Agile and Cognitive Cloud-edge Continuum management

Concertation and Consultation on Computing Continuum: From Cloud to Edge to IoT

Prof. Christos Verikoukis

10-11/5/2023

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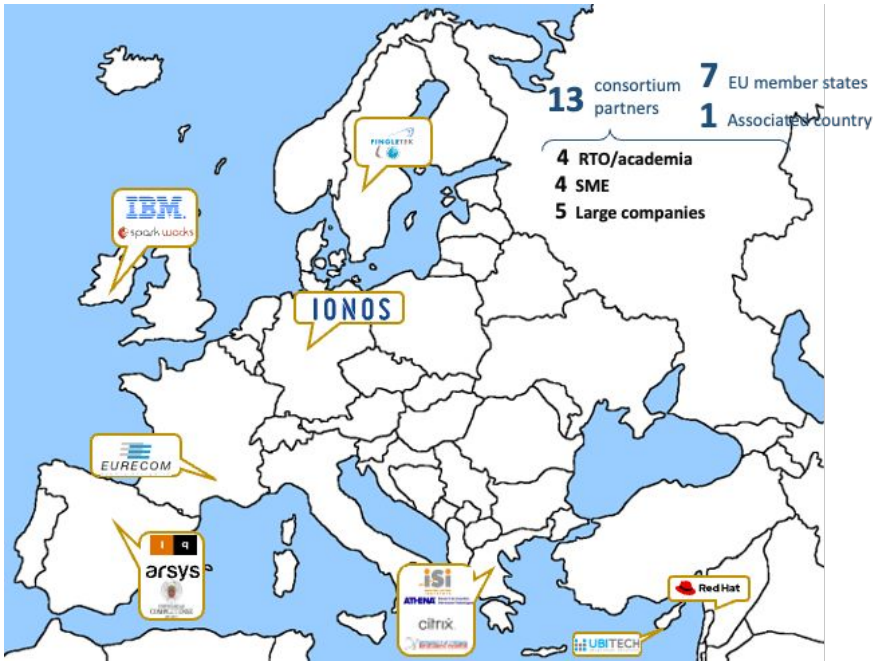
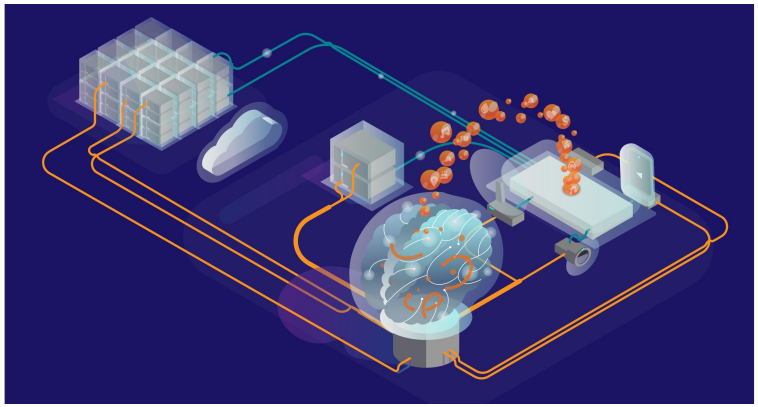
AC³ at a glance

Seamlessly handling application life-cycles and underpinning IT and networking resources.

On top of a federated infrastructure that includes Cloud, Edge, far edge, and data sources from multiple stakeholders.





AC3 will employ AI/ML algorithms to predict CECC usage as well as far edge availability, which when combined with application profiles, will help determine the optimal placement of the microservices that will run applications on the CECC infrastructure.

www.ac3-project.eu

Objectives - Use Cases

O1. A novel architecture for Cloud Edge Continuum including the far edge.

O2. New enablers for microservice-based applications deployment in Cloud Edge Computing Continuum (CECC).

O3. New federation model as well as trust and security enablers to accelerate resource sharing in CECC.

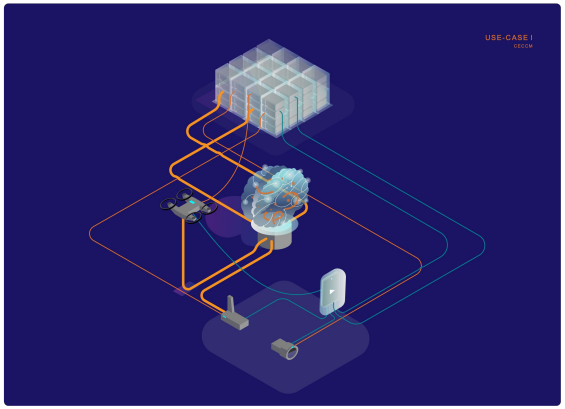
O4. Integrate data management as a PaaS in CECCM.

O5. Zero-touch management and configuration of application LCM.

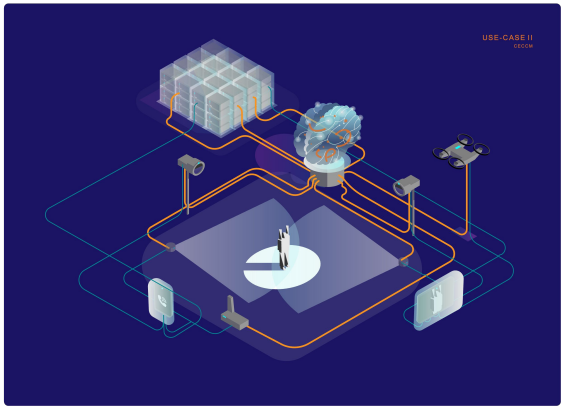
O6. Green-oriented zero-touch configuration and management of the CECC infrastructure.

O7. Towards end-to-end CECC network programmability.

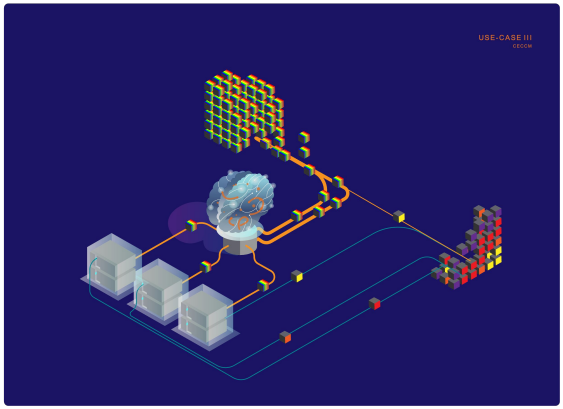
UC1: IoT and Data



UC2: Smart Monitoring System using UAV



UC3: Deciphering the universe



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ACES Autopoietic Cognitive Edge-cloud Services

Autopoietic Cognitive Edge-cloud Services

ACES will develop autopoietic and cognitive behaviors for an an edge-services cloud i.e. to manage and automate a compute platform, network fabric, storage resources, virtualization, and analytics to increase resilience while managing simultaneous service constraints.

