



D2.1: ECOSYSTEM DEFINITION AND REQUIREMENTS

ANNEX 10: DETAILED SERVICE REQUIREMENTS PER USE CASE

In this annex you will find an elaboration of the service requirements referred to in annex 1 to successfully implement the COP-PILOT ecosystem

D2.1: Ecosystem definition and requirements

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Abstract	<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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Nature of the deliverable:	R	
Dissemination Level		
PU	Public, fully open, e.g. web (Deliverables flagged as public will be automatically published in CORDIS project's page)	X
SEN	Sensitive, limited under the conditions of the Grant Agreement	
Classified R-UE/ EU-R	<i>EU RESTRICTED under the Commission Decision No2015/ 444</i>	
Classified C-UE/ EU-C	<i>EU CONFIDENTIAL under the Commission Decision No2015/ 444</i>	
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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.

ANNEX 8 DETAILED SERVICE REQUIREMENTS PER USE CASE

Use Case Requirement ID	Elaborated Description of Requirement	Dimension Name	Dimension Value
		How the requirement is measured	An example to understand how the value will be measured in units
CLUSTER 1: INDUSTRY			
Use Case: 1.1 – IoT Mining Seismics			
1.1.1	Seismic sensors must provide trigger-based, sliced data on micro-seismic events	Yes or No	Yes
1.1.2	Data visualization of both historical and near-live data of induced seismic events within the mine	Yes or No	Yes
1.1.3	Enabled automated provisioning of compute resources	Yes or No	Yes
1.1.4	IoT/Sensor Time sync accuracy	Time	0.1 ms (corresponding to approximately 5m spatial precision)
1.1.5	System availability	% of incoming requests handled	99.99%
1.1.6	System resilience, the processing of seismic event data continues when one or more system components go down.	Yes or No	Yes
1.1.7	Handle sustained data rates whilst keeping active cloud resources at a minimum	# of seismograms per second	50
1.1.8	Peak load capacity, system's ability to handle large bursts of seismograms at the same time	# of triggered seismograms handled simultaneously	> 5000
1.1.9	The system's ability to handle large numbers of sensors or channels	# of sensors supported	> 5000
1.1.10	Processing delay, the time from event to completed processing	Time	< 15 min
Use Case 1.2: Logistics of IoT			

1.2.1	Support data stream bandwidth with regards to data reception performance of	Packets per second	10 000 packets
1.2.2	Support alarm detection latency regarding time from sensor reading to user being alerted of	Detection to alert latency	< 10 seconds
1.2.3	Enable a threshold of sensors connected to gateway	Sensor count threshold	1000 pcs
1.2.4	Ensure sufficient rock bolt rupture detection accuracy	Detection accuracy	+/-10% of bolt length
1.2.5	Support fault identification time in RBM-sensor	Time	≤10s
1.2.6	Ensure a positional update rate for asset tracking	Update rate	Every 10 seconds
1.2.7	ColonyOS/Arrowhead platform integration	Yes or no	Yes
1.2.8	Service availability	% of time	99.999%
1.2.9	Rock bolt installation time, the time it takes to physically install and configure a rock bolt	Time	< 300 s
1.2.10	Integration between underground asset tracking and Mining 4.0 platform	Yes or no	Yes
1.2.11	Support for data visualization from a large number of sensors	Number of sensors	25000
1.2.12	Visualization of assets underground	Yes or no	Yes
Use Case: 1.3 - Condition Monitoring and Predictive Maintenance in Mining			
1.3.1	Provide data with a sufficiently high sample rate	Sample rate	1000 Hz
1.3.2	Minimal loss in connectivity between IoT devices and cloud for each device	% of time availability	99.80%
1.3.3	Data needs to be stored for a predefined period per device and customer	Time	1 year
1.3.4	Forward data streams to data consumers with limited delay	Time	1 minute
1.3.5	Insights need to be generated within a certain time frame	Time	1 minute

