



OPEN CALL #1

TECHNICAL GUIDELINES CL4 INFORMATION

Revision: V1

COVER PAGE

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TABLE OF CONTENTS

COVER PAGE	2
TABLE OF CONTENTS	3
1 CLUSTER 4: SMART VINEYARDS & SUSTAINABLE WINERY ECOSYSTEMS	4
1.1 Cluster Overview.....	4
1.2 Available Infrastructure & Technical Capabilities	6
1.3 Open Call Challenges & Innovation Opportunities.....	18
1.4 The Cluster 4 Technologies and Protocols	20
1.5 The Cluster 4 Platform Standards and Communities	21

1 CLUSTER 4: SMART VINEYARDS & SUSTAINABLE WINERY ECOSYSTEMS

1.1 CLUSTER OVERVIEW

Cluster Title	Cluster 4: Smart Vineyards & Sustainable Winery Ecosystems
Domain	Wine ecosystem, vineyards, viticulture, and winery ecosystem
Locations	Multiple pilot sites across Europe (Portugal, Spain, Ireland, and Switzerland)
Objective	Bring digital intelligence to the wine ecosystem, establishing connected vineyards where field data drives production decisions and promote sustainable, optimised processes.

Europe's wine sector is changing amid pressure from climate, water scarcity, resource constraints, and rising expectations for environmental sustainability. Cluster 4 addresses these challenges by deploying interoperable IoT, AI/ML and robotics across the wine ecosystem. The cluster integrates three complementary domains, i.e., smart vineyards, circular IoT infrastructure, and optimised winery production lines into a unified demonstration of sustainable viticulture. The piloting environments include (i) operational vineyards using Terraview's agronomic analytics and data-driven irrigation workflows, (ii) winery production lines equipped with JIG's IoT-enhanced monitoring, (iii) RedZinc's IoT lifecycle management facilities enabling circular sensor re-use in agriculture, and (iv) Nokia's 5G Green-Powered experimental site, providing long-range wireless connectivity and remote robotic capabilities for advanced agricultural operations. In the vineyards, monitoring relies on a combination of field sensors, weather stations, satellite imagery, drones, and other spatial or visual detection tools to provide high-resolution situational awareness. Together with COP-PILOT's distributed orchestration capabilities, these platforms enable real-time data acquisition, cross-domain integration, and the deployment of advanced AI/ML workloads.

Cluster 4 tackles a broad range of operational, environmental, and technical challenges affecting modern vineyards and wineries. Vineyards face rugged terrain, variable network coverage, and significant operational maintenance costs. Water scarcity and climate variability demand accurate, predictive irrigation planning that combines soil, weather, satellite, and crop-growth data. Wineries require consistent monitoring of throughput, machinery behaviour, and bottleneck detection across fast-paced bottling lines, yet often rely on manual tracking and non-digitised operations. Ensuring robust connectivity across large agricultural parcels is a persistent issue, alongside the energy limitations of distributed sensors operating in remote or low-access areas. Furthermore, accelerating climate variability imposes new pressures on water use, crop planning, and production resilience, making decision-support tools essential for long-term sustainability. On the data side, vineyards and wineries generate heterogeneous information that must be integrated securely and reliably. While efficient irrigation remains a core challenge, these data sources can also support wider monitoring

tasks such as disease detection, growth tracking, and environmental risk assessment. Wineries face additional challenges related to sensor calibration and device interoperability with existing production systems. Cross-cutting issues include cybersecurity and privacy in distributed operations, as well as the financial burden of deploying and maintaining sensor fleets.

The ambition of Cluster 4 is therefore to create a unified and sustainable digital ecosystem that connects vineyard sensing, winery production, IoT, and device lifecycle management. Vineyard monitoring is enriched through multiple complementary data sources (ground sensors, weather information, satellite imagery, drone-based imaging, etc.), creating a coherent situational picture of vineyard conditions. While at the vineyard level, the cluster currently concentrates on smart irrigation and water efficiency, the digital foundation it builds naturally enables broader monitoring applications that vineyards may adopt in the future. Vineyard richer insights are also expected to support more predictable production planning, helping wineries better anticipate harvesting volumes and timing, thereby improving scheduling, resource allocation, and overall efficiency in the bottling and packaging stages. These ambitions are directly aligned with the vision of a more resilient viticulture, reduced waste, optimised resource use, and higher production quality. The cluster empowers wine producers, agronomists, IoT integrators, and manufacturing operators to validate market-ready technologies in realistic conditions, opening new commercial opportunities and supporting the EU's green transition objectives.

To achieve this ambition, the cluster partners, roles, and UCs are designed to fully align in a coherent and complementary way, leading to the following cluster-level objectives:

- **Obj#4.1: Enhance Operational and Economic Efficiency** - Use IoT for real-time insights and process optimisation to boost efficiency and process utility, reduce costs, and ensure compliance.
- **Obj#4.2: Advance Technological Innovation and Sustainability** - Merge IoT, AI, and ML to innovate and automate, thereby reducing the environmental footprint and promoting sustainability.
- **Obj#4.3: Foster scalability and collaborative data-driven insight in EU sovereign and GDPR compliant data ecosystem** - Create a GAIA-X/IDSA-compliant IoT data framework serving EU and global deployments.

