH-Comet	MongoDB
Long-Term Historic Storage	Yes	—	HDFS, Hive, PostgreSQL
Analytical Database (BDA)	Yes	—	MySQL, PostgreSQL
Complex Event Processing (CEP)	Yes	—	Esper
Big Data Infrastructure	Yes	Apache Hadoop Ecosystem	HDFS, Spark, Hive
Open Data Portal	Yes	FIWARE CKAN	CKAN, REST APIs
Identity Management	Yes	FIWARE Keyrock	OAuth 2.0, OpenID Connect
Authorization & Policy Enforcement	Yes	FIWARE AuthZForce	XACML
Secure Context APIs	Yes	NGSI + OAuth 2.0	REST APIs
Security Monitoring & Auditing	No	—	Proprietary
Visualization & Dashboards	No	—	URBO
Administration & Configuration Portal	No	—	TEF Proprietary
Data Models	Yes	FIWARE Smart Data Models	NGSI, JSON

This table describes the components of the Thinking City platform, detailing which of them are open source and which are not, the standard on which they are based, and the technologies used in them.

All documentation can be found on the following URLs:

- https://thinking-cities.readthedocs.io/en/latest/index.html
- https://github.com/telefonicaid

1.4 OPEN CALL CHALLENGES & INNOVATION OPPORTUNITIES

Applicants are expected to propose use cases, demonstrators, software modules, or prototype integrations that can be validated in the different locations of cluster 2 testbed within a 8-month timeframe. Proposals should clearly describe the technical innovation, integration approach with existing COP-PILOT and Cluster 2 components, and expected impacts, demonstrating improvements in efficiency, sustainability, or interoperability. Solutions are expected to start at a minimum Technology Readiness Level (TRL) 6 and reach TRL 7–8 by the end of the project, ensuring deployment-ready maturity and clear validation under real operational conditions.

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The following challenges represent areas where applicants can propose solutions to enhance **cluster 2** capabilities and demonstrate innovative approaches.

- Smart Access and Resource Management at UPV Campus
- Robotic patrol and surveillance at UPV Campus (and/or Valencia City)
- Autonomous terminal shuttle
- Municipal buildings management

OC#2.1. "**Smart Access and Resource Management at UPV Campus**": This use case aims to digitalize and automate two key operational processes at the Universitat Politècnica de València:

- Access management, by sensorizing and remotely controlling motorized gates and barriers in parking and restricted areas. The current manual system relies on security personnel to operate these elements, often leading to delays when the guard is busy. The new system will enable secure remote operation and status monitoring of these access points, improving both efficiency and user experience.

- Water resource management, by replacing traditional water meters with smart LoRaWAN-enabled ones for real-time consumption monitoring, leak detection and data-driven maintenance. These devices will provide valuable insights to support sustainability goals and optimize water usage on campus.

The users involved are campus security staff, maintenance workers, UPV as the LoRaWAN network manager and students and staff benefiting from faster access and improved resource management.

The technologies used are the IoT sensors and actuators (gate controllers, barrier sensors, smart water meters), the private LoRaWAN network for low-power, long-range connectivity and the management platform for monitoring.

The use case will be implemented in the UPV Campus, including parking areas, selected building entrances and water network nodes.

OC#2.2. "**Robotic patrol and surveillance at UPV Campus (and/or Valencia City)**": This use case aims to enhance security, surveillance, and situational awareness at the UPV campus and selected urban areas in Valencia through autonomous robots (robotic dogs).

The main goals are:

- Campus security: Robotic dogs patrol predefined routes, detect unusual activity, and provide live video and sensor data to security personnel. This reduces dependency on human patrols and increases coverage efficiency.
- Urban collaboration: in collaboration with Valencia local police, robotic dogs can assist in public safety operations, providing mobile surveillance, rapid situational reporting, and remote sensor monitoring in urban environments.

