



ICOS

Towards a functional continuum operating system

SWForum2023

Development of an IoT2Cloud Operating System (ICOS)



Marina Giordanino
27 June 2023



Funded by
the European Union

ICOS Consortium

ICOS → IoT2Cloud Operating System

- 20 Participant Organisation (11 countries)
 - 13 Companies (some SMEs)
 - 7 Univ. / Research
- 4 validation scenarios from vertical
 - Agriculture Operational Robotic Platform
 - Railway Structural Alert Monitoring system
 - In-car Advanced Infotainment and Multimedia
 - Management system Energy Management and Decision Support system
- 2 OpenCall will be implemented to support 20 focussed activities involving new organizations



<https://www.icos-project.eu/>

ICOS Ecosystem: Cloud, Edge IoT



Cloud Provider

Connect and extend computational capabilities to new and existing applications in the data center and/or cloud.



Near Edge Provider

Cloud Provider extension where Cloud Providers (AWS, Azure, etc.) deploy and manage regional / local computation nodes following the same "cloud business models".



Far Edge Provider

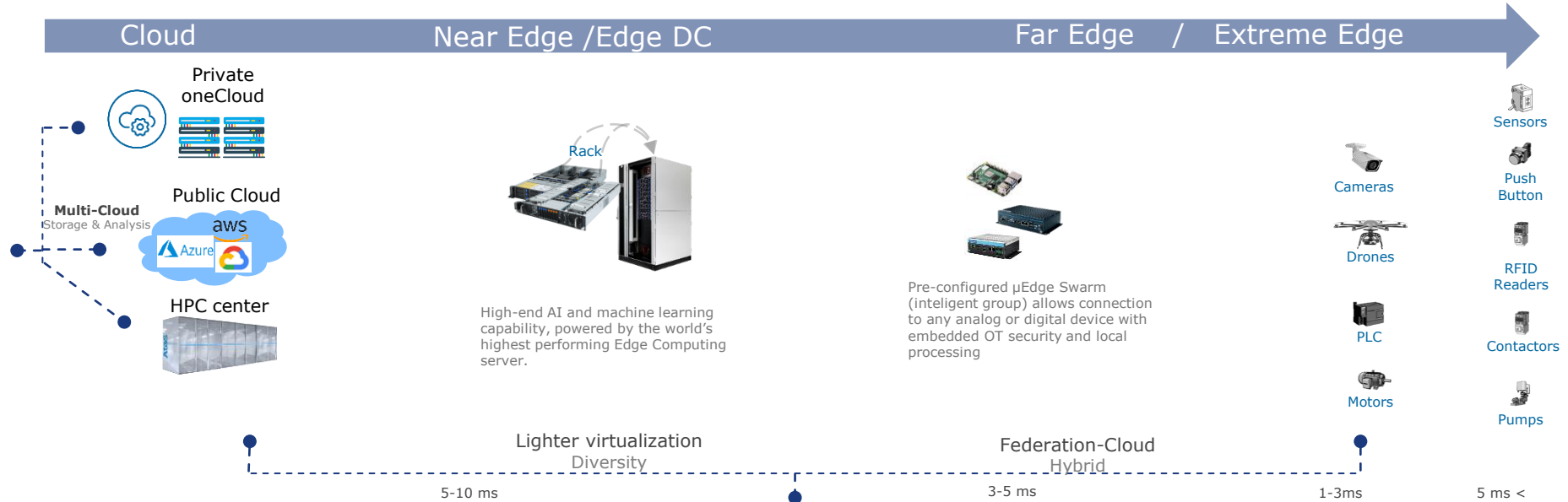
Ad-hoc computation node installed and/or operated by both a Vertical Service Provider and an Independent Vendor



IoT/Edge devices Providers

Edge / Micro Controllers

Sensors / Actuators



ICOS Ecosystem: Cloud, Edge IoT



Cloud Provider

Connect and extend computational capabilities to new and existing applications in the data center and/or cloud.



Near Edge Provider

Cloud Provider extension where Cloud Providers (AWS, Azure, etc.) deploy and manage regional / local computation nodes following the same "cloud business models".