These objectives are aligned with COP-PILOT's ambition to orchestrate interoperable, multi-domain IoT infrastructures across heterogeneous operational environments. Cluster 4, reflecting key market trends driven by climate pressures and EU digitalisation priorities, demonstrates how vineyards and wineries can adopt data-driven, climate-resilient approaches. The use of renewable-powered connectivity and interoperable IoT platforms highlights the viability of advanced digital services in rural areas, supporting new agritech offerings and improving production predictability, including bottling efficiency. Circular IoT workflows address the rising demand for environmentally responsible device management, while alignment with GAIA-X positions the cluster as a model for future agricultural data spaces. The expected outcomes of Cluster 4 are:

- **EO#4.1: Enhanced Efficiency and Sustainability Through IoT Integration** - IoT solutions aim to improve operational efficiencies in various industries by enabling real-time monitoring and process optimisation. This not only supports environmental sustainability but also reduces waste.
- **EO#4.2: Cost-Effective Modernisation and Scalability** - The deployment of IoT sensors and software allows for the cost-effective modernisation of operations, ensuring scalability for future growth without requiring large initial investments.

- **EO#4.3: Sovereign data GAIA-X/IDSA conform IoT platform incorporating AI/ML Technologies** - The use of AI and ML technologies facilitates informed decision-making by analysing data and predicting outcomes, enhancing efficiency and effectiveness across diverse industries, and paving the way for future innovations.

Cluster 4 use cases depicted in Figure 1 can be summarised as follows:

- **UC#4.1 “Circular IoT Sensor Lifecycle Management”** – RedZinc demonstrates workflows for cleaning, refurbishing, testing, and reconfiguring IoT sensors for redeployment in vineyards and other agricultural scenarios, reducing e-waste and improving device sustainability.
- **UC#4.2 “Water Utilisation Efficiency Through Satellite and IoT Data Fusion”** – Terraview deploys a combination of satellite imagery, climate data, and in-field sensors to deliver precise irrigation recommendations, supporting adaptive vineyard management under climate stress.
- **UC#4.3 “Smart Winery Production Optimisation Through OEE Monitoring”** – JIG implements a FIWARE-based monitoring tool to capture real-time bottling-line performance, identify inefficiencies, and increase overall equipment effectiveness in winery operations.
- **UC#4.4: “Advanced Agricultural IoT for vineyards by using 5G Green powered site and AGV Remote Driving”** – Nokia SP provides a renewable-powered private 5G site in Matanzas-Soria for deploying vineyard IoT sensors, cameras, and robotic platforms. The site generates detailed energy and network KPIs, supports remote AGV and quadruped robot missions with real-time video and edge AI processing, and enables device charging using on-site green energy.



Figure 1- Cluster 4 Use Cases breakdown.

1.2 AVAILABLE INFRASTRUCTURE & TECHNICAL CAPABILITIES

To operationalise the Cluster 4 activities, the COP-PILOT architecture considers an integrated multi-domain environment linking the different vineyard, winery, and IoT lifecycle locations where the use cases are deployed. As shown in the figure below, the Terraview vineyard domain, the JIG winery production domain, the RedZinc IoT lifecycle domain, and the Nokia 5G Green Site operate as distinct computational and operational domains within the cluster. Each domain provides its own combination of IoT devices, data sources, and computing resources, ranging from field-edge analytics in vineyards to production-line monitoring systems in wineries. These domains are

interconnected via the Secure Integration Fabric (SIF), which ensures secure data exchange, coordinated service deployment, and federated resource management across geographically distributed sites. Across all Cluster 4 locations, the use cases involve deploying vineyard sensors and data sources. In some vineyard with limited on-site compute, data is securely transferred to a partner domain (e.g., ONE Portugal or Terraview) for processing through COP-PILOT's orchestrated edge-cloud continuum. Similarly, data from winery production lines and RedZinc's IoT lifecycle workflows is exchanged across domains to support predictive analytics, irrigation insights, and circular device management processes. The architecture also incorporates FIWARE-based data management components as a unified observability and interoperability layer, providing visibility into the data flows, operational behaviour, and cross-domain interactions of all use cases.

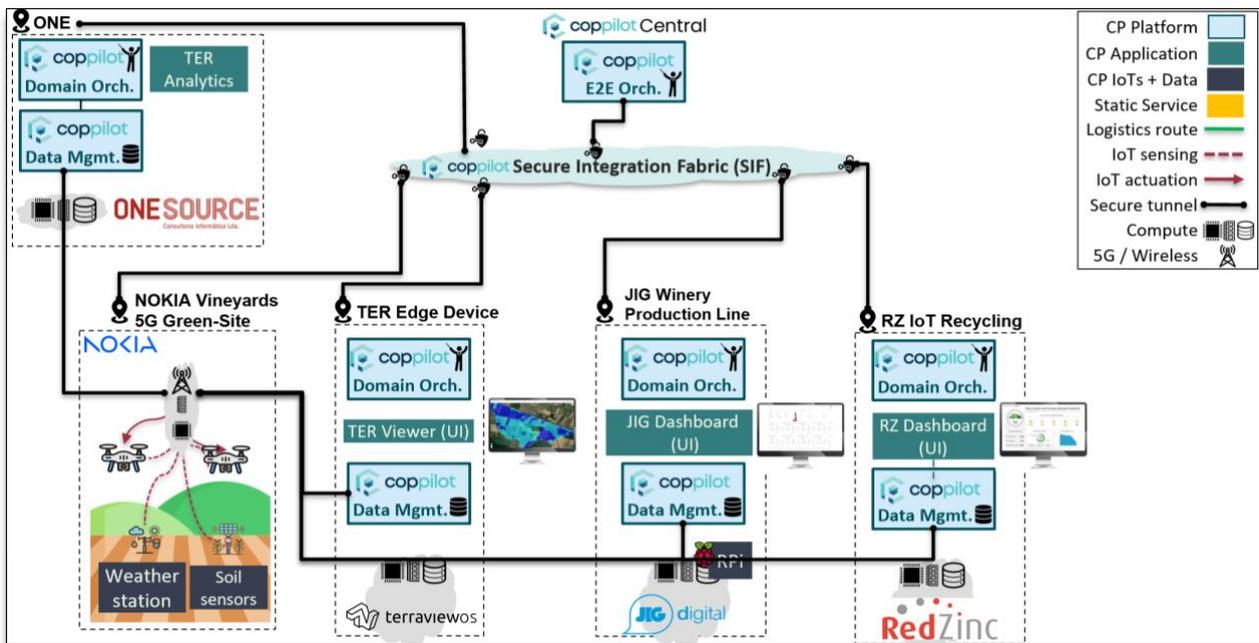


Figure 2 - Cluster 4 Infrastructure Overview.