	after a complete revolution of a conveyor belt		
Use Case: 1.4 - IoT Edge Cloud Continuum For Digital Mines			
1.4.1	Reducing manual work to deploy services in an ECCC environment	Time	6 hours
CLUSTER 2: Smart Sustainable IoT Solutions in Valencia			
Use Case: 2.1 - Smart City Data Monitoring and Sustainable Mobility Service Model A : 5G-Connected Radars for Traffic Classification and Vehicle Counting			
2.1A.1	Scalability: ability of the system to handle an increasing number of connected radars.	Number of supported connected radars	Up to number of radars connected
2.1A.2	Security & Data Privacy: collected data is encrypted, anonymized, and handled according GDPR.	Data encryption and anonymization	GDPR compliant (yes/no)
2.1A.3	Reliability: guarantees continuous system operation with minimal downtime.	System uptime	%
2.1A.4	Accuracy: precision of classification and counting	Classification accuracy	%
2.1A.5	Interoperability: integration with platforms and infrastructure using open and standardized protocols.	Standard communication interface	Use of REST API, MQTT, JSON format
2.1A.6	Low latency: time between radar data capture and its availability for analytics or decision-making.	End-to-end latency	ms
2.1A.7	Maintainability: ease of performing updates, fault recovery and diagnostics without major service interruption.	Mean time to repair (MTTR)	hour
2.1A.8	Energy efficiency: power consumption of radars	Average power consumption per radar	kW, W
2.1A.9	Robustness: ability of the system to remain operational under adverse conditions.	Operational continuity rate	%
2.1A.10	Quality of Service: ensures consistent packet delivery for real-time data transmission	Packet delivery rate	%

2.1A.11	Real-time analytics: ability to process and visualize data nearly-instantly for monitoring and support	Processing delay	milliseconds, seconds
Use Case: 2.1 - Smart City Data Monitoring and Sustainable Mobility Service Model B: Flood Warning and Mitigation System Through Radar Sensing			
2.1B.1	Reliability on communications: guarantees continuous system operation with minimal downtime.	System uptime	%
2.1B.2	Scalability: ability of the system to handle an increasing number of connected sensors.	Number of supported connected sensors	Up to number of sensors connected
2.1B.3	Security: collected data is encrypted, and handled according GDPR.	Data encryption and anonymization	GDPR compliant (yes/no)
2.1B.4	Long life-cycle: nodes must support long-term operation with minimal maintenance and component replacement.	Operational lifetime	months, years
2.1B.5	Accuracy: precision of water level height measurement.	Measurement accuracy	cm
Use Case: 2.2 - Smart and Sustainable IoT - Connected Campus Service Model A: Smart Resources Management in the UPV Campus			
2.2.1	Scalability: ability of the system to handle an increasing number of connected sensors.	Number of supported connected sensors	Up to number of sensors connected
2.2.2	Reliability: guarantees continuous system operation with minimal downtime.	System uptime	%
2.2.3	Accuracy: precision of measuring fill waste levels	Measurement accuracy	% fill level error
2.2.4	Security: collected data is encrypted, and handled according GDPR.	Data encryption and anonymization	GDPR compliant (yes/no)
2.2.5	Interoperability	Standard communication interface	E.g. Use of REST API, MQTT, JSON format
Use Case 2.3: Advanced Maritime and Terrestrial Traffic Management in Ports			
2.3.1	Reliability: ability of the platform to guarantee interrupted radar monitoring and ship tracking.	System uptime	%