Far Edge Provider

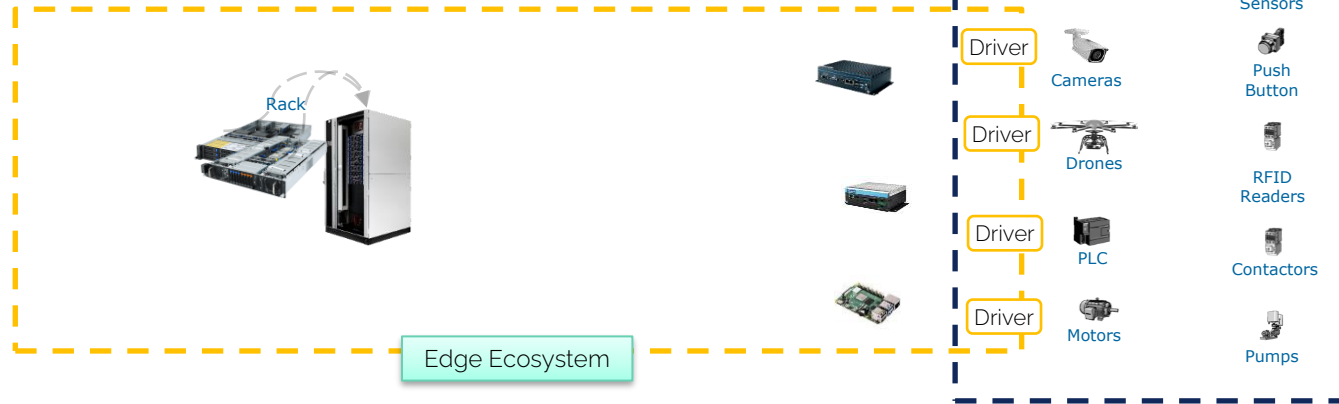
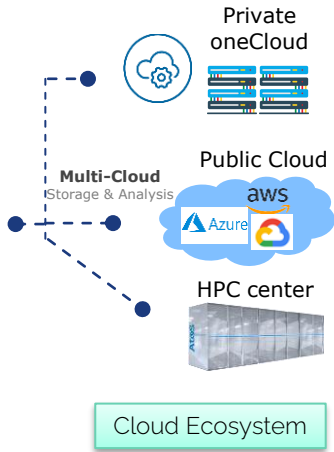
Ad-hoc computation node installed and/or operated by both a Vertical Service Provider and an Independent Vendor



IoT/Edge devices Providers

Edge / Micro Controllers

Sensors / Actuators



ICOS Ecosystem: Cloud, Edge IoT



Cloud Provider

Connect and extend computational capabilities to new and existing applications in the data center and/or cloud.



Near Edge Provider

Cloud Provider extension where Cloud Providers (AWS, Azure, etc.) deploy and manage regional / local computation nodes following the same "cloud business models".

Far Edge Provider

Ad-hoc computation node installed and/or operated by both an Vertical Service Provider and an Independent Vendor