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

Next figure depicts JIG's end to end industrial IoT architecture that connects warehouse sensors to a cloud native application stack for managing plant and production operations. On the left, physical sensors installed in the warehouse feed measurements into Raspberry Pi edge devices, which act as local gateways collecting and forwarding raw data.

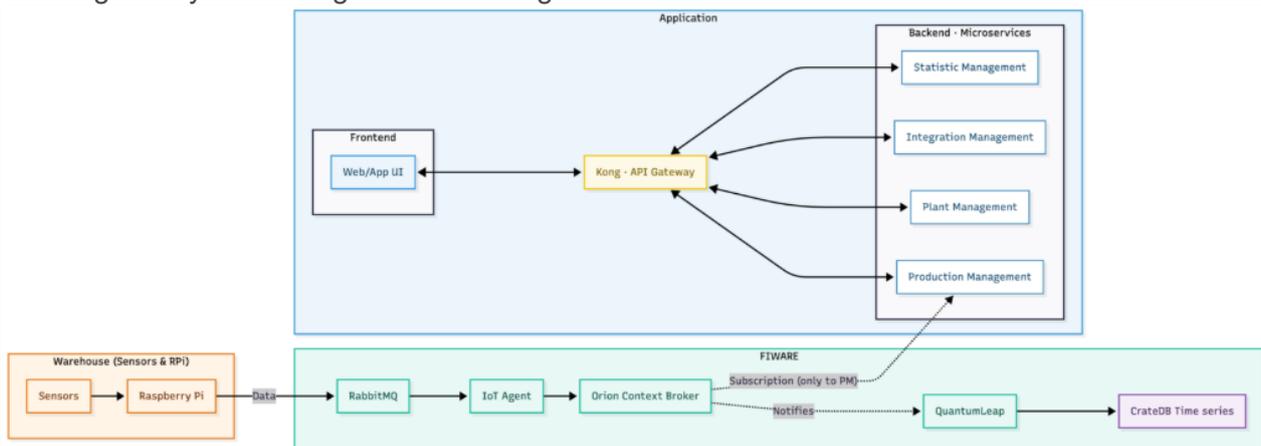


Figure 3 - Diagram of JIG end to end industrial IoT infrastructure

These gateways publish the sensor streams into a RabbitMQ message broker, decoupling device traffic from downstream services, and providing reliable buffering and routing. An IoT Agent consumes the RabbitMQ messages and converts them into standard NGSI-LD entities that are ingested by the FIWARE Orion-LD Context Broker as the central context management component. From Orion, a subscription sends relevant updates to QuantumLeap, which persists in all selected attributes as timeseries data into a CrateDB backend optimized for analytics over industrial measurements. This FIWARE data layer is integrated with the upper application layer, where a set of containerized microservices run on Kubernetes to provide statistics, integration, plant management and production management capabilities. Access to these microservices is unified through a Kong API gateway, which handles request routing, authentication, rate limiting, and other crosscutting concerns between the frontend and backend. The front-end Web/App UI communicates exclusively with the API gateway, ensuring that clients are decoupled from internal service topology while still exposing all required functionality for operators and managers. Production Management services can subscribe to context changes and timeseries data to calculate KPIs, detect anomalies and drive optimization workflows based on both real time and historical information. Overall, the architecture enables a modular, scalable, and standards-based environment where new IoT devices, analytics modules or external systems can be integrated with minimal changes to the core platform.

Table 1: Infrastructure components provided by the Cluster 4 - JIG domain.

Infrastructure type	Description
Physical compute infrastructure	Raspberry Pi gateways installed in the factory, connected to the local Ethernet network, plus one or more cloud VPS servers running Linux that host the Kubernetes cluster and backend services.
Virtual compute infrastructure	Kubernetes cluster on the VPS servers running the FIWARE components, OpenSlice domain orchestrator, and the web/microservice applications for plant and production management.
Physical network infrastructure	Wired Ethernet network linking sensors, Raspberry Pi devices and the factory switch/router, using shielded cabling in the plant to reduce electrical interference and ensure stable connectivity.
Virtual network infrastructure	Service to service communication provided by Kubernetes networking plus a secure overlay with OpenZiti to create encrypted tunnels between the factory edge, the cloud cluster and authorized external users.
Physical IoT infrastructure (or data sources)	Onsite sensors installed in the warehouse and production areas (for example temperature, humidity or machine status) wired to the Raspberry Pi gateways that capture and forward the measurements.
Virtual IoT infrastructure (or data sources)	FIWARE NGSI-LD entities and timeseries data stored in Orion, QuantumLeap and CrateDB, representing sensors, machines and production states, plus optional connectors to external systems such as ERP/MES.