2.3.2	Accuracy: precision in ship position, orientation and distance	Measurement accuracy	cm, m
2.3.3	Low latency: time between radar data capture and its availability for analytics or decision-making.	End-to-end latency	ms
2.3.4	Real-time monitoring for the position and orientation of the ships which will dock at the terminal.	Position	Lat, Lon
2.3.5	Real-time monitoring for the orientation of the ships which will dock at the terminal.	Orientation	Degrees (0° North)
2.3.6	Real-time monitoring for the distance to the dock of the ships which will dock at the terminal.	Distance	Centimetres
2.3.7	Data visualization with dashboards	Visualization type	Dashboard
Use Case 2.4: IoT-Driven Smart Building Management at La Harinera Service A			
2.4A-1	Scalability: ability of the system to handle an increasing number of connected sensors.	Number of supported connected sensors	Up to number of sensors connected
2.4A-2	Security: collected data is encrypted, and handled according GDPR.	Data encryption & authentication	GDPR compliant (yes/no)
2.4A-3	Reliability: guarantees continuous system operation with minimal downtime.	System uptime	%
2.4A-4	Accuracy: precision in environmental and occupancy data.	Measurement accuracy	%
2.4A-5	Interoperability	Standard communication interface	Use of REST API, MQTT, JSON format
2.4A-6	Low latency: time between sensor data capture and its availability for analytics or decision-making.	End-to-end latency	milliseconds
2.4A-7	Maintainability: ease of performing updates, fault recovery and diagnostics without major service interruption.	Mean time to repair (MTTR)	hour

2.4A-8	Real-time analytics	Processing delay	milliseconds, seconds
Use Case 2.4B: IoT-Driven Smart Building Management at La Harinera Service B			
2.4B-1	Continuous monitoring: ability to collect and transmit environmental quality data to enable real-time supervision and quick anomaly detection.	Monitoring frequency	%
2.4B-2	Remote management: remote configuration, firmware updates and diagnostics of radar and gateways from a centralized interface.	Remote accessibility	Dashboard availability
2.4B-3	Low latency: time between radar data captured and its availability for analytics or decision-making.	End-to-end latency	ms
2.4B-4	Scalability: ability of the system to handle an increasing number of connected radars.	Number of supported connected radars.	Uo to number of radars connected
2.4B-5	High availability	% of time	%
CLUSTER 3A: AGRITECH TRANSFORMATION AND SUSTAINABILITY AND SUSTAINABILITY INITIATIVE (ATSI)			
USE CASE: 3A.1 – Integrated Precision Agriculture and Crop Monitoring			
3A.1.1	FMIS: Centralized farm management platform providing dashboards, alerts, and decision-support for ongoing crop operations.	Data Update Frequency	Every 15 minutes
3A.1.2	Real-Time Field Monitoring: Continuous real-time monitoring of crop health, soil moisture, and weather conditions through integrated sensors.	Data Latency	≤5 seconds
3A.1.3	Satellite Monitoring Service: Automated acquisition and interpretation of satellite imagery for vegetation indices and stress detection.	Spatial Resolution	10 m per pixel (Sentinel-2)
3A.1.4	UAV Crop Scouting: Drone-based imaging and analysis	Survey Interval	Every 7 days during growth phase

	service providing health maps and anomaly detection.		
3A.1.5	Crop Lifecycle Traceability: Digital synchronization of crop calendar events with blockchain for verified traceability and certification.	Synchronization Lag	≤1 minute after event update
3A.1.6	Agronomic Advisory Service: AI-powered recommendation service producing actionable insights for irrigation, fertilization, and pest control.	Advisory Accuracy	≥90% based on validation data
3A.1.7	Domain Orchestration Service: Automated workflow orchestrator ensuring end-to-end interoperability across data, sensors, and analytics layers.	Interoperability Index	100% synchronization success
3A.1.8	Connectivity Service: Reliable network infrastructure providing uninterrupted communication between field devices and cloud servers.	Network Uptime	≥99.5% availability
3A.1.9	Data Visualization and Alerts: Web-based dashboard providing analytics, alerts, and historical insights for farmers and advisors.	User Response Time	≤3 seconds to load dashboard
Use Case 3A.2: Advanced AgriRobotics For Autonomous Intervention			
3A.2.1	FMIS (Advanced Integration): Enhanced farm management interface integrating IoT, UAV, and UGV data to create a complete digital twin of field operations.	Data Integration Completeness	≥95% sensor and system integration achieved
3A.2.2	UAV Scouting & Analytics Service: Drone-based imaging and analytics service	Flight Duration	25 minutes per flight