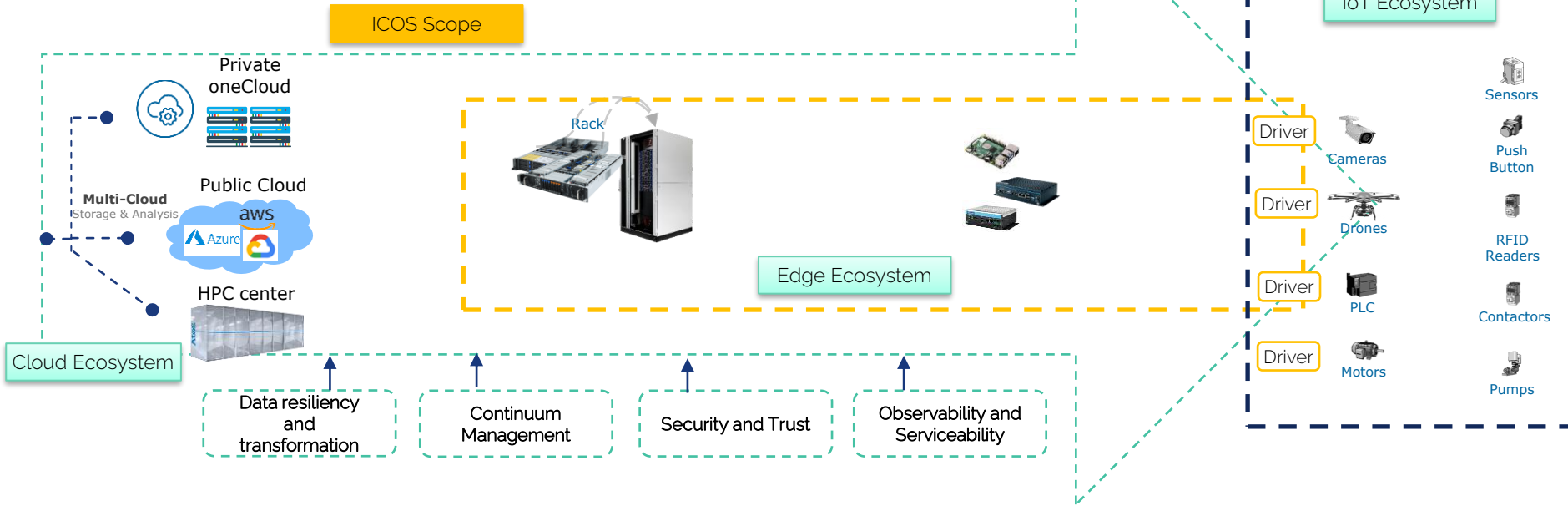


IoT/Edge devices Providers

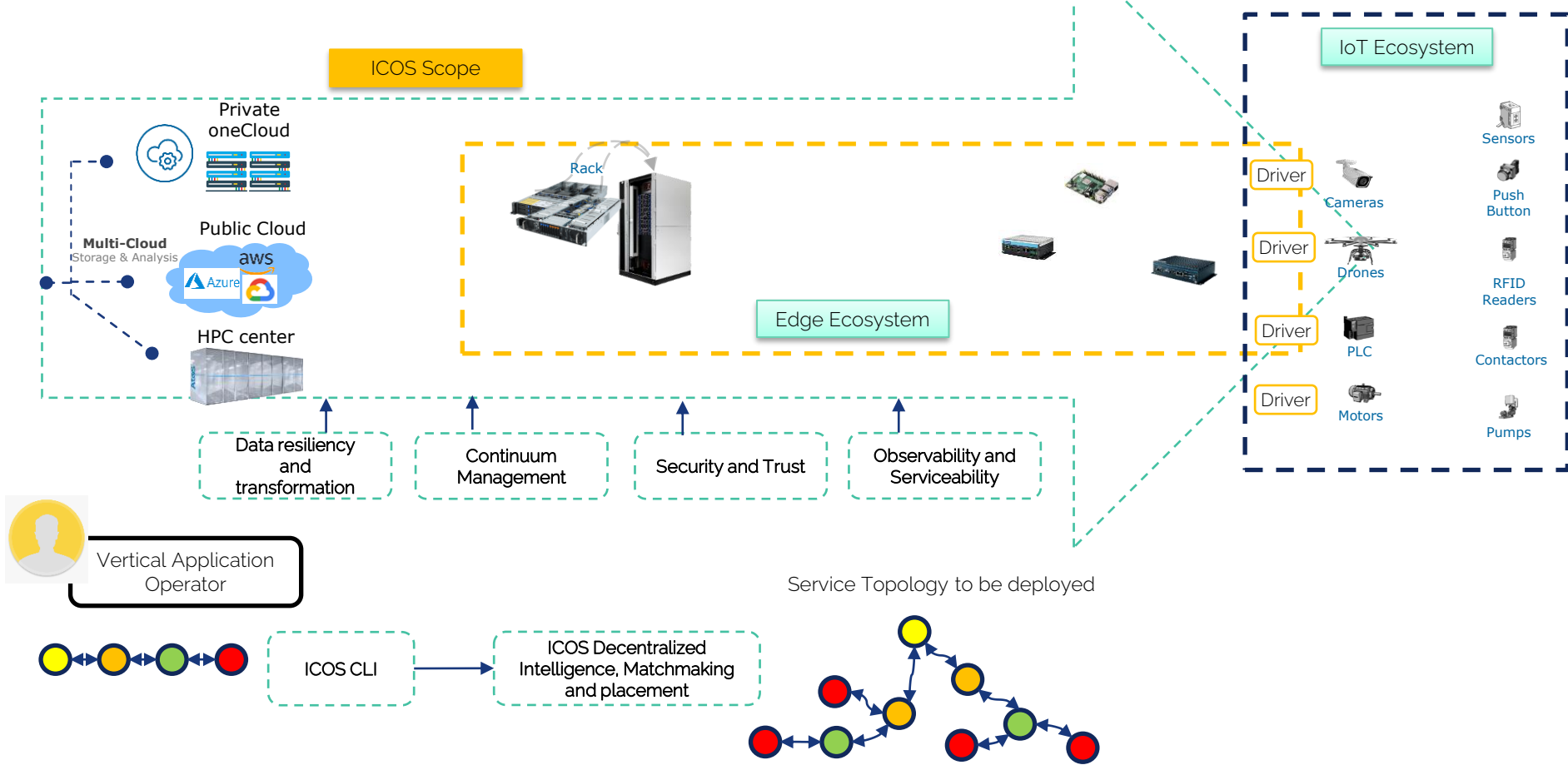


Edge / Micro Controllers

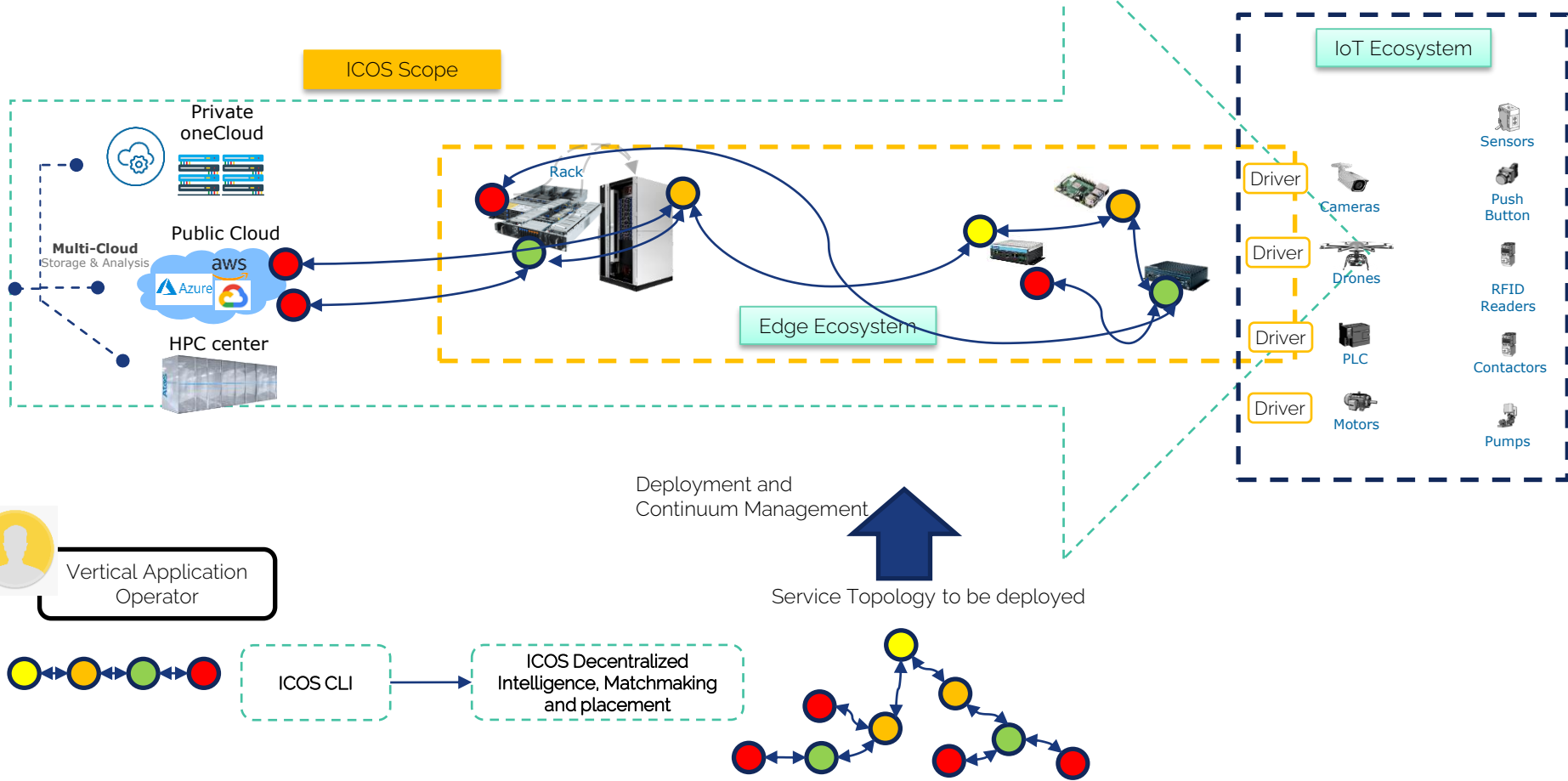
Sensors / Actuators



ICOS Ecosystem: Cloud, Edge IoT



ICOS Ecosystem: Cloud, Edge IoT

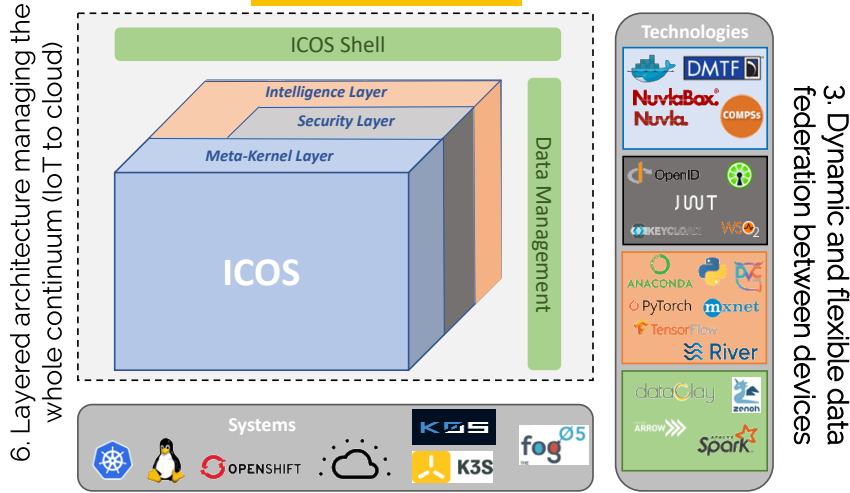


ICOS Challenges

1. Modeling strategy for proactive continuum management (dynamic deployment, configuration, migration, anomalies detection, SLA deviations, etc.)

2. Decentralized AI-assisted approach (online training under changing conditions, FL for privacy, etc.)