Members
8 beneficiaries
3 associated partners

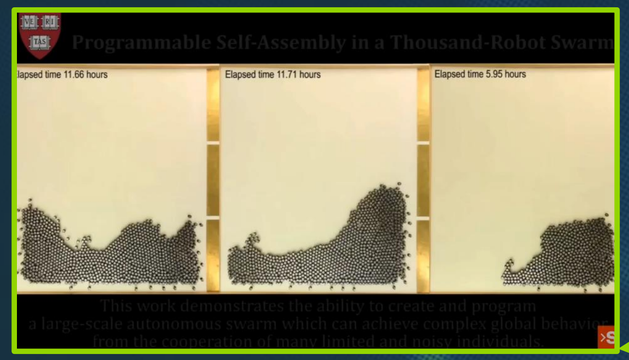
Funds
€ 5 543 925.00

Duration
36 months
Start Date: 01/ 01 /2023

HORIZON-CL4-2022-DATA-01
Grant Agreement Number: 101093126

Fred Buining
HIRO-MicroDataCenters BV

Funded by the European Union



Autopoietic Edge-cloud

Future edge distributed architectures will be built from fully disaggregated hardware, locally customized for categories of workloads. Autopoietic edge services enable dynamic optimization between services demand and supply using AI/ML and Swarm technologies.

Unity

Elements operating largely interactively, independently, autonomously are acting as a unity.

Regenerate

Transform, (re-) create, and renew, re-produce itself and/ or some of its components or processes.

Regulation

Regulate its composition and conserving its boundaries

Balancing complexity

Balance external complexity with internal complexity of the system **multi objectives**

Living system

Living systems behavior

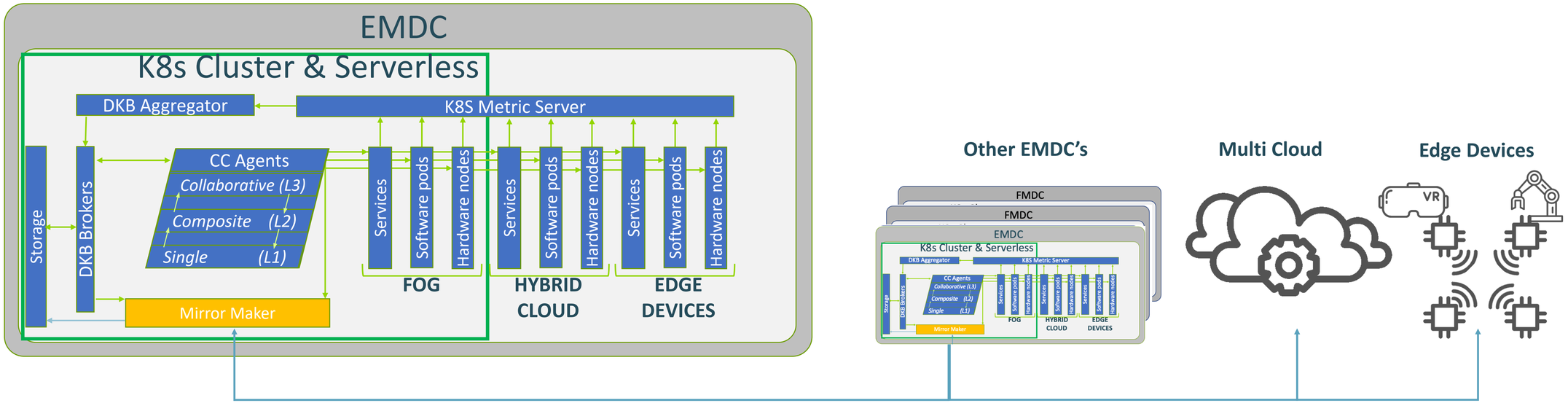
Embodiment

Subjective sense making while pursuing collective multi objectives

ACES
HORIZON-CL4-2022-DATA-01
Grant Agreement Number: 101093126

Fred Buining
HIRO-MicroDataCenters BV

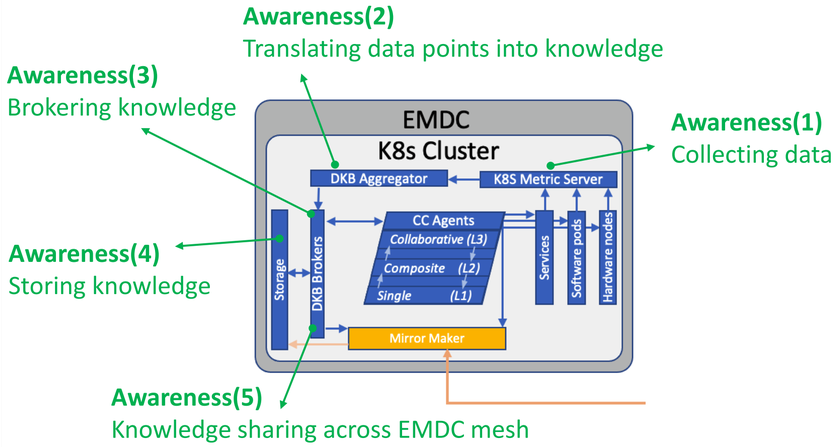
EMDC Mesh (Edge/ Fog Middleware) with a tiered cognitive engine



CAPABILITIES

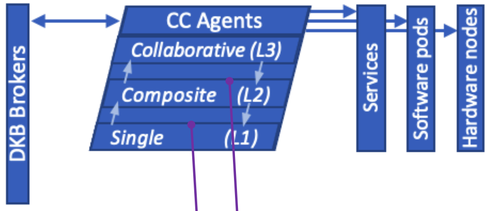
Awareness of Edge service Infrastructure (HW, SW)

Data Acquisition, Knowledge Generation and Organisation



Cognitive-Control of Services, Software Stack, Hardware

Self-management, -healing, -orchestration, etc.



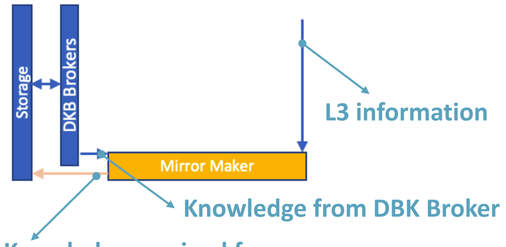
Cognitive control

Is achieved by autonomous agents interacting across three abstraction levels: L1 agents acting on a single service, pod, HW node. L2 agents acting within one EMDC on composites of L1 agents. L3 agents active for collaborations between EMDC's.
The agents interactions create emergent behaviour on various levels.