	generating vegetation indices, yield estimates, and anomaly maps for precision crop management.		
3A.2.3	UGV Autonomous Operation Service: Ground vehicle performing automated field scanning, weed detection, and spot treatment for improved operational efficiency.	Field Coverage Rate	2 hectares/hour
3A.2.4	AI Weed Mapping Service: Deep-learning model identifying, classifying, and mapping weed clusters using multispectral and RGB imagery.	Detection Accuracy	≥92% correct classification
3A.2.5	IoT Meteorological Network: Distributed network of weather stations continuously collecting temperature, humidity, and rainfall data for predictive modeling.	Data Refresh Rate	Every 15 minutes
3A.2.6	Crop Calendar Traceability: Blockchain-enabled crop lifecycle management service automatically recording cultivation stages and certification events.	Data Synchronization Delay	≤2 seconds
3A.2.7	Predictive Advisory Engine: AI-driven module analyzing multi-source data to generate predictive recommendations for irrigation, fertilization, and disease control.	Model Precision	≥90% validated performance
3A.2.8	Orchestration & Workflow Automation: Centralized orchestration service coordinating IoT, UAV, and UGV tasks with automatic data handover and task scheduling.	Workflow Execution Time	≤10 seconds per task
3A.2.9	Network Reliability & Security: Encrypted and	Network Uptime	≥99.5% uptime

	redundant network architecture ensuring secure, uninterrupted data transfer between field devices and cloud services.		
3A.2.10	Farmer Decision Dashboard: Unified decision-support dashboard providing real-time data visualization, risk alerts, and performance summaries to farm managers.	Dashboard Refresh Rate	Every 10 seconds
Use Case 3A.3: Secure Data Management and interoperability			
3A.3.1	Secure Data Management and Interoperability: Federated data architecture enabling secure, traceable, and regulation-compliant data exchange across agri-food actors using blockchain and multi-cloud interoperability. Hyperledger Fabric ensures cryptographic data integrity, controlled access, and real-time validation of telemetry from field to logistics.	Data Integrity Assurance	100 % verified hash consistency across all blockchain nodes
3A.3.2	Secure Data Management and Interoperability: Blockchain layer providing immutability, traceability, and smart-contract-based automation for compliance, quality checks, and provenance tracking.	Transaction Finality Time	≤ 10 seconds per committed block
3A.3.3	Secure Data Management and Interoperability: Cross-platform data federation ensuring interoperability with existing FMIS, IoT, and logistics systems.	Interoperability Latency	≤ 2 minute between federated nodes
3A.3.4	Secure Data Management and Interoperability: Modular blockchain architecture supporting plug-	System Scalability	Up to 10 parallel nodes with > 99.9 % uptime

	and-play consensus and ordering services for scalability and auditability.		
Use Case 3A.4: Smart Logistics and Supply Chain Optimisation			
3A.4.1	Smart Logistics and Supply Chain Optimization: AI-driven orchestration framework for real-time route optimization of refrigerated vehicles transporting perishable crops. It adapts dynamically to freshness, temperature, and delay conditions to ensure efficient, low-waste delivery.	Routing Optimization Frequency	Every ≤ 60 seconds based on live telemetry
3A.4.2	Smart Logistics and Supply Chain Optimization: Continuous telematics monitoring of temperature, humidity, and geolocation enabling predictive freshness estimation and SLA compliance.	Telemetry Update Interval	Every 10 seconds
3A.4.3	Smart Logistics and Supply Chain Optimization: Event-driven orchestration integrating Power Fleet routing engine with COP-PILOT orchestrator for Just-in-Time logistics.	Decision Response Time	≤ 10 seconds from event trigger
3A.4.4	Smart Logistics and Supply Chain Optimization: Secure GNSS and environmental sensor data synchronized with blockchain for immutable delivery traceability.	Data Synchronization Delay	≤ 40 seconds between vehicle and cloud
3A.4.5	Smart Logistics and Supply Chain Optimization: Automated failover and redundancy ensuring uninterrupted routing even under connectivity loss or device fault.	Operational Availability	≥ 99 % service uptime