Key Innovation



5. Transparent deployment on top of native OSs

4. Open and unified programming model

6. Layered architecture managing the whole continuum (IoT to cloud)

Technical Impact

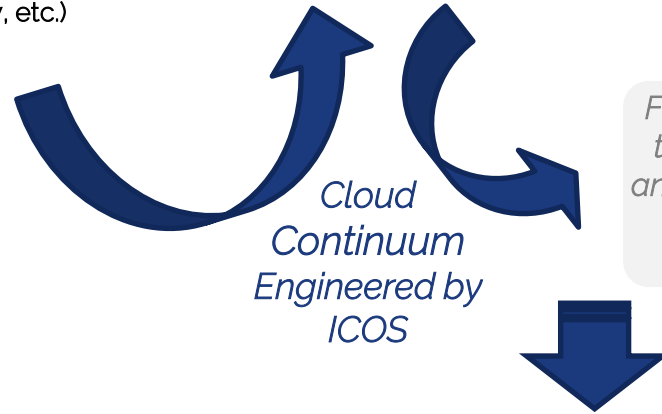
Design of an innovative, beyond SOTA ICOS ecosystem, providing a secure (common standards), smart (AI-assisted), efficient (green) and integrated (modular) platform for managing applications lifecycle across the continuum

Economic Impact

Feasibility demonstrated through the ICOS micro analysis, according to UCs KPIs and open call winners' specifications