Edge-wide Collaboration

Mirror Maker

Offers fine-grained control over shared information
Restricts access based on policies



ACES
HORIZON-CL4-2022-DATA-01
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Main Objectives of these 2 days.
ACES is in the requirements definition phase

ACES Consortium would like to exchange and align where possible with other projects on:

- SLA, QOS definitions and metrics for edge services;
- Tools to extract metrics from infrastructure and processes;
- Services to create a Distributed Services mesh;
- AI/ML approaches for perceiving, creating knowledge, taking action

Partners.

hiro MICRODATACENTERS

inesc id lisboa

MARTEL innovate

TECHNISCHE UNIVERSITÄT DARMSTADT

Lakeside Labs
SELF-ORGANIZING NETWORKED SYSTEMS

POLITÉCNICA

University of Ljubljana
Faculty of Computer and Information Science

IDSIA
SUPSI

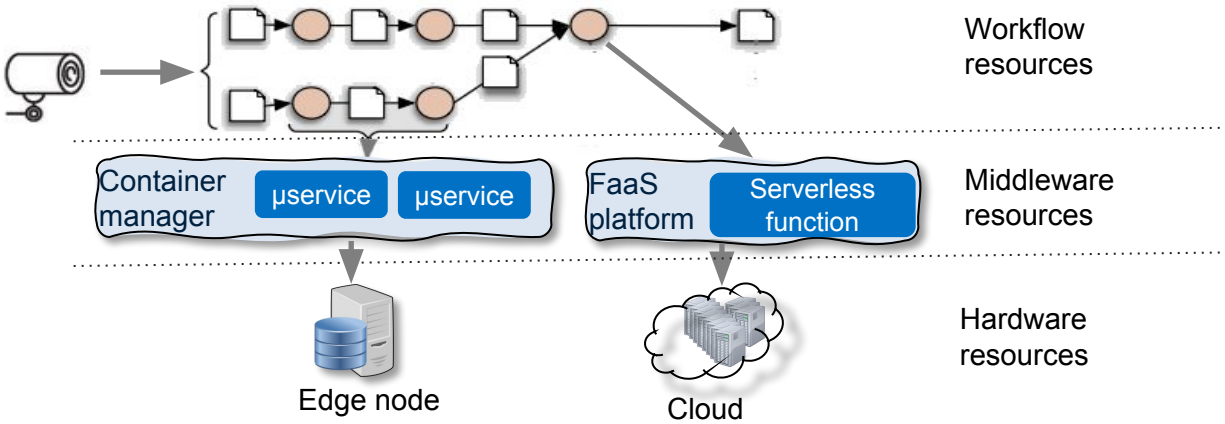
ipto
INDEPENDENT POWER TRANSMISSION OPERATOR

sixsq

DATAPOWER CONSULTING

A continuum environment

- For an **ideal integration of different Cloud-edge silos**, several important challenges remain:

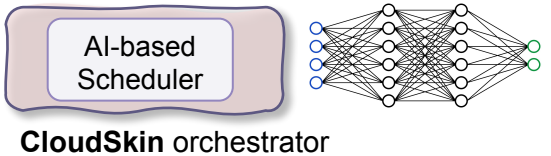


- **CH-1. Lack of AI-assisted service provisioning, migration, and orchestration of tasks in the continuum** based on multi-objective optimization (e.g. performance, privacy, security, energy, emissions).
- **CH-2. Lack of a seamless, trusted execution layer across the continuum**, enabling data and code to move freely, wherever most appropriate for reasons of privacy, latency, capacity, etc.
- **CH-3. Lack of continuum infrastructure** to enable short-lived tasks (of 1 to 10ms, or less) and extremely intense bursts with fast data access requirements.

Coordinator: Marc Sanchez Artigas E-mail: marc.sanchez@urv.cat

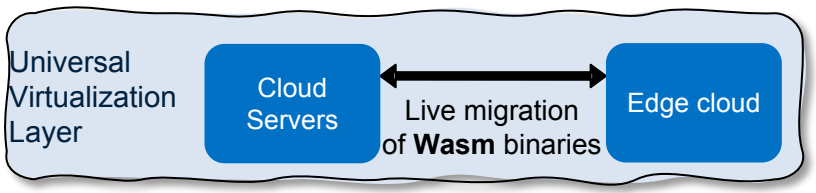
Mission

- **CloudSkin** aims to design a **cognitive cloud continuum** platform to fully exploit the available Cloud-edge heterogeneous resources by:



- Smartly adapting to changes in application behaviour via **AI**

- Building a **universal container-like execution** abstraction based on **WebAssembly** (Wasm) and **Trusted Execution Environments** (TEEs)



- Designing a **high-performance infrastructure** for the cloud continuum, tailored to the short-lived, also bursty, execution of Cloud-edge tasks

- **Use cases:** Mobile edge, Metabolomics, Computed-Assisted Surgery and Agriculture

Coordinator: Marc Sanchez Artigas

E-mail: marc.sanchez@urv.cat

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CODECO

Cognitive Decentralised
Edge Cloud Orchestration

CODECO Website

CODECO Eclipse Research Lab

Dr. Rute C. Sofia (sofia at fortiss dot org)

fortiss - research Institute of the Free State of Bayern

EUCEI Concertation and Consultation On Computing Continuum

10th-11th May 2023 – Claridge, Brussels

Funded by the European Union under Grant Agreement 101092696

OVERVIEW

A novel Edge-Cloud orchestration framework, focusing on data-compute-network adaptability

Main Challenges

5G/6G smart services Dense environments	Mobility High portability	Far Edge to Cloud

Vision

Highly adaptive Edge-Cloud management framework (TRL4-5) that integrates a unique, smart, and cross-layer orchestration considering **decentralised data flow**, **computation**, and **adaptive networking**

Simplification & Automation	**O1:** Reduce Edge-Cloud Setup and Management Time
Data-compute-network Orchestration	**O2:** Optimize Edge-Cloud Operation via privacy-preserving data-compute-network orchestration
Security & Privacy Preservation	**O3:** Provide automated, privacy preserving secure management for multi-clusters
Openness & Greenness	**O4:** Support multi-domain Edge Cloud operations integrating openness and greenness
Broad Impact	**O5:** Build a consolidated ecosystem appealing to the different CODECO stakeholder groups

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ASSETS AND USE-CASES

CODECO

A1

Open toolkits and smart Apps

Advanced management of containerized applications across far Edge to Cloud, federated and single cluster environments

A2

Open-source Eclipse repository

https://gitlab.eclipse.org/eclipse-research-labs/codeco-project

A3

Training Database

Training tools and events, to support the development of services based on the CODECO framework.