Infrastructure Availability for COP-PILOT and Open Calls	The Kubernetes cluster, FIWARE data services and selected sensor streams are available for COP-PILOT and Open Call projects under controlled access, allowing third parties to deploy their own containers and consume testbed data securely.
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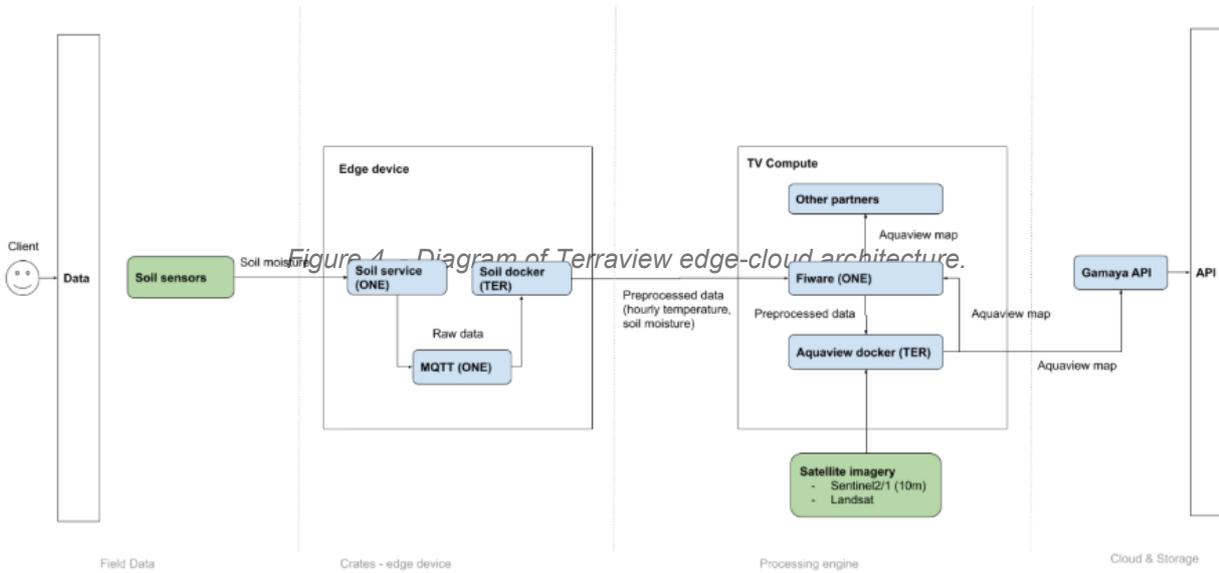


Figure 4. Diagram of Terraview edge-cloud architecture.

Figure 16 illustrates the Terraview edge–cloud architecture where agronomic data from multiple sources converges into a unified processing pipeline. Inputs include field soil sensors, satellite imagery (Sentinel-1/2 and Landsat), and data from APIs such as Gamaya and FIWARE. The edge device acts as the first processing layer, ensuring proximity-based computation and reduced data latency. At the edge processing level, containerized services (MQTT Broker, Soil Docker, etc.) and a local processing engine perform initial data treatment, including formatting, filtering, and generation of pre-processed datasets such as hourly soil moisture and temperature values. Data is then transmitted to the TV-Compute domain thanks to FIWARE which is installed on this domain, enabling reliable and continuous data exchange between the field and the cloud environment. Pre-processed data are stored and managed within cloud services. In the cloud analytics layer, Aquaview applies data fusion algorithms combining sensor data with spatial and satellite information to generate soil moisture maps and other geospatial products. These outputs are visualized through Aquaview Map which is transferred to Gamaya infrastructure through API and displayed via Gamaya Viewer, providing users with spatially resolved insights for monitoring and decision-making. This structured flow ensures seamless integration from data acquisition to visualization while maintaining scalability and interoperability across platforms.

Table 2: Infrastructure components provided by the Cluster 4 – TER domain (edge).

Infrastructure type	Description
Physical compute infrastructure	Avantech Compute Unit UNO-2372G V2

Virtual compute infrastructure	Micro k8s Kubernetes cluster
Physical network infrastructure	Wired Ethernet connection
Virtual network infrastructure	Accessible from external IP
Physical IoT infrastructure (or data sources)	Soil sensors in field
Virtual IoT infrastructure (or data sources)	Soil Service, MQTT Broker and Soil Service to process raw data from sensor and send them to the FIWARE Context-Broker instance in cloud
Infrastructure Availability for COP-PILOT and Open Calls	The Kubernetes cluster and sensor streams are available for COP-PILOT and Open Call projects under controlled access, allowing third parties to deploy their own containers and consume data securely.

Table 3: Infrastructure components provided by the Cluster 4 – TER domain (cloud).

Infrastructure type	Description
Physical compute infrastructure	Computer with 32 (Intel(R) Xeon(R) Gold 6226R CPU @ 2.90GHz), 32 GB RAM
Virtual compute infrastructure	Kubernetes k8s cluster
Physical network infrastructure	Wired Ethernet connection
Virtual network infrastructure	Accessible from external IP
Physical IoT infrastructure (or data sources)	None
Virtual IoT infrastructure (or data sources)	FIWARE Context Broker instance with farm data available, Aquaview data (API for accessing it to be created if needed)

<p>Infrastructure Availability for COP-PILOT and Open Calls</p>	<p>The Kubernetes cluster, FIWARE service and Aquaview data are available for COP-PILOT and Open Call projects under controlled access, allowing third parties to deploy their own containers and consume data securely.</p>
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The ONE domain provides a flexible and high-performance compute environment that supports COP-PILOT integration, orchestration, and data-processing needs within Cluster 4. It combines several multi-core servers, GPU-equipped nodes, and a virtualized infrastructure that hosts Kubernetes clusters running COP-PILOT components and research workloads. Local and shared storage are connected through high-bandwidth fibre-channel links, enabling efficient handling of large datasets and AI/ML pipelines.

Table 4: Infrastructure components provided by the Cluster 4 - ONE domain.