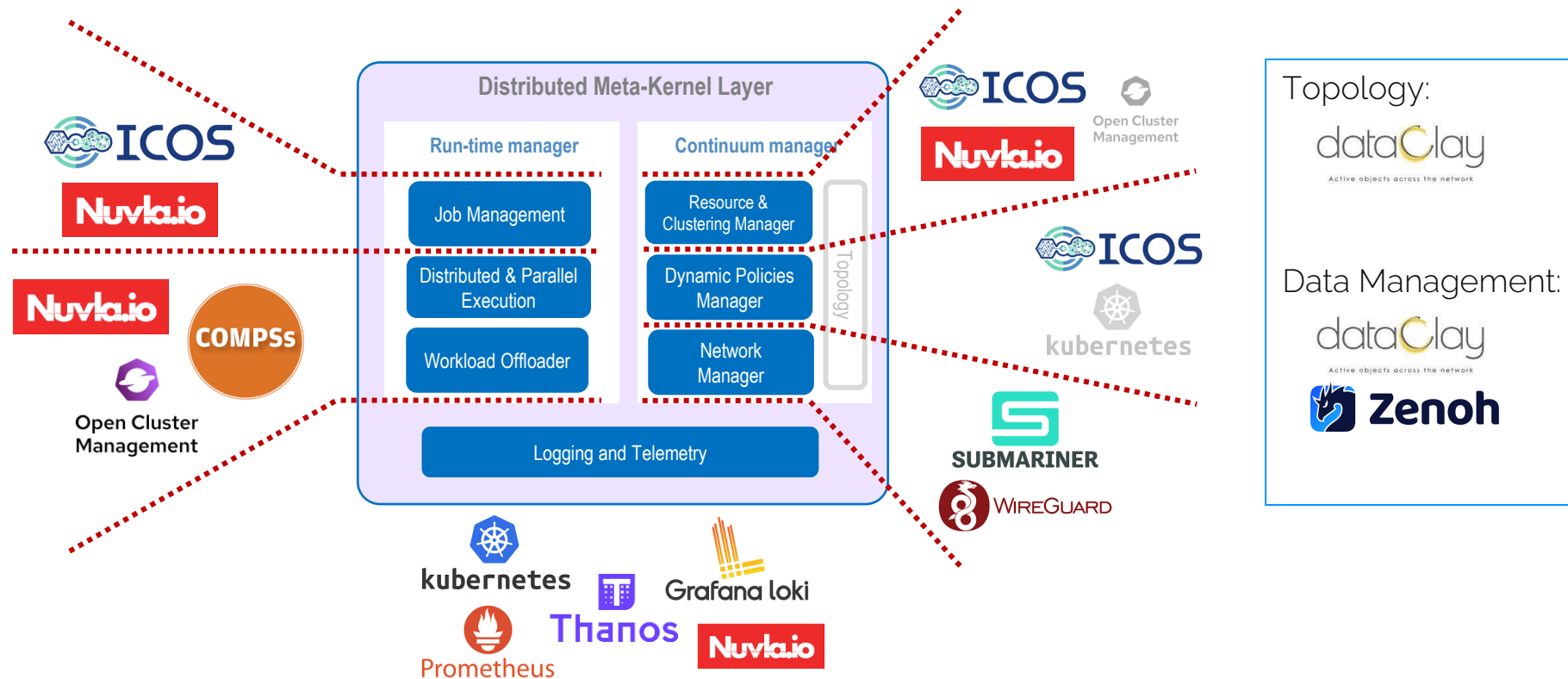
EU Competitiveness

The ICOS ecosystem to contribute to the creation of a globally attractive, secure and dynamic data-agile economy, supporting the market to move beyond a simple send-data-to-the-cloud, offering new opportunities to European actors to establish market and services increasing EU's autonomy and performance in the data economy



Meta-kernel layer

Proposed technologies



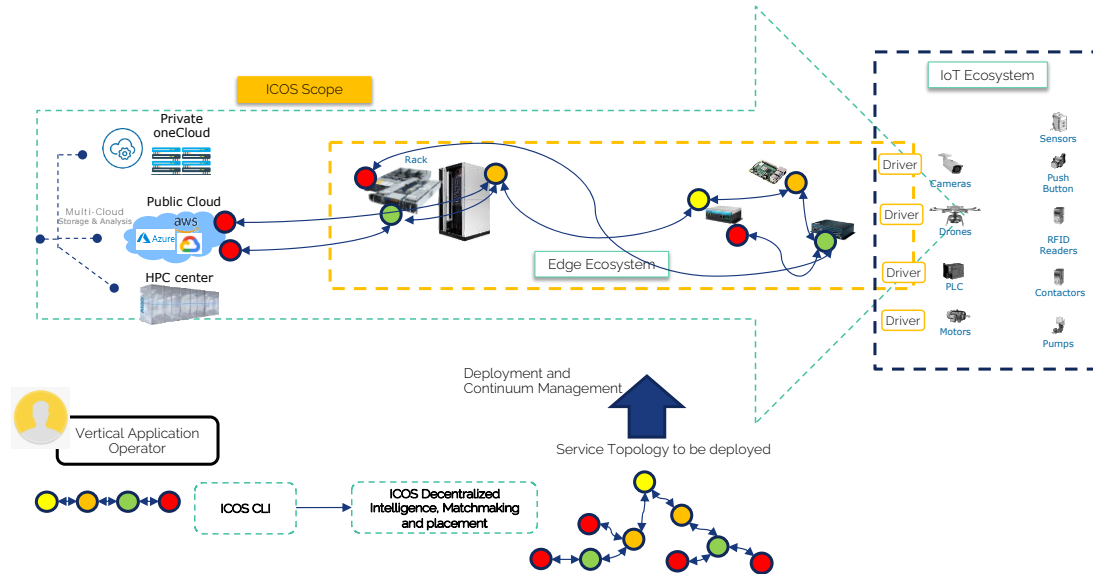
ICOS Security Layer

Objectives

Key assets

- Reliability
- Privacy
- Mobility
- Trust
- Multi-systems
- Smartness
- Attacks diversity
- Predictive models