A4

Edge-Cloud Use-cases

6 Use-cases across 4 domains (Smart Cities, Energy, ManufacturingMobility)

A5

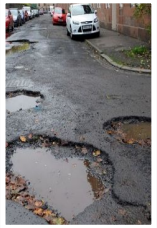
R&I Engagement Programme

Community engagement via hands-on events

A6

Open Experimental Framework

CODECO components in the large-scale EdgeNet, accessible to the wide research community



P1: Smart Monitoring of the Public Infrastructure

Lead: Univ Göttingen/City of Göttingen, DE

VP: Improved QoE

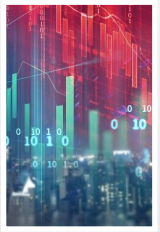
Domain: Smart Cities

P2: Vehicular Digital Twin for safe urban mobility

Lead: I2CAT, SP

VP: Increasing road safety

Domain: Mobility



P3: Decentralized Edge MDS

Lead: Telefonica, SP

VP: cross-layer resource optimization for MDS

Domain: Smart Cities

P4:Decentralized Grids Collective Demand Side Management

Lead: Univ Politecnica de Madrid, SP

VP: Smart monitoring of the energy generation, consumption,availability

Domain: Energy

P5:Decentralised, wireless AGV Control for Flexible Factories

Lead: fortiss, DE

VP: Increased AGV autonomy and scalability via decentralized control

Domain: Manufacturing

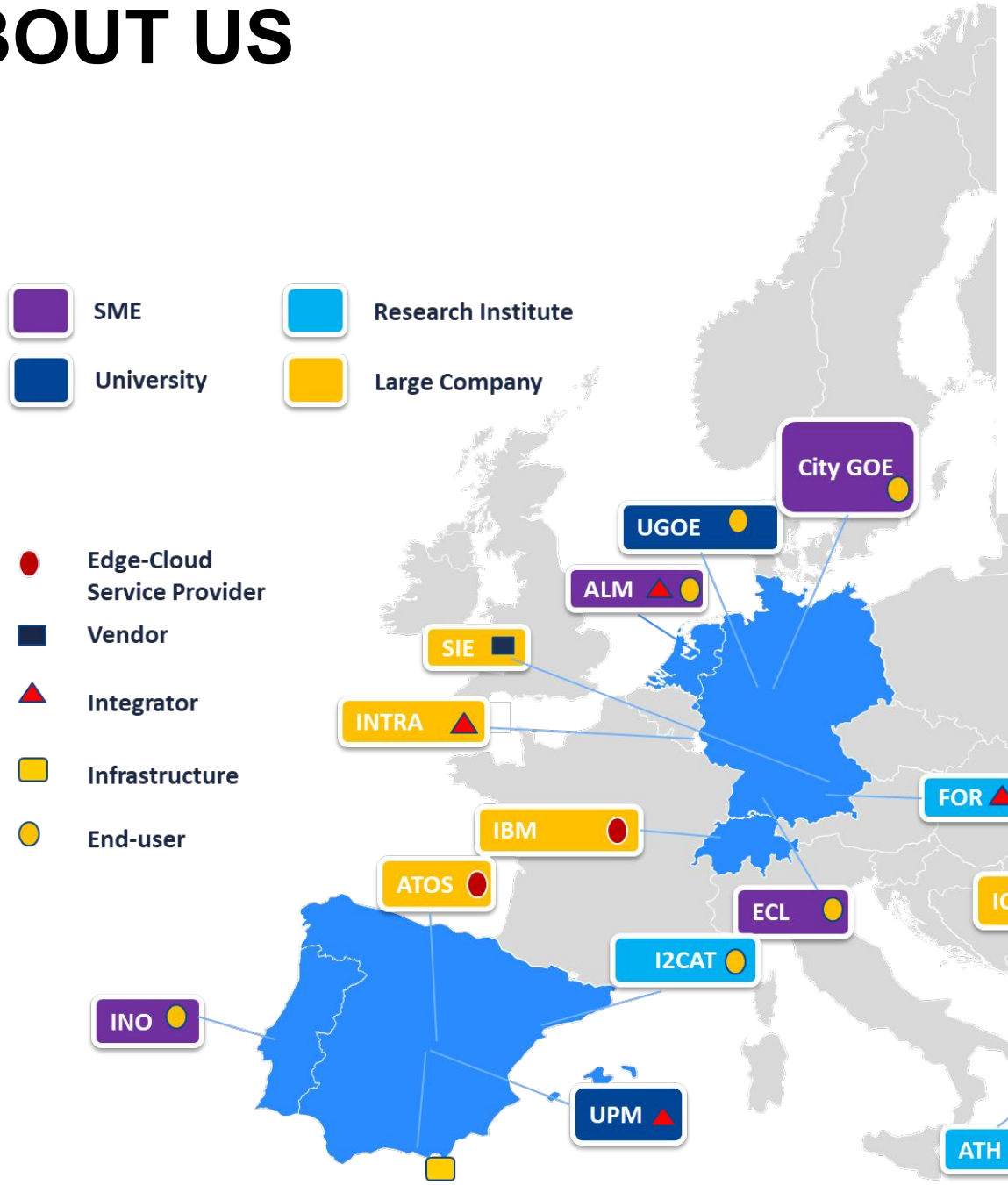
P6:Smart Buildings

Lead: Almende, NL

VP: far Edge management of Crownstone meshes and their appliances

Domain: Energy

ABOUT US



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COGNIFOG

AI-empowered Edge Cloud Continuum for self-aware cognitive computing environments