Infrastructure type	Description
<p>Physical compute infrastructure</p>	<p>2x Dell PowerEdge M520 with an Intel(R) Xeon(R) CPU E5-2430L (24 cores), 128 GB RAM,</p> <p>1x Dell PowerEdge M630 with an Intel(R) Xeon(R) CPU E5-2620 v4 @ 2.10GHz (32 cores), 256GB RAM</p> <p>1x HPE ProLiant DL630P Gen8 with an Intel(R) Xeon(R) CPU E5-2650 0 @ 2.00GHz (32 cores), 196 RAM</p> <p>2x L4 GPUs with 24 GB VRAM with a bandwidth of 300GB/s</p> <p>1x RTX 4070 with 12 GB VRAM with a bandwidth of 500GB/s</p> <p>The servers described above are mounted in a V-RTX unit connected directly to HDD local storage (12TB) through fiber-channel. Additionally, the servers are connected to a storage switch through fiber-channel, which is connected to a shared SSD storage unit (6TB).</p>
<p>Virtual compute infrastructure</p>	<p>The physical infrastructure relies on Proxmox virtualization, which hosts the following (the virtualized infrastructure can be extended to accommodate different requirements and architectures, including Operative System. GPU support, cloud-native approaches):</p> <p>1 x VM (hosts a Kubernetes cluster with the COP-PILOT integration components, such as domain orchestrator, FIWARE, OpenZiti)</p> <ul style="list-style-type: none"> ● 16 vCPUs ● 32 GB RAM ● 64 GB storage <p>1 x VM (hosts a Kubernetes Cluster which contains cloud-native 5G components, including, OCF, NEF and Open5GS)</p>

	<ul style="list-style-type: none"> ● 12 vCPUs ● 16 GB RAM ● 64 GB storage <p>3 x VM (each VM corresponds to a Kubernetes Cluster node, where the access is restricted by namespace for the different research teams activities)</p> <ul style="list-style-type: none"> ● 8 vCPUs ● 32 GB RAM ● 64 GB storage <p>This cluster includes an additional computing node with a L4 GPU integrated in Kubernetes, mainly used for Ollama models.</p>
Physical network infrastructure	High-bandwidth external networking access to computing infrastructure.
Virtual network infrastructure	Proxmox virtualized network
Physical IoT infrastructure (or data sources)	N/A
Virtual IoT infrastructure (or data sources)	N/A
Infrastructure Availability for COP-PILOT and Open Calls	The Kubernetes cluster and computing infrastructure are available for COP-PILOT and Open Call projects under controlled access, allowing third parties to deploy their own containers and exchange data securely.

The Nokia domain consists of two deployment sites, Matanza de Soria and the Madrid Nokia facility, each providing specific infrastructure components that are listed below and available for use by applicants. Nokia NaC green powered site in Matanza Spain will host agricultural experiments using only green energy and remote driving of AGVs that are taking pictures integrated in the edge-site ML/AI platform.



Figure 5- Cluster 4 5G green site external view



Figure 6- Cluster 4: 5G site energy usage breakdown in Matanza, detailed by battery.

The Nokia Matanza location and Nokia Madrid 5G networks serves as the two computational domains, each providing computing capabilities and private 5G networks. These domains are interconnected through interslicing, ensuring coordinated management and secure data exchange. Across the two Cluster 4 locations (Matanza and Madrid), the use cases involve the deployment of sensors and IoT devices. In Matanza some computation capacity is available, but the full capacity will be available in Madrid Nokia site. **Error! Reference source not found.** represents the architecture of the Nokia sites, incorporating the Network as Code API from Nokia and the CAPIF APIs from Telefónica that facilitates the integration in the COP-PILOT platform.

High level Diagram

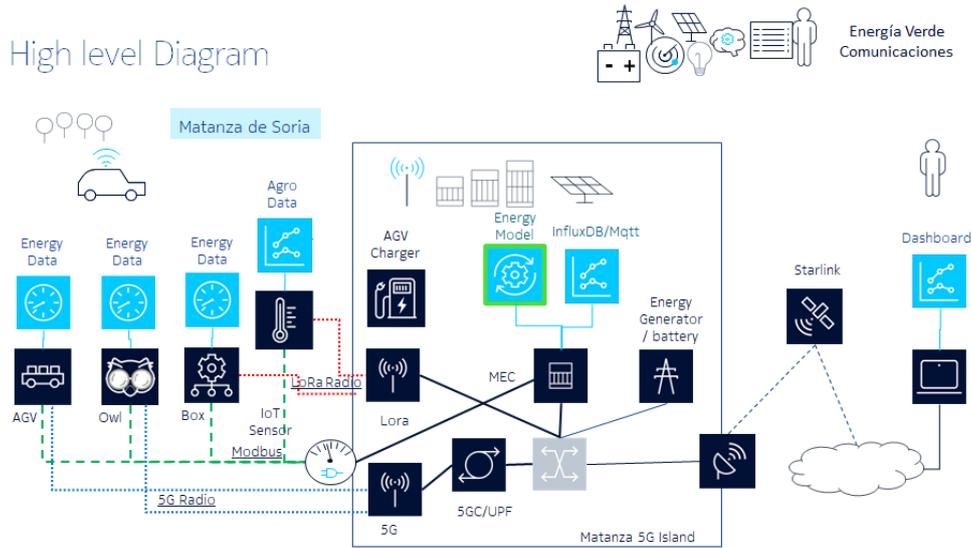


Figure 7- Diagram of NOKIA's 5G infrastructure.