End-to-end Security (Horizontal)

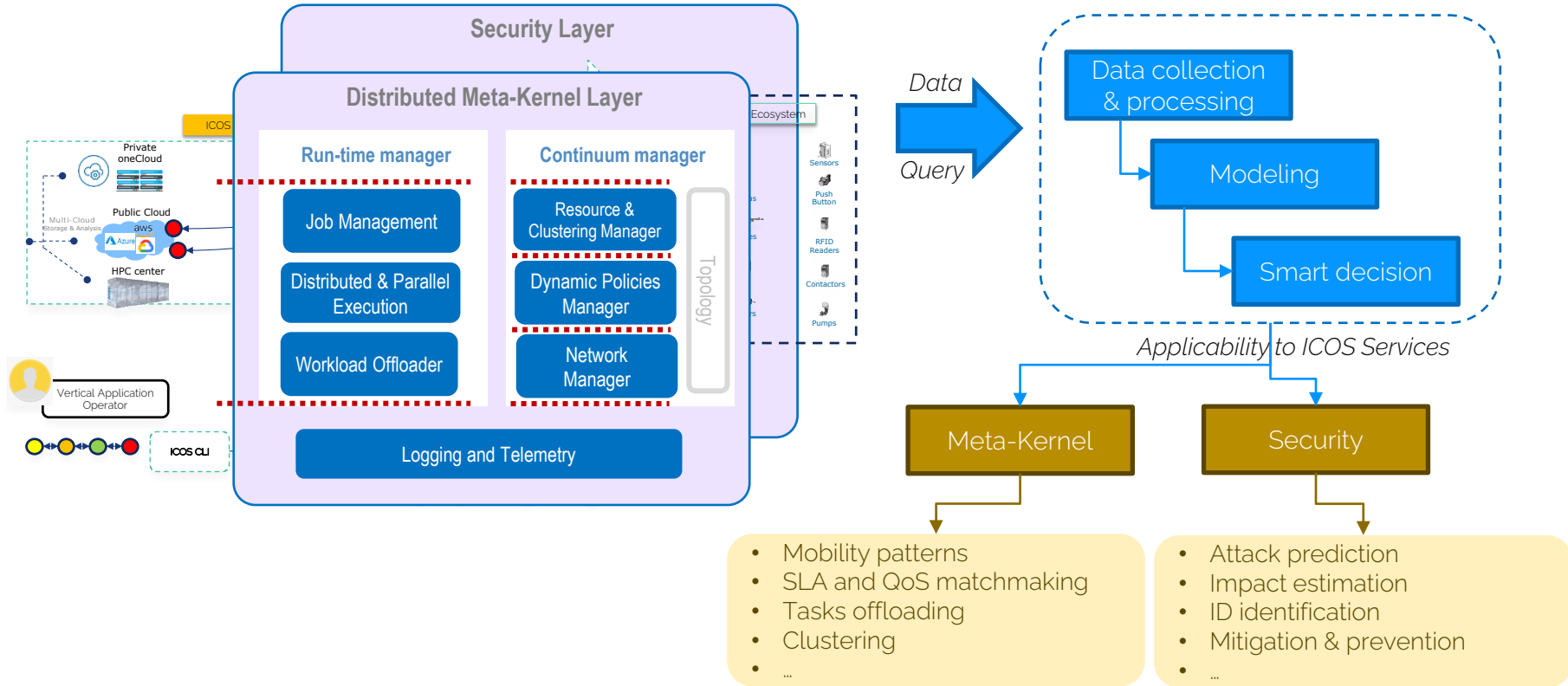


Stack Security (Vertical)

End-to-end Trust (Horizontal)