Selma Azaiez

CEA

Concertation and Consultation on Computing Continuum:
From Cloud to Edge to IoT

10-11 May 2023

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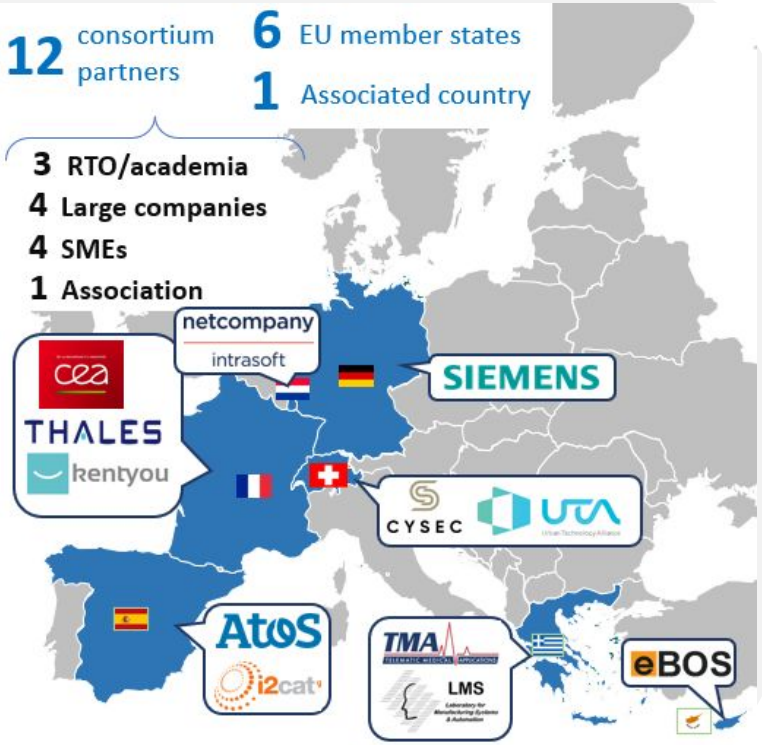
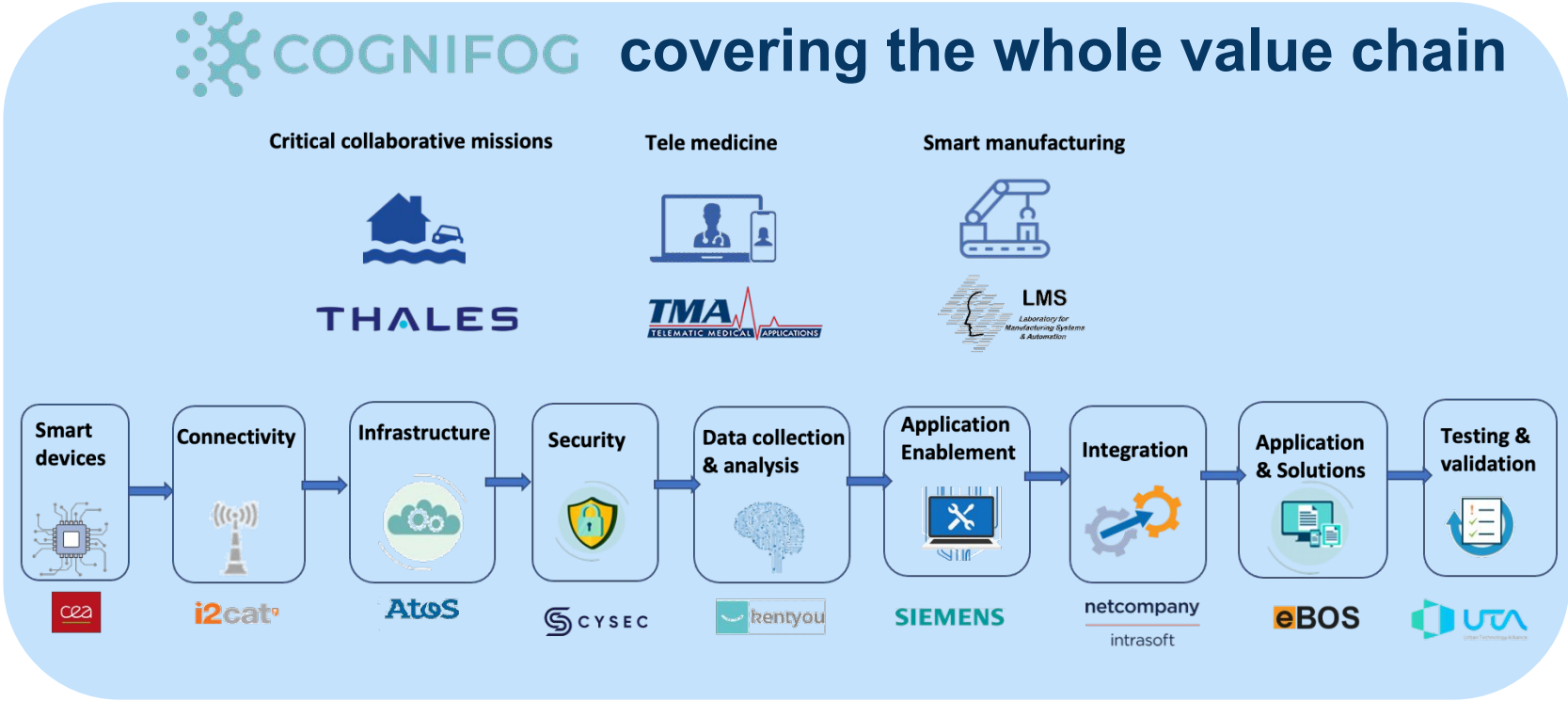
COGNIFOG IN A NUTSHELL

- Start Date: 01 January 2023
- Programme: Horizon Europe - Project ID: 101092968

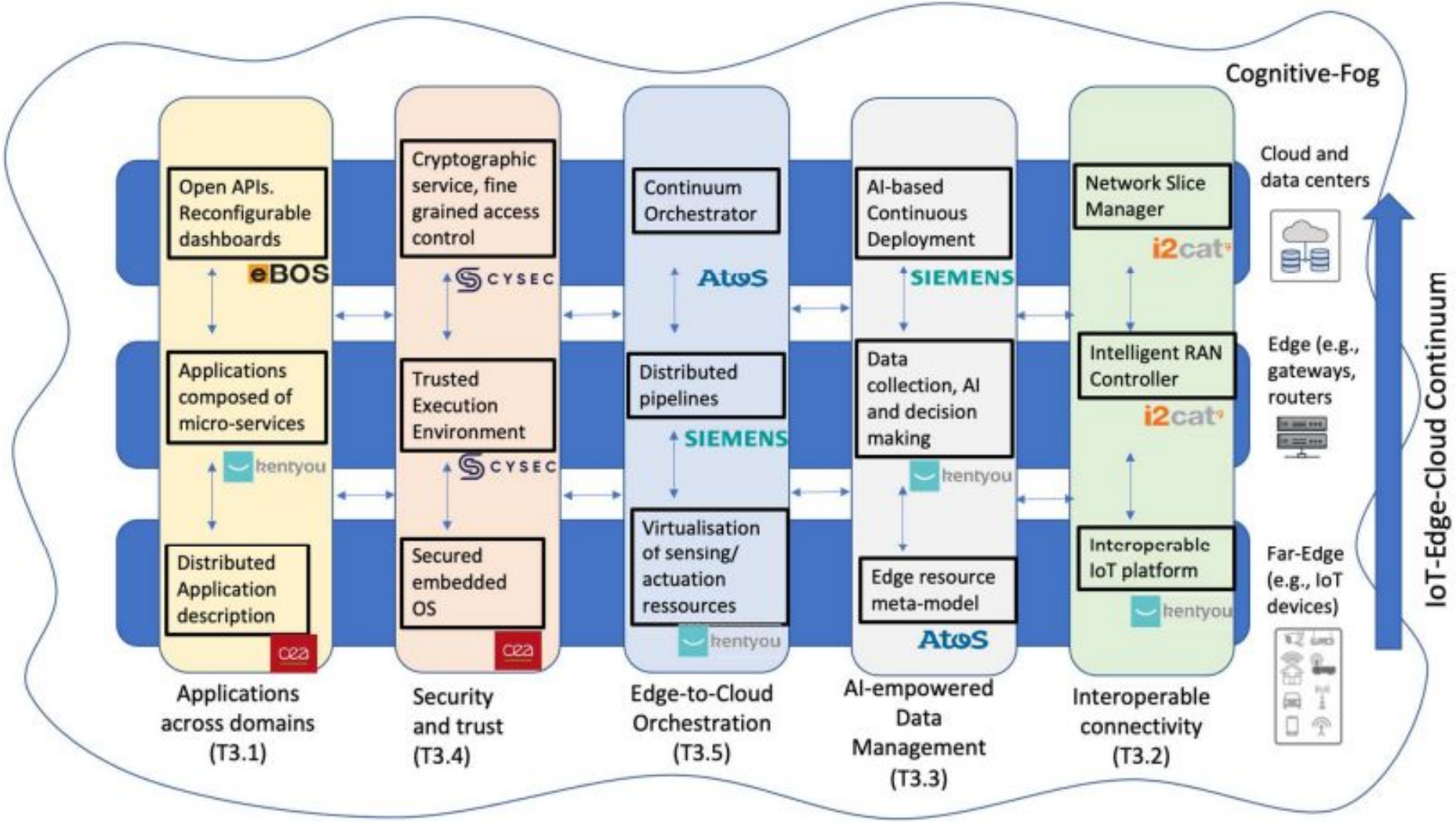




COGNIFOG framework with technology providers building blocks

Cognitive-fog 5 main topics:

- **Application, hardware and dataflow**
- **Security and trust**
- **Orchestration**
- **AI-empowered Data Management**
- **Connectivity and interoperability**



Trials Validation

TRIAL 1	TRIAL 2	TRIAL 3
Critical collaborative missions	**Tele medicine**	**Smart manufacturing**
Title: Collaborative mission in urban areas **Description:** ○ Detection of inundation zone by collecting and analysing data from multiple sensors ○ Mission coordination scenario using a combination of drones with advanced sensors **Main goal:** OODA (Observe, Orient, Decide, Act) loop in the continuum **Challenges:** ○ HW/SW Heterogeneity ○ Low bandwidth intermittent connectivity	**Title:** E-health services in the Edge-Cloud Continuum **Description:** ○ Allow video calls with remote attending physicians via TMA's NoAH are telemedicine stations for rural medical centers and marine/aviation applications where connectivity with the internet is often severely restricted **Main goal:** Provide self-management evaluation notifications to users, to enhance Medical IoT devices and forward measurements to cloud infrastructure for evaluation of the users overall health **Challenges:** ○ Provide first level diagnosis without human assessment ○ Overcome harsh network conditions ○ Enhance security and privacy	**Title:** Automated Edge-Cloud Continuum for smart manufacturing **Description:** ○ Cooperative robots and mobile robots ○ Smart Robot Control System strong support from ICT infrastructure **Main goal:** Create dynamically reconfigured workplaces **Challenges:** ○ Achieve flexibility and efficiency ○ Industrial robots advantages not exploited in their full potential

Path to Impacts

Main challenge

- **Massive data generation** pushing network and processing capacity to its limits.
- Inefficient management in **disaster scenarios.**

Sot A

- **Cloud focused** data storage and processing.
- **Latency**, single points of failure
- **Organisational and interoperability barriers** between cloud and edge resources

Main result beyond SotA

- **Open, interoperable, secure and self-adaptive** edge-cloud continuum for time-critical, privacy-friendly, energy-efficient next generation IT systems
- **Proof of concept** in three application domains

Main outcome

- **Standardised** edge-cloud continuum reference model
- **Advanced interoperability and context-awareness** in IT systems
- **Decentralized AI capabilities** along the Cloud-Edge Continuum

Main impact

- **10%** reduced energy consumption in data centers;
- **30%** reduced OPEX for services
- **x10** faster service provisioning and deployment
- **400+** enterprises adapting and using COGNIFOG framework **within 5 years**

COGNIFOG

Thank you for you attention!

CEA

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https://cognifog.eu/

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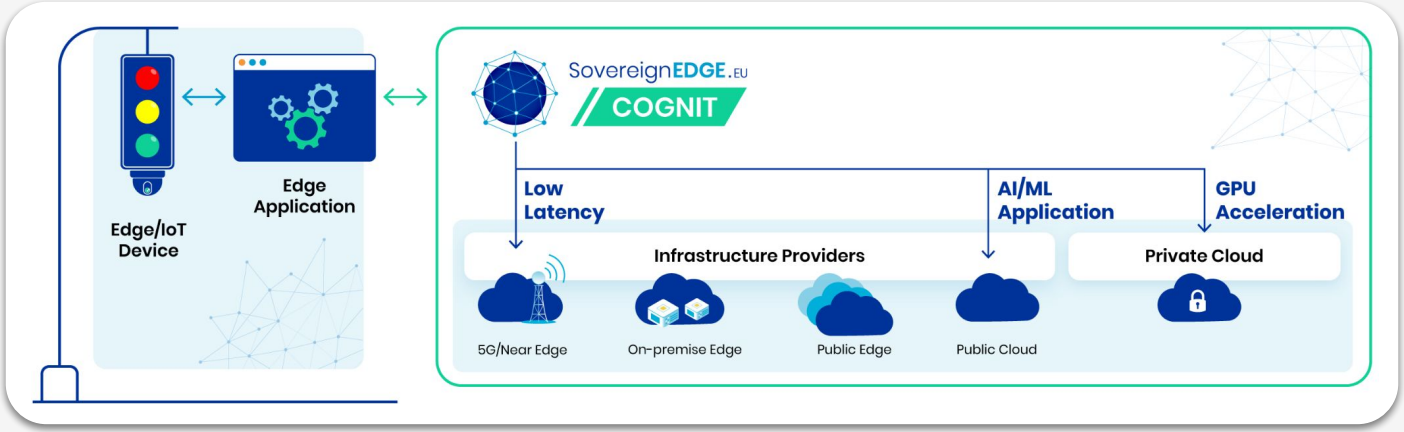
A Cognitive Serverless Framework for the Cloud-Edge Continuum

Topic: **HORIZON-CL4-2022-DATA-01-02** (Cognitive Cloud) · Execution Dates: **2023 - 2025**

Open Nebula · Umeå Universitet · ikerlan · cetic · RISE Research Institutes of Sweden · SUSE · acisa · Nature 4.0 · Phoenix Systems · Atende Industries

COGNIT Project Goals, Expectations and Vision

AI-enabled Adaptive Serverless Framework for the Cognitive Cloud-Edge Continuum



- **Supporting a new innovative FaaS paradigm in Europe for edge application management:**
  - European open-source ecosystem (SUSE, OpenNebula, …),
  - based on code off-loading,
  - easy to manage, automate and optimise
- **Enabling on-demand deployment of large-scale, highly distributed and self-adaptive serverless environments**
- **Optimizing where data is processed and stored** according to
  - security and privacy regulations,
  - changes in application demands and behavior,
  - energy efficiency heuristics

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DECICE

DECICE

DEVICE - EDGE - CLOUD

Intelligent Collaboration Framework

Georg-August-Universität Göttingen

Felix Stein

Concertation and Consultation on Computing Continuum: From Cloud to Edge to IoT

10-11 May 2023 | The Claridge – Brussels, Belgium

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DECICE

Device-Edge-Cloud Intelligent Collaboration Framework

DECICE aims to develop an AI-based, open and portable cloud management framework for automatic and adaptive optimization and deployment of applications in a federated infrastructure, including computing from the very large (e.g., HPC systems) to the very small (e.g., IoT sensors connected on the edge).