Table 5: CL4 Nokia Domain

Infrastructure type	Description
Physical compute infrastructure	1 x Nokia OpenEdge RM20, Gold 6148 CPU @ 2.40GHz processor (40 cores), 180 GB RAM, 1 x 960 GB SSDs
Virtual compute infrastructure	1 x VM for Open5GS core with 3x UPFs (one per slice) with: <ul style="list-style-type: none"> 4 vCPUs 8 GB RAM 32 GB storage 1 x physical network interface 1 x VM (to host MQTT and Modbus monitoring devices) with: <ul style="list-style-type: none"> 4 vCPUs 8 GB RAM 32 GB storage 1 x physical network interface
Physical network infrastructure	Dedicated switches/routers: Nokia IXR 7250 Private 5G network:

	<ul style="list-style-type: none"> ● Coverage and deployment: <ul style="list-style-type: none"> ● The 5G network is deployed Matanza de Soria, Spain. ● Sites and operating bands: <ul style="list-style-type: none"> ● One outdoor rural site with omni antenna: 5G SA on n78 ● Spectrum and PLMN configuration: <ul style="list-style-type: none"> ● Spectrum from Telefónica: n78 (100 MHz) ● PLMNs: <ul style="list-style-type: none"> ● 99999 (private) for n78 ● Radio units and antennas: <ul style="list-style-type: none"> ● RRH n78 (indoor, 256QAM, integrated omni antenna) <p>This domain communicates with:</p> <ul style="list-style-type: none"> ● Internet by Starlink modem (client VPN required) ● Nokia VPN with TIG in Nokia Madrid monitoring center <p>5x Modems installed in Matanza site distributed under radio 5G n40 coverage</p>
<p>Virtual network infrastructure</p>	<p>Proxmox Virtual Environment (PVE) used as the hypervisor to manage VMs and provide virtual networking</p>
<p>Physical IoT infrastructure (or data sources)</p>	<p>4x Earth Stations with sensors deployed in vineyards in the area (NPK, humidity, etc)</p> <p>1x Weather Station with sensors deployed in one vineyard (solar radiation, temperature, humidity)</p> <p>Energy measure</p>
<p>Virtual IoT infrastructure (or data sources)</p>	<p>Powermeters:</p> <ul style="list-style-type: none"> ● maso-batuta (Rpi) ● Antena StarLink ● Netgear Switch ● External Camera 1 with PoE alternative power supply ● Internal Camera 2 with PoE alternative power supply

	<ul style="list-style-type: none"> ● afoe-PSU0 ● afoe-PSU1 <p>Radio energy use:</p> <ul style="list-style-type: none"> ● 5G baseband module integrated energy meter ● 5G radio module integrated energy meter <p>Electrical inersor</p> <ul style="list-style-type: none"> ● Energy inserted in batteries ● Energy feeded from batteries 8x Electrical batteries ● Battery energy level
<p>Infrastructure Availability for COP-PILOT and Open Calls</p>	<p>This infrastructure is fully available for COP-PILOT to deploy necessary platform and application component for the validation of Cluster 4 and potential Open Call projects to be integrated with this cluster in the future.</p> <p>Open Call projects may bring and deploy a new domain within Cluster 4, introducing complementary technologies, datasets, or services; or they may host and validate their solution within one of the existing Cluster 4 domains, leveraging its infrastructure, data environment, and demonstration use cases.</p>

RedZinc use case focuses on enabling sustainable lifecycle management of IoT sensors deployed across healthcare and vineyard environments. Many IoT devices in these sectors require frequent maintenance, replacement of consumables, or end-of-life recycling; however, traditional processes are manual, disconnected, and wasteful, leading to unnecessary electronic waste, increased operational cost, and poor traceability.

The system operates as a three-party component on its higher-level architecture: The supplier interacts with COP-PILOT Service to receive replacement or recycling requests, then updates eulD wallet with new sensor identity or recycling outcome. The customer operates sensors in the field (patient rooms, vineyard parcels) and then sends measurements and lifecycle updates (e.g., battery low, failure, end-of-use). The COP-PILOT Service (Recycling, Maintenance & Logistics of IoT) orchestrates the entire lifecycle: data ingestion → monitoring → trigger → recovery → recycling. It stores lifecycle data in an eulD wallet (operational + lifecycle wallet) and ensures that maintenance and recycling processes conform to EU data sovereignty and GDPR.

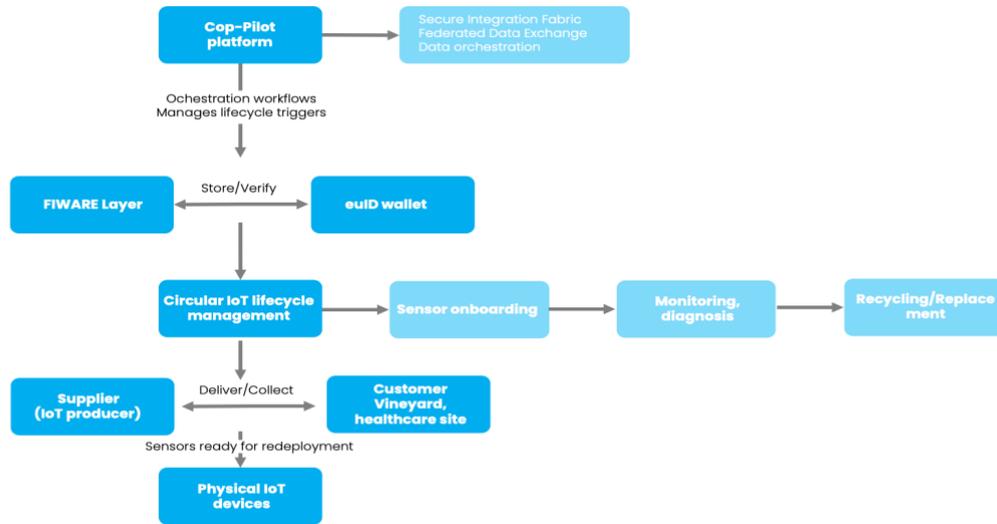


Figure 8- Diagram of Redzinc application architecture.