CLUSTER 3E: Agriculture and Energy; Edge Intelligence For Enhancing Grid Reliability in RES - Rich Distribution Grids			
3E.1.1	Interoperability with Distributed Energy Resources (DERs) such as solar PV, batteries, and controllable loads to enable seamless data and control exchange.	DER Interoperability	Supports IEEE IEC 61850, OCPP, OpenADR, Modbus protocols
3E.1.2	Estimate flexibility available from DERs by analyzing real-time generation, consumption	Flexibility Estimation Accuracy	% (improvement compared with baseline)
3E.1.3	Continuously monitor grid conditions (thermal limits, voltage) to ensure stability and optimize DER utilization.	Monitoring Frequency	1 minute
3E.1.4	Ensure reliable, low-latency communication between distributed nodes to support real-time control	Communication Latency	<1 sec latency
3E.1.5	Set operational setpoints to DERs dynamically to provide flexibility services such as demand response or voltage regulation.	Control Command Success Rate	>99,5%
3E.1	Support scaling to additional DER assets and grid nodes (up to a city level)	Number of supported assets	100 nodes
UC 3E.2: Ensuring Uninterruptible Power Supply for Fast EV Chargers			
3E.2.1	Integration with power meters, EV chargers, and environmental sensors to collect real-time electrical and operational data.	Data Integration Capability	Supports OCPP protocol
3E.2.2	Scalability to easily add new charging stations or power management units without affecting system performance.	System Scalability	add / configure new charging station to the platform in less than 10 minutes
3E.2.3	Reliability ensuring uninterrupted operation of power supply and charging	System Uptime	99.5% operational availability

	management services under all conditions.		
3E.2.4	Automated and secure access to datastreams to ensure seamless, real-time data flow between devices and cloud services.	Data Access Automation	Secure API-based access with OAuth2 authentication between services
3E.2.5	Real-time monitoring of charger operational status.	Data Latency	< 1 second delay in power telemetry updates
3E.2.6	Predict per-charging-point energy demand using historical usage patterns and real-time traffic conditions.	Predictive Accuracy	
3E.2.7	Detect anomalies in charging behavior and raise alerts for potential EV charger health degradation.	Alert Responsiveness	Health degradation alerts issued within 5 seconds of anomaly detection
Use Case 3E.3: Predictive Maintenance and Monitoring of Biogas Plant Operations			
3E.3	Integration with industrial sensors using COP-PILOT's Data Orchestrator to collect and harmonize process data from multiple sensor types.	Sensor Data Integration Capability	Supports Sensor's protocols (e.g. Modbus TCP)
3E.3	Modularity to easily add new services and sensors through COP-PILOT without disrupting existing operations.	System Scalability	add new sensor / service to the platform in less than 10 minutes
3E.3	Reliability ensuring the system operates continuously with minimal downtime or data loss.	System Uptime	99.9% operational availability
3E.3	Automated and secure access to data streams to reduce manual intervention and maintain data integrity.	Data Access Automation	Access through secure channel
3E.3	Secure access to cloud and edge compute resources	Compute Access security	Access through secure channel
3E.3	Real-time monitoring of anaerobic digestion process parameters such as pH, temperature, and biogas production.	Data Latency	< 2 seconds delay in live sensor data feed

3E.3	Provide alerts for anomalies when sensor readings deviate from normal operating ranges, and for predictive analytics suggestions	Alerts Response Time	Notification within 5 seconds of threshold breach
3E.3	Predictive maintenance service able to forecast equipment failures and schedule interventions proactively.	Predictive Accuracy	>90% precision
CLUSTER 4: ENERGY MANAGEMENT			
Use Case 4.1: Recycling, Maintenance and Logistics of IoT Service A			
4.1A.1	Collection of any IoT sensor data from the deployed sensors at customer sites for measurement and lifecycle tracking.	Data Collection Frequency	Continuous / Periodic (seconds)
4.1A.2	Storage of IoT data in euID wallet format, ensuring compliance with EU data protection, sovereignty, and interoperability standards.	Data Format	EU ID-Compliant (100% protection against data loss) (99.999% availability) (Tier4 Data Center) (Dual data center Redundancy with failover time of 1 second)
4.1A.3	Automated storage process to the EU ID wallet without manual intervention, triggered by data generation or lifecycle events.	Automation level	Missing
4.1A.4	COP-PILOT service must provide a trigger point that detects when a sensor element (e.g., battery, module) has reached end-of-life and needs replacement.	Trigger condition	Sensor lifecycle (Seconds)
4.1A.5	The system must guarantee GDPR-level security and EU data sovereignty for all IoT data transfers between supplier and customer.	Security level	GDPR / EU-compliant
4.1A.6	COP-PILOT must host a measurement service capable of operating across different IoT sensor types and suppliers.	Service interoperability	Multi-sensor (100s of sensors)