EDGE | CLOUD | HPC | IoT | HETEROGENOUS SYSTEMS | AI-SCHEDULING | MACHINE LEARNING | DATA CENTERS | SYSTEM MONITORING | DIGITAL TWIN | KUBERNETES

BACKGROUND

Growth and higher complexity of cloud computing industry

CHALLENGE

Ultra-low latency, security and close location (e.g. in Smart Cities)

SOLUTION

AI-Scheduler: using the available resources of a digital twin

CONTACT & FACTS

www.decice.eu office@decice.eu @DECICE_EU DECICE Project

SUBSCRIBE TO OUR NEWSLETTER NOW!
Discover our latest updates and news about the DECICE project.

Programme
Horizon Europe
HORIZON-CL4-2022-DATA-01-02
Research & Innovation Action

Reference
101092582

Duration
12/2022 to 11/2025

Coordinator
Georg-August-Universität Göttingen

DECICE OBJECTIVES

- **LEVERAGE A COMPUTE CONTINUUM** ranging from Cloud and HPC to Edge and IoT.
- **AI-SCHEDULER** supporting dynamic load balancing for energy efficient compute orchestration, improved use of Green Energy, and automated deployment.
- **API** that increases control over network, computing and data resources.
- **DYNAMIC DIGITAL TWIN** of the system with AI-based prediction capabilities.
- **REAL-LIFE USE CASES** of DECICE framework (usability and benefits).
- **SERVICE DEPLOYMENT** with a high level of trustworthiness and compliance with relevant security frameworks.

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Cognitive edge-cloud with serverless computing

WORLDLINE

ubiwhere

Technische Universität München

SIEMENS

infineon

Consiglio Nazionale delle Ricerche

Telefónica

AEGIS IT RESEARCH

Atos

eurecat Centre Tecnològic de Catalunya

UNIVERSITY OF CAMBRIDGE

This project has received funding from the EUROPEAN HEALTH AND DIGITAL EXECUTIVE AGENCY (HADEA) program under Grant Agreement No 101092950

EDGELESS Overview

Goal of EDGELESS

Leverage the **serverless** concept in all the layers in the **edge-cloud** continuum to fully benefit from **diverse** and **decentralised** computational resources available **on-demand** close to where data are produced or consumed

Objectives

Obj#1.	Efficient operation of data-intensive applications with a dynamic behaviour
Obj#2.	Cognitive tools and techniques for efficient use of resources on constrained and specialised edge nodes
Obj#3.	Trusted access to lambda functions on edge nodes, including limited computational capabilities
Obj#4.	Interfaces and models to deploy edge applications in a continuum multi-provider environment
Obj#5.	Evaluate the solution in a wide range of realistic use cases

Contact us!

Use Cases

UC#1.	Autonomous Smart City Surveillance
UC#2.	Internet of Robotic Things
UC#3.	HealthCare Assistant