ICOS Intelligence Layer

Objectives



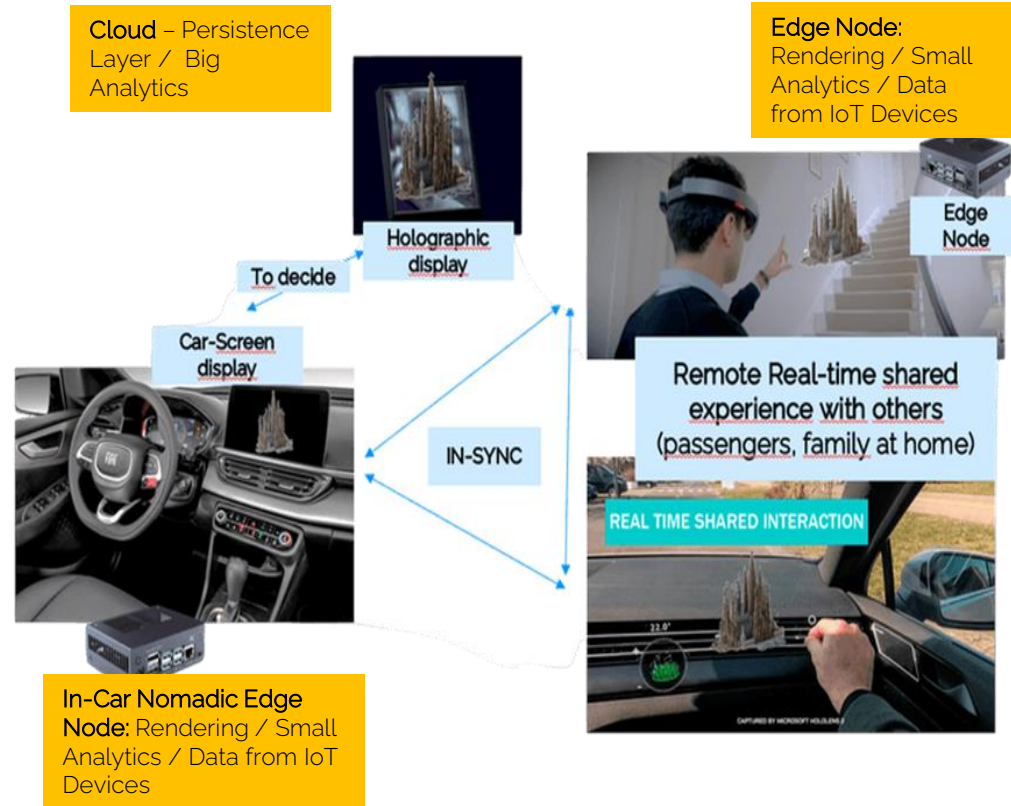
In-car Advanced Infotainment and Multimedia Management system (IAIMM)

Concept:

Multi-users and Multi-sites Virtual Sharing Experience to interact in sync with high-definition media contents (3D models, immersive videos, pictures, etc.) with in-car passengers and other users far away.

Benefits:

- Ensure **seamless user experience** by optimizing the distribution of multimedia content and maintaining high levels of quality of service (QoS) and quality of experience (QoE) also in case of low connectivity
- Provide **secure multiuser communication** and interaction infrastructure able to ensure privacy and security of shared data



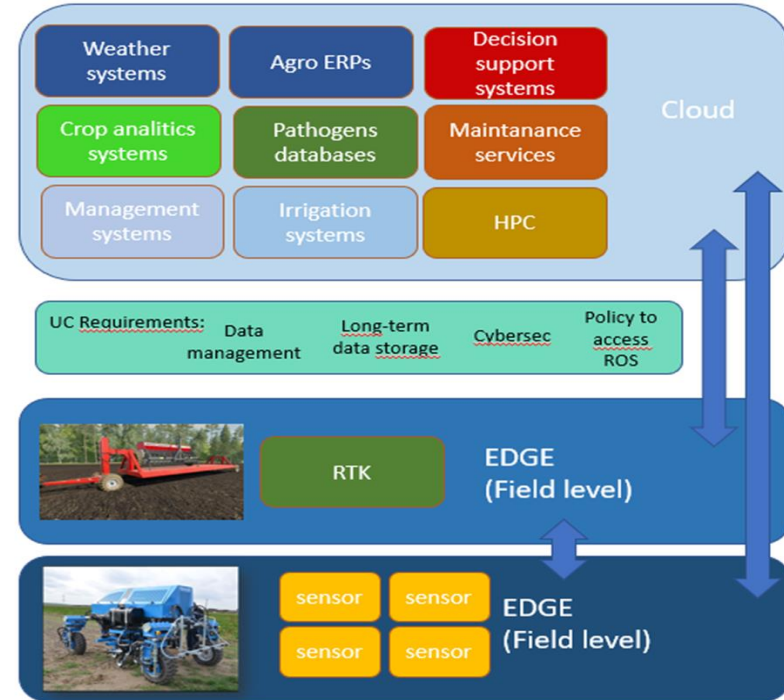
Agriculture Operational Robotic Platform (AORP)

Concept:

robotic systems based on a data exchange ecosystems and services based on their semantic processing to provide knowledge and tools to increase efficiency, ensure safety, and confirm product quality in the supply chain while reducing costs.

Benefits:

- **Realtime and Predictive maintenance of the machinery and remote steering:** a) Data from cameras, logs, from IoT / robotic platform to be stored using ICOS as raw data on the cloud (long-term storage / 100 GB per day); b) Cloud analysis (prediction), which will take vibrations and signal control information into account.
- **Crop management analytics (weed map):** using the predefined mission, machinery will take field images that will be used for the purpose of creating a weed map. The robot make a precision treatment based on the location on maps. With that the expected accuracy is 2-3 cm.
- **Validation and improvements of the ML models for robot operations and steering:** functionality to allow to improve AI models used on the near and far EDGE. The data will be sent from the devices to the cloud to train, validate and improve AI models that will be used for further missions, and for improving the robot capabilities.