Use Case 4.1: Recycling, Maintenance and Logistics of IoT Service B

4.1B.1	Enable in-lifecycle management of IoT sensors, including logistics for consumables and battery replacement, and in-field repairs.	Lifecycle phase	In-use / Active. 100% automatic
4.1B.2	Support post-lifecycle management for disposal and recycling of IoT sensors and their materials (polymers, electronics, metals).	Lifecycle phase	End-of-life / Recycled. 100% recycling
4.1B.3	COP-PILOT must support logistics tracking, including collection, replacement, and transport of sensors and components.	Logistics tracking	Real-time status / Location (within second)
4.1B.4	Replace old sensors with new ones and update eUID wallet to reflect the new sensor identity and lifecycle status.	Update frequency	Upon replacement event
4.1B.5	The recycling process must handle battery changes, chemical cleaning, polymer disposal, and electronic recovery under defined procedures.	Recycling process	Multi-step (Battery, Chemical, Polymer, Electronic)
4.1B.6	COP-PILOT must manage two eUID wallets per sensor – one for operational data, one for in-lifecycle and post-lifecycle status tracking.	eUID structure	Dual-wallet model
4.1B.7	Ensure complete traceability of sensors through all phases — deployment, maintenance, recovery, and recycling	Traceability type	End-to-end lifecycle

Use Case 4.2: Sustainable Solution For Crops Water Use Efficiency

4.2.1	IoT sensor data acquired at customer sites and available to calibrate soil moisture model	Data availability	Continuous / Periodic
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4.2.2	Data visualization as an interactive map to show results of soil moisture analytic	Visualization type	Interactive map
4.2.3	Automated recalibration of soil moisture model when new data is available from client's sensors	Automation level	Fully automated
4.2.4	Timeline view of moisture retention trends over the last ten years	Visualization type	Graph
4.2.5	Storage of IoT data, ensuring compliance with EU data protection, sovereignty, and interoperability standards.	Data storage	EU ID-Compliant
Use Case 4.3: Optimised Winery Production Using IoT-Enhanced OEE Anal			
4.3.1	Real-time monitoring of the production line ensuring sub-second responsiveness through COP-PILOT's orchestration layer	Time	Seconds / Milliseconds
4.3.2	Integration with existing MES and ERP systems using COP-PILOT's DataOrch for standardized NGSi-LD interoperability	Compatibility	MES, ERP version numbers
4.3.3	OEE (Overall Equipment Effectiveness) calculation, production analytics and automated KPI reporting through the COP-PILOT orchestration framework	Performance metric	Percentage (%)
4.3.4	Data visualization and operational control via COP-PILOT dashboards and unified monitoring tools for orchestration, efficiency, and maintenance insights.	Visualization type	Dashboard, Graph, Chart
4.3.5	Automated orchestration and lifecycle management of IoT and AI services using COP-PILOT InfraOrch and AppOrch components.	Automation level	Full lifecycle automation (deployment, scaling, monitoring)

4.3.6	Secure data handling, GDPR compliance, and EU data sovereignty enforced through COP-PILOT's Security and Compliance layer	Compliance	GDPR, ISO 27001, EU-hosted infrastructure
4.3.7	Scalable and replicable architecture enabling reuse of the winery orchestration model across other agri-food sectors	Scalability	Horizontal scalability / Cross-domain applicability