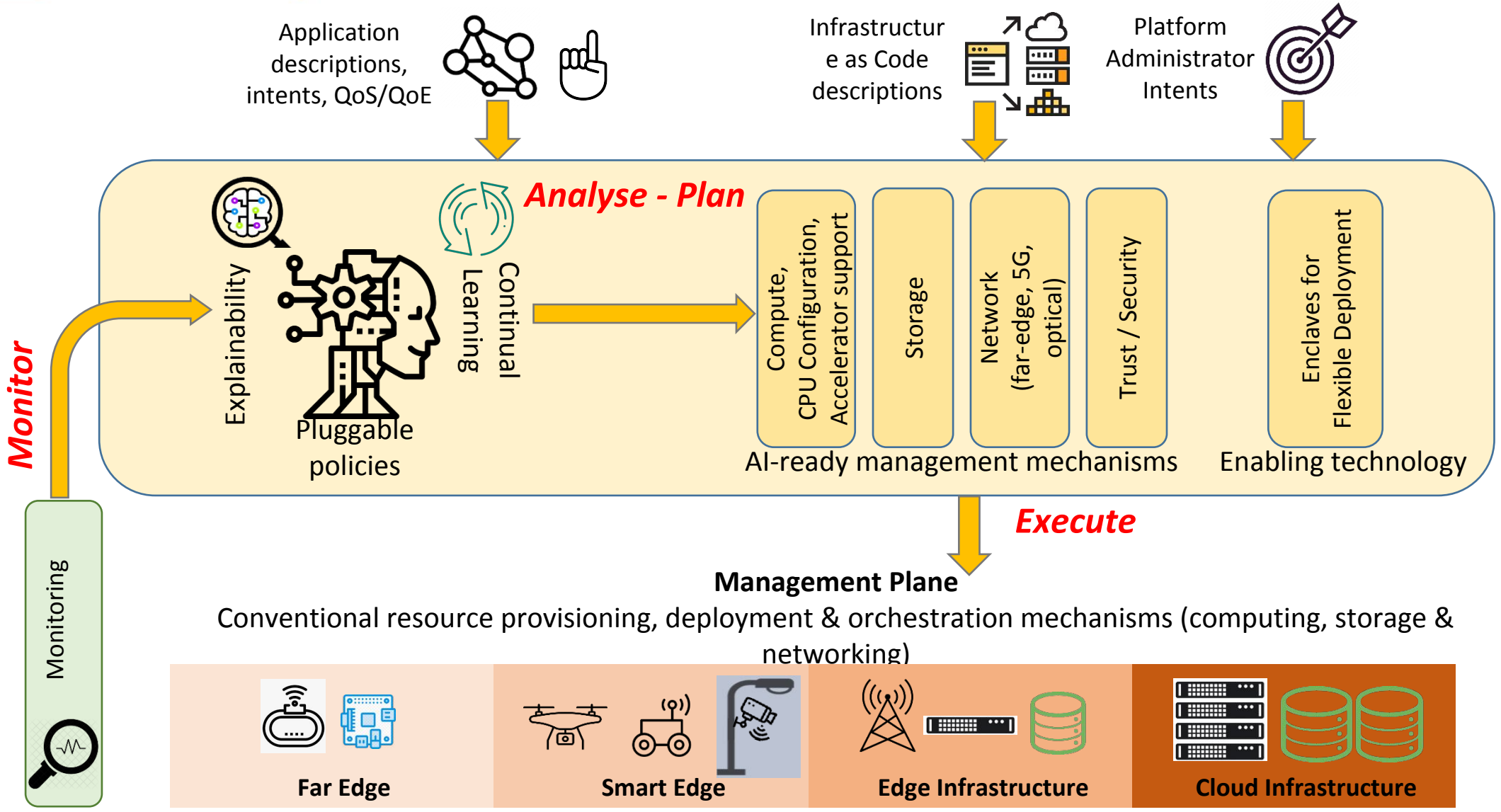
Expected Results

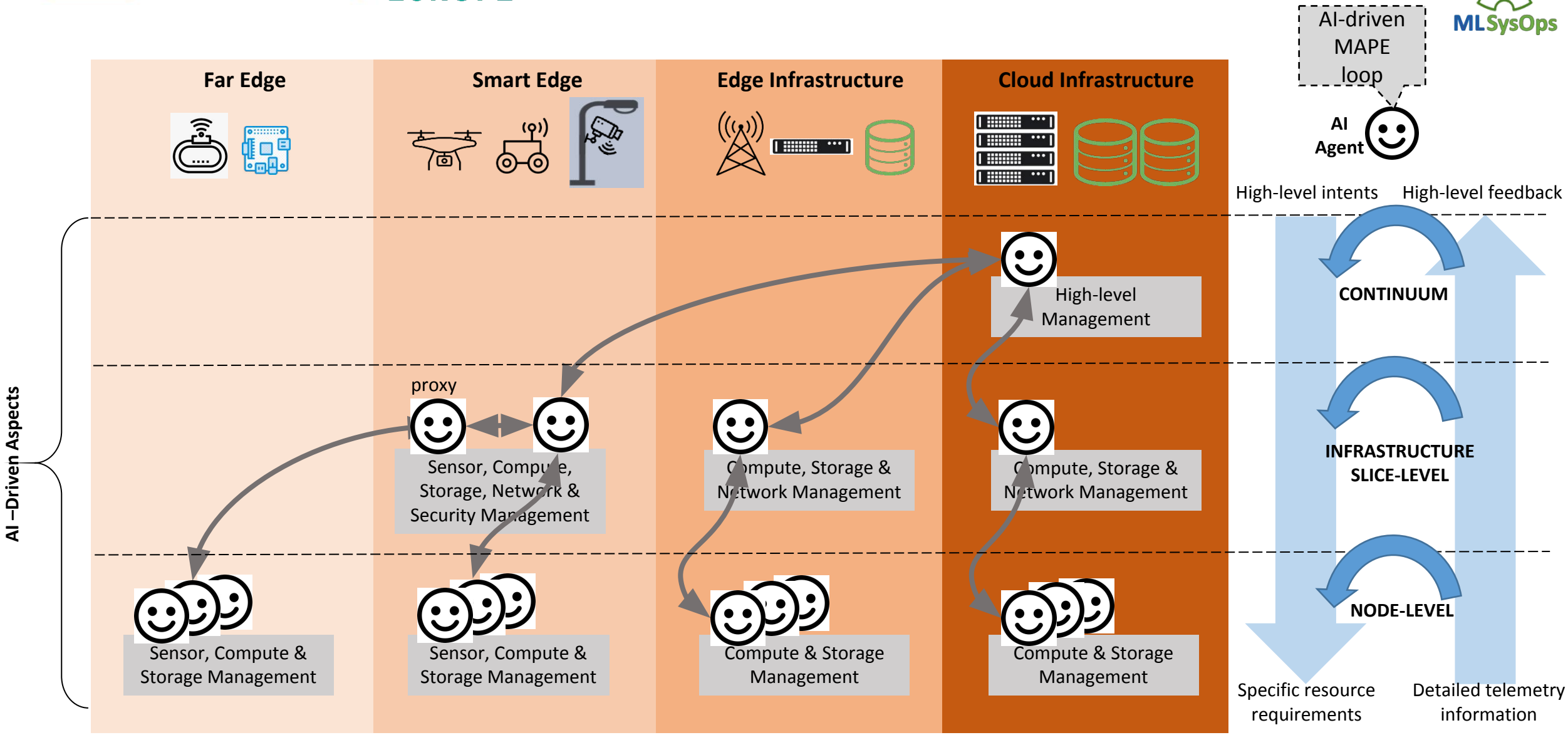
Res#1.	State management framework at the edge
Res#2.	Small device hypervisor
Res#3.	Specialised HW serverless executor
Res#4.	Trusted environment for serverless function execution
Res#5.	Physically-isolated secure elements
Res#6.	ε-controller
Res#7.	ε-orchestrator
Res#8.	SLA in serverless and edge/cloud context

Machine Learning for Autonomic System Operation in the Heterogeneous Edge-Cloud Continuum (MLSysOps)

Spyros Lalis

University of Thessaly


Application descriptions, intents, QoS/QoE
Infrastructure as Code descriptions
Platform Administrator Intents
Analyse - Plan
Explainability
Continual Learning
Pluggable policies
Compute, CPU Configuration, Accelerator support
Storage
Network (far-edge, 5G, optical)
Trust / Security
Enclaves for Flexible Deployment
AI-ready management mechanisms
Enabling technology
Monitor
Monitoring
Execute
Management Plane
Conventional resource provisioning, deployment & orchestration mechanisms (computing, storage & networking)
Far Edge
Smart Edge
Edge Infrastructure
Cloud Infrastructure

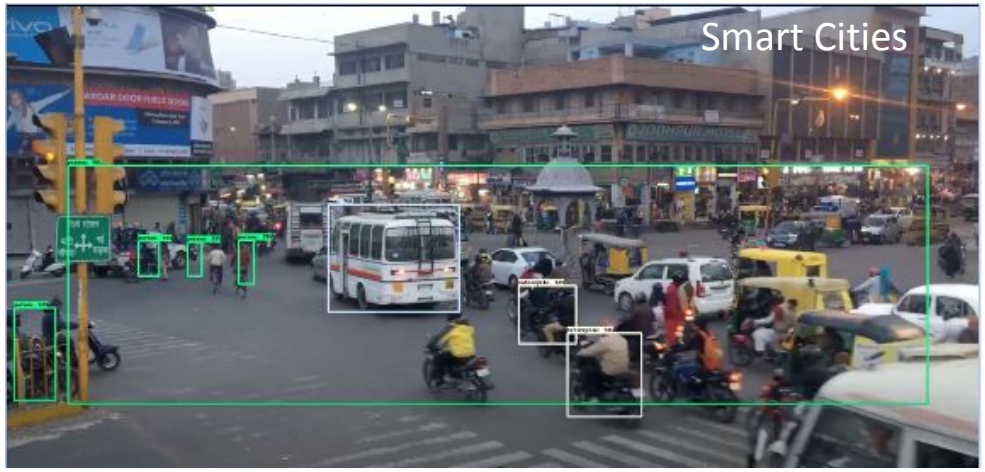

AI-driven MAPE loop
AI Agent
Far Edge
Smart Edge
Edge Infrastructure
Cloud Infrastructure
High-level intents
High-level feedback
CONTINUUM
INFRASTRUCTURE SLICE-LEVEL
NODE-LEVEL
AI –Driven Aspects
High-level Management
proxy
Sensor, Compute, Storage, Network & Security Management
Compute, Storage & Network Management
Compute, Storage & Network Management
Sensor, Compute & Storage Management
Sensor, Compute & Storage Management
Compute & Storage Management
Compute & Storage Management
Specific resource requirements
Detailed telemetry information

European Commission | HORIZON EUROPE

MLSysOps

Consortium

Application Use Cases



Channels

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