Railway Structural Alert Monitoring system (RSAM)

Concept:

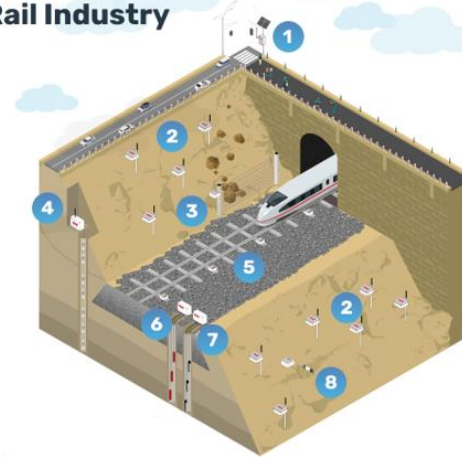
continuous monitoring of critical infrastructure on rail tracks to ensure safety and improve maintenance activities: rail track geometry, alarm detection, maintenance.

Benefits:

- **Energy-efficient solutions** for low-power IoT devices to guarantee safety operation monitoring in real time while ensuring a very long lifetime of the deployed technology in remote locations.
 - Improve raw data transmission and balance processing between the edge and cloud.
- **Improve wireless networking protocols** to achieve reliable system operation in remote locations while ensuring connectivity management for the whole continuum.
- **Edge to cloud orchestration of several applications** according to complexity, processing, or time requirements while using the same devices deployed and improving the coexistence of real-time processing and coordination with cloud services.



IoT Wireless Monitoring in the Rail Industry



- 1 Gateway powered by a solar kit, wind power or other means, with its data retrievable 24/7, manually or automatically via FTP, API, Dalls or Modbus protocols
- 2 Wireless Tiltmeters mounted on a pole and installed on a slope to monitor lateral displacement due to slope instability.
- 3 Load cells connected to a Piconode
- 4 A string of in-place inclinometers connected to a Digital node used to monitor in-depth lateral displacements of the subsoil due to instability and/or presence of discontinuities.
- 5 Wireless Tiltmeters with an internal antenna used to measure railway tracks condition (cant, twist and height variation).
- 6 Vibrating wire multipoint piezometers connected to a Vibrating wire 5-channel node used to measure pore water pressure and water level variations associated with vertical displacement and bearing capacity of the soil.
- 7 A multiple point borehole extensometer (MPBX) connected to a Vibrating wire 5-channel node used to measure vertical displacements linked to soil settlement.
- 8 Crack meter connected to a Piconode used to measure soil cracks that can lead to soil failure.

Energy Management and Decision Support system (EMDS)

Concept:

Data flow from 5 Smart Homes to implement an energy management system including use of Machine Learning models and edge computing.

- Micro-generation: PhotoVoltaics (PV) or wind turbines
- Electric Vehicles (EV) and Heat pumps
- Home energy storage and Smart meters

Benefits:

Understanding the usage and consumption of electricity becomes of fundamental importance to manage energy crisis.

- New AI models with resource sharing to optimise energy management
- Cloud /edge for secure and sustainable solutions
- Large flexibility with solutions adapted to customer needs
- The customer can decide to: a) Buy/Sell energy from/to the grid; b) Sell/trade energy to peers; c) Store energy or Create dispatchable demand





1st Open Call



Funding:

Up to €200k per consortium (€150k + €50k for a consortium); 5 projects to be awarded



Supported activities:

ICOS solution development project



What kind of support will be offered?

Support programme - 12 months



Type of applicants:

Consortia of 2 SMEs and mid-caps (1 tech provider, 1 end user)



Expected start/end:

1 August/ 2 October 2023



More Information available at:

<https://www.icos-project.eu/>

1st Open Call

Who are we looking for? What types of activities can be funded?

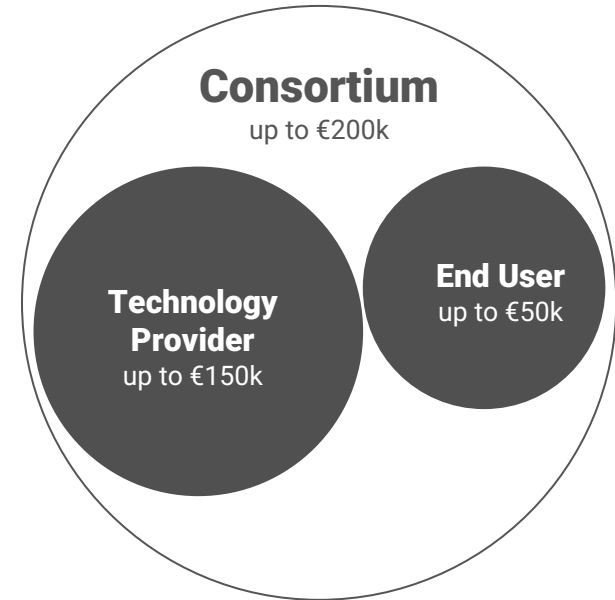
Who are we looking for?

Technology Provider is any entity that is an IoT infrastructure provider, who is providing the infrastructure that will be **deployed across the ICOS continuum**.

End User is an entity that will be the end user of the deployed application.

What types of activities can be funded?

1. **Development of the proposed services;**
2. **Development of the original service**
 - within an application area that is different from the project's use cases, based on the project objectives, reference architecture and components already under development





Towards a functional continuum operating system

For more information please contact:

Francesco D'Andria

francesco.dandria@atos.net

ICOS project coordinator

ICOS project has received funding from the European Union's Horizon Europe Framework Programme under the Grant Agreement N° 101070177. Views and opinions expressed in this presentation are however those of the ICOS Consortium only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them



**Funded by
the European Union**