Users involved:

- UPV security staff
- Valencia local police
- Robotics operators and maintenance teams
- IT services for 5G network management

Enabling technologies:

- Autonomous quadruped robots with cameras, LiDAR, and environmental sensors
- Private 5G network for ultra-low latency, high-bandwidth connectivity
- Remote control and monitoring platforms (dashboards, mobile apps)
- Edge/cloud systems for real-time analytics, video streaming, and alerts

Test sites:

- UPV campus (València)
- Selected urban streets and public areas in collaboration with Valencia local police

OC#2.3. "**Autonomous terminal shuttle**": At the Port of Valencia, terrestrial mobility involves a diverse mix of vehicles, including trucks delivering and retrieving cargo, private cars of employees from eight different terminals, Port Authority personnel, maritime service workers (mooring, piloting, etc.), and staff from external companies performing construction and maintenance operations. This could lead to more frequent bottlenecks and congestion; particularly as global trade growth brings a higher influx of trucks.

This use case aims to test and analyse roaming between two private networks, ensuring smooth transportation of employees between the common port area and terminal-controlled zones. By enhancing safety, interoperability, and network cooperation, it addresses key regulatory concerns, paving the way for faster adoption and regulatory approval of autonomous shuttles in ports and beyond. The use case goes beyond the current state of the art by integrating private 5G networks, advanced network slicing, and V2X communication to enable real-time remote control of autonomous vehicles in critical situations.

To optimize mobility under these challenging conditions, the port is exploring a smarter way to transport employees and workers from the port's main entrances to terminals, buildings, and outdoor work sites. The proposed solution involves deploying autonomous shuttle buses to transport personnel, significantly reducing private car use and freeing up road space for the increasing volume of cargo-related traffic (e.g., trucks). The autonomous shuttles will be equipped with a backup system that allows manual remote operation from a control centre using a remote-control cockpit. This requires ultra-reliable, low-latency connectivity to enable safe, precise, and real-time vehicle control.

Enabling technologies:

- 5G SA private network with advanced network slicing capabilities, ensuring the safe teleoperation of shuttles in challenging port conditions.
- V2I (Vehicle-to-Infrastructure) and V2V (Vehicle-to-Vehicle) communication technologies will be integrated to enhance overall autonomous driving safety.
- Road-mounted cameras can detect obstacles beyond the vehicle's line of sight, sending alerts to autonomous shuttles to prevent collisions and ensure seamless operations.

OC#2.4. "**Municipal buildings management**": The pilot will be able install further IoT devises to measure, analyse, and visualize the behaviour of municipal buildings in Valencia. We have wireless IoT and wired sensing for temperature, humidity, CO_2, occupancy, and energy consumption, combined with integration of third-party data sources. This gives us high-resolution insight into comfort, usage patterns, and inefficiencies.

The next step has two layers. First, we need intelligent analytics that can translate raw data into concrete recommendations for facility managers — for example, where comfort can be improved (thermal, air quality, ventilation), where spaces are being conditioned while unoccupied, or where equipment is consuming more energy than expected. These insights should help the city the city council infrastructure managers understand how to improve operational efficiency and user comfort in each building, room, or zone.

Beyond that, what is still missing is the closed-loop automation layer that turns those insights into direct operational impact.

We require an interoperable, cybersecure and explainable actuation layer that can execute real-time control strategies across diverse public buildings. This layer should be able to:

- Adjust climate control parameters (heating/cooling/ventilation) based on occupancy, comfort targets, outdoor conditions, and energy cost.
- Switch equipment on/off or move it into low-power modes when spaces are not in use.
- Regulate and schedule energy consumption to avoid peaks and support sustainability targets.
- Detect operational anomalies (e.g. abnormal consumption, HVAC malfunction, comfort drifts) and trigger corrective actions or maintenance alerts.

Every proposal submitted to Cluster 2 should analyse the environmental, economic and technological impact, and its progress beyond state of the art, as well as replication and scalability aspects.

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