The system uses the following infrastructure elements:

- Physical IoT devices such as healthcare sensors (that measure vital signs), vineyard sensors (soil moisture, humidity, temperature), batteries, and consumables.
- Communication technologies such as Wi-Fi, LTE, BLE depending on deployment site.
- Lifecycle compute infrastructure (RedZinc backend) including EU-hosted servers with GDPR compliance and automated lifecycle services (trigger engine, wallet updates, orchestration logic).
- COP-PILOT Core Components such as Secure Integration Fabric (SIF), DataOrch (data pipeline orchestration), euID-compatible Digital Wallet modules.

Table 6- Infrastructure components provided by the Cluster 4 - RZ domain.

Infrastructure type	Description
Physical compute infrastructure	EU-hosted RedZinc servers used for IoT lifecycle processing, secure storage of sensor metadata, euID wallet operations, and orchestration logic. Includes compute capacity for device monitoring, trigger evaluation, and execution of recycling/maintenance workflows.
Virtual compute infrastructure	Cloud-based COP-PILOT components (SIF, DataOrch, InfraOrch, AppOrch) deployed on virtual machines/containers. Provides scalable execution of lifecycle automation, data processing, and orchestration.

Physical network infrastructure	Gateways and connectivity equipment used in healthcare and vineyard testbeds: Wi-Fi access points, 5G/4G routers
Virtual network infrastructure	Secure virtual communication channels used to route IoT data into COP-PILOT: MQTT/HTTP endpoints, FIWARE IoT Agent connectors, TLS-encrypted APIs.
Physical IoT infrastructure (or data sources)	Real IoT sensors deployed in both domains: vital-sign healthcare sensors, temperature/soil moisture vineyard sensors, batteries, consumables, and physical assets requiring lifecycle tracking.
Virtual IoT infrastructure (or data sources)	Digital twins of sensors, lifecycle datasets, virtual eUID wallets (operational + post-lifecycle), historical measurements for predictive replacement.
Infrastructure Availability for COP-PILOT and Open Calls	Open Call participants receive access to IoT data streams and eUID wallet interfaces.

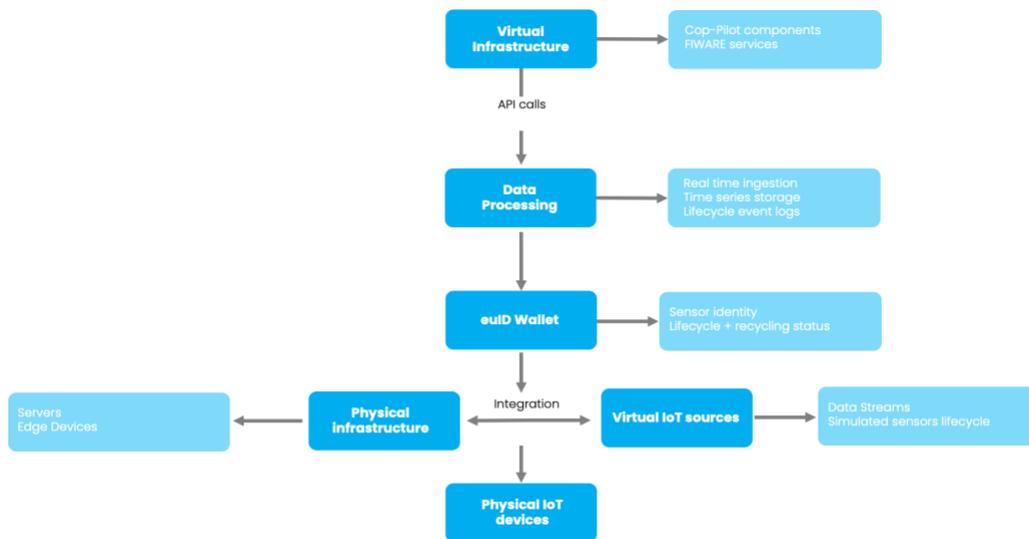


Figure 9- Figure 18 RedZinc Infrastructure Architecture Diagram.

1.3 OPEN CALL CHALLENGES & INNOVATION OPPORTUNITIES

Applicants are expected to propose use cases, demonstrators, software modules, or prototype integrations that can be validated within the Cluster 4 testbed over a 6–8-month period. Proposals must clearly describe the technical innovation, the integration approach with existing COP-PILOT and Cluster 4 assets, and the expected impact on efficiency, sustainability, or interoperability across the vineyard–winery ecosystem. Solutions should start at TRL 5-6 and reach TRL 7–8 by the end of the project, ensuring deployment-ready maturity under real operational conditions. Cluster 4 welcomes solutions that complement, extend, or enhance the existing use cases, which collectively

cover smart vineyards, water-efficient viticulture, winery production optimisation, renewable-powered 5G connectivity, and circular IoT sensor workflows.

Open Call applicants may address one or more of the following challenges, or present other related innovations that demonstrate clear relevance to the vineyard–winery ecosystem addressed by Cluster 4:

- **OC#4.1 – Advanced Vineyard Monitoring, Zoning & Environmental Intelligence:** Solutions that enhance vineyard intelligence through improved sensing, imaging, or modelling. This includes integrating soil sensors, weather and climate inputs, satellite data, drone imagery, or spatial analytics to support zoning, yield forecasting, harvest timing, plant-health assessment, and environmental prediction. Proposals should demonstrate added value and interoperability with the FIWARE Context-Broker NGSI-LD based data layers.
- **OC#4.2 – Water Efficiency, Winery Production Intelligence & Energy Performance:** Solutions addressing both vineyard water efficiency and winery operational optimisation. Solutions may include irrigation scheduling based on soil moisture, climate models or satellite indices, anomaly detection in irrigation networks, and microclimate-aware water management. On the winery side, proposals may target predictive maintenance, bottling-line analytics, fermentation monitoring, thermal or energy-use optimisation, and improved KPI/OEE computation. All solutions should integrate with FIWARE NGSI-LD Context-Broker and Kubernetes-based deployments.
- **OC#4.3 – Vineyard Robotics, Automation & Field Operations Support:** Solutions focusing on robotics and connected automation in vineyards. This includes AGV/tractor routing, quadruped support, drone operations, terrain-aware navigation, safety monitoring, and task-planning functions. Solutions may also exploit on-site connectivity for remote robot operation, real-time video analytics, or edge-based processing to improve field-level automation and decision-making under rural constraints.
- **OC#4.4 – Circular IoT Sensor Lifecycle Management:** Tools enhancing diagnostics, calibration, refurbishment, reuse, or traceability of agricultural IoT sensors. Proposals may include automation of lifecycle workflows, quality-control mechanisms, secure device onboarding, or logistics support aligned with RedZinc’s circular IoT domain.
- **OC#4.5 – Cross-Domain Data Interoperability & GAIA-X/IDSA-Aligned Services:** Mechanisms ensuring secure, sovereign data exchange between vineyard, winery, and IoT lifecycle domains. This includes semantic harmonisation, federated analytics, privacy-preserving computation, and connectors aligned with FIWARE, GAIA-X and IDSA principles to support multi-domain orchestration within COP-PILOT.
- **OC#4.6 – Operator Dashboards, Decision-Support & Human-Machine Interfaces:** User-centric dashboards, mobile apps, or decision-support tools that deliver clear, actionable insights for agronomists, winery technicians, production managers, or logistics operators. Solutions should present complex data in a transparent and operationally useful way.

All proposals should demonstrate clear environmental, economic, and technological impact, showing progress beyond the state of the art and potential for replication and scalability across the European wine sector. Solutions must provide measurable improvements in sustainability, operational efficiency, interoperability, or digital maturity. Every proposal submitted to Cluster 4 should demonstrate measurable impact in the following dimensions:

- **Environmental Impact:** e.g., reduced water use, lower energy consumption, increased sensor reuse.
- **Economic Impact:** e.g., reduced downtime, lower operational costs, improved productivity.
- **Technological Impact:** e.g., better interoperability via FIWARE/Kubernetes, advanced analytics, reusable components.
- **Societal Impact:** e.g., reduced manual tasks, safer working conditions, improved decision support.
- **Replication & Scalability:** solutions should be portable across vineyards, wineries, and other agri-food sectors and scale across distributed COP-PILOT nodes.

1.4 THE CLUSTER 4 TECHNOLOGIES AND PROTOCOLS

This section links the Cluster 4 assets with relevant technologies, protocols, etc as shown in Table 7.

Table 7: Map of Cluster 4 Assets related to relevant technologies and protocols.

Cluster Component Name	4	COP-PILOT Use Case	Relevant Technologies, Protocols, etc.
Digital IoT Recycling Platform (DIRP)		UC4.1 Recycling, Maintenance, and Logistics of IoT sensors	OpenZiti; FIWARE; Kubernetes-based deployment
Aquaview (Terraview WUE application)		UC4.2 Water Utilisation Efficiency	IoT soil moisture sensors, FIWARE, microk8s, Aquaview analytic
Aquaview — Front-facing workflow		UC4.2 Water Utilisation Efficiency	Gamaya Viewer
Aquaview — Back-facing prediction module		UC4.2 Water Utilisation Efficiency	AI/ML for soil moisture analysis, FIWARE, Docker,
IoT Wine Platform / OEE analytics & monitoring platform (bottling line)		UC4.3 Sustainable optimized Winery Production Lines	Raspberry Pi edge + sensors; RabbitMQ; FIWARE IoTAgent; NGSI-LD data normalisation; Orion Context Broker; QuantumLeap; Cratedb; dashboards/alerts; AI/ML for anomaly detection/predictive maintenance; Keycloak (IAM); Kong; MongoDB; Docker; PostgreSQL
Energy monitoring for 5G Green Site		UC4.4 AI-Driven Green Energy Vineyard Management	Modbus energy sensor, 5G Green Site 8x 3Kwh batteries, influxdb, FIWARE datalogger, OpenSlice integration

5G Site Management for 5G Green Site	UC4.4 AI-Driven Green Energy Vineyard Management	5G Green Site n78 band 100MHz, x4 5G deployed modems with WIFI coverage in vinyards, 10x 5G SIMs with coverage for deployment of new sensors, influxdb, Nokia Network as Code SDK for site management reconfiguration, OpenSlice integration, LEO Starlink remote connectivity
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1.5 THE CLUSTER 4 PLATFORM STANDARDS AND COMMUNITIES

This section links the Cluster 4 platform assets with relevant standards and open-source (software) communities as shown in Table 8.

Table 8: Map of Cluster 4 Assets related to relevant standards and open-source communities.

Cluster 4 Component Name	COP-PILOT Use Case	Relevant Standards	Relevant Open-source Communities
Digital IoT Recycling Platform (DIRP)	UC4.1 Recycling, Maintenance, and Logistics of IoT sensors	GDPR compliance	FIWARE ecosystem
Aquaview (Terraview WUE application)	UC4.2 Water Utilisation Efficiency	GDPR compliance	FIWARE ecosystem
IoT Wine Platform / OEE analytics & monitoring platform	UC4.3 Sustainable optimized Winery Production Lines	NGSI-LD; GDPR/ISO 27001	FIWARE; RabbitMQ ecosystem; Keycloak ecosystem; Kong ecosystem.
Energy monitoring for 5G Green Site	UC4.4 AI-Driven Green Energy Vineyard Management	GDPR compliance	FIWARE ecosystem
5G Site Management for 5G Green Site	UC4.4 AI-Driven Green Energy Vineyard Management	NGSI-LD; GDPR/ISO 27001	FIWARE ecosystem