



Cognitive Computing Continuum Cluster



Webinar on Standardization
Activities in the Cognitive
Computing Continuum

1 July 2025



Funded by
the European Union



Programme Topic: HORIZON-CL4-2023-DATA-01-04 - Cognitive Computing Continuum: Intelligence and automation for more efficient data processing (AI, data and robotics partnership) (RIA)

Expected Outcomes:

Enhance Openness & Strategic Autonomy: in data and AI, integrating systems from edge to device, and towards digital and green transitions.

Pave the Way to Industrial Cooperation: Develop open platforms for future hyper-distributed applications, building a robust European industrial open-edge ecosystem.

Establish Hybrid Computing: Establish adaptive hybrid computing, cognitive clouds, and edge intelligence beyond existing data infrastructure.

Better International Collaboration: Promote interoperability and portability with trusted partners to boost competition and facilitate European access to global markets in Cloud and Edge services.



Agenda

- Introduction
- Presentation of each project on their standardisation activities
 - **HYPER-AI** – Mohammed Elbamby
 - **INTEND** – Thijs Metsch
 - **EMPYREAN** – Panagiotis Kokkinos
 - **ENACT** – Alexandros Nizami
 - **MYRTUS** – Alessandra Bagnato
 - **Swarmchestrator** – Jay Deslauriers
 - **CoGNETs** – Angel Cataron
- A joint panel session
- Closing remarks and next steps



Thank you





Panel Discussion and Next Steps

Hyper-Distributed Artificial Intelligence Platform for
Network Resources Automation and Management
Towards More Efficient Data Processing Applications

Slide title here



Cognitive Computing Cluster Standardization Seminar

01 July 2025

Mohammed Elbamby, Telefónica Research

- **Title:** Hyper-Distributed Artificial Intelligence Platform for Network Resources Automation and Management Towards More Efficient Data Processing Applications (HYPER-AI)
 - Enabling seamless, intelligent, and hyper-distributed data management
 - Facilitating collaboration between cloud, edge, and IoT infrastructures
 - Empowering diverse industries through advanced AI and data-driven insights
 - Enhancing operational efficiency across European data ecosystems
 - Supporting secure and decentralized data sharing and processing
 - Driving innovation in AI-driven automation, optimization, and resilience

EU partners:

1. CERTH [EL] / ETHNIKO KENTRO EREVNAS KAI TEXNOLOGIKIS ANAPTYXIS
2. TID [ES] / TELEFONICA INNOVACION DIGITAL
3. ECL [DE] / ECLIPSE FOUNDATION EUROPE GMBH
4. NKUA [EL] / ETHNIKO KAI KAPODISTRIAKO PANEPISTIMIO ATHINON
5. VIF [AT] / VIRTUAL VEHICLE RESEARCH GMBH
6. ODINS [ES] / ODIN SOLUTIONS SOCIEDAD LIMITADA
7. SABO [EL] / SABO SA
8. TRUST-IT [IT] / TRUST-IT SRL*
*8.1 Commpla Srl (Affiliated)
9. CUT [CY] / TECHNOLOGIKO PANEPISTIMIO KYPROU
10. EBOS [CY] / EBOS TECHNOLOGIES LIMITED
11. ENEA [IT] / AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE

Associated partners:

1. CSEM [CH] / CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA - RECHERCHE ET DEVELOPPEMENT
2. HES-SO [CH] / HAUTE ECOLE SPECIALISEE DE SUISSE OCCIDENTALE

International partners:

1. SUNDO [S.KR] / SUNDOSOFT LTD



- **Title:** Hyper-Distributed Artificial Intelligence Platform for Network Resources Automation and Management Towards More Efficient Data Processing Applications (HYPER-AI)
 - Design HYPER-AI architecture for decentralized, **swarm-based intelligence** through the computing continuum
 - Enable continuous, **optimized decision-making** across app lifecycle
 - Develop **autonomous Smart-Nodes** and swarm coordination mechanisms with CHOP capabilities.
 - Ensure a **secure, private, and robust** Edge-Cloud ecosystem
 - Guarantee **openness**, interoperability, and international collaboration
 - Demonstrate usability, performance, and **impact** through pilots
 - **Disseminate results** broadly and ensure vertical exploitation

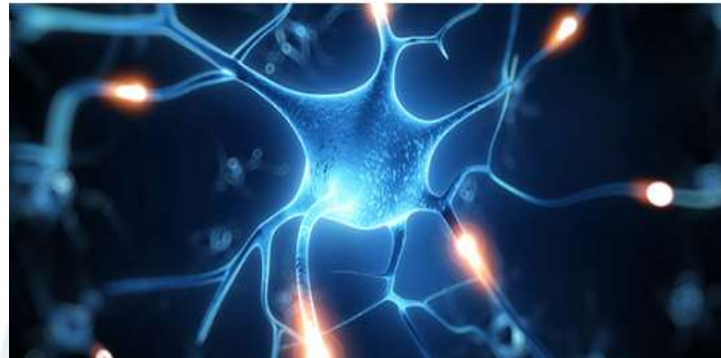
Use case #1: Industry 4.0 (Manufacturing) (SABO)



Use case #2: Green Energy (ENEA)



Use case #5: Healthcare (SUNDOSOFT)



Use case #3: Mobility and Automotive (VIF)



Use case #4: Farming and Agriculture (ODINS)



- **Four-Phase Approach:**

- Phase 1: Collected partner standardization activities and involvement
- Phase 2: Categorized and analyzed standards landscape
- Phase 3: Applied **to HSBooster** for expert consultancy
- Phase 4: Plan engagement with ICT Rolling Plan task forces



HSbooster.eu
Horizon Standardisation Booster

Expert support for EU Projects (CSA HE)

- Pilot for Standardisation Booster
- Expert consultancy services to HH2020 & HE EU projects
- Standards Training Academy

<https://www.hsbooster.eu/>

- Major Standards Bodies:
 - Telecommunications: 3GPP, ETSI, O-RAN
 - Security: IETF OAuth 2.0, W3C DID, NIST frameworks
 - Cloud/Edge: IEEE OpenFog, ETSI MEC, ISO cloud computing
 - AI/ML: ISO/IEC JTC 1/SC 42, IEEE P2048
 - Industry: ISO 26262 (automotive), ISO 9001 (manufacturing)

Four Strategic Categories

- Cloud, Edge, and IoT Computing (OASIS TOSCA, ETSI MEC, OpenFog)
- AI and Machine Learning Standards (ISO/IEC JTC 1/SC 42, IEEE P2048)
- Security and Privacy Standards (OAuth 2.0, TLS 1.3, NIST Cybersecurity)
- Industry-Specific Applications (ISO 26262, SOTIF, MQTT)

Recommendation and next steps

- JTC25 as a potential engagement target
- Submit findings to ICT Rolling Plan task force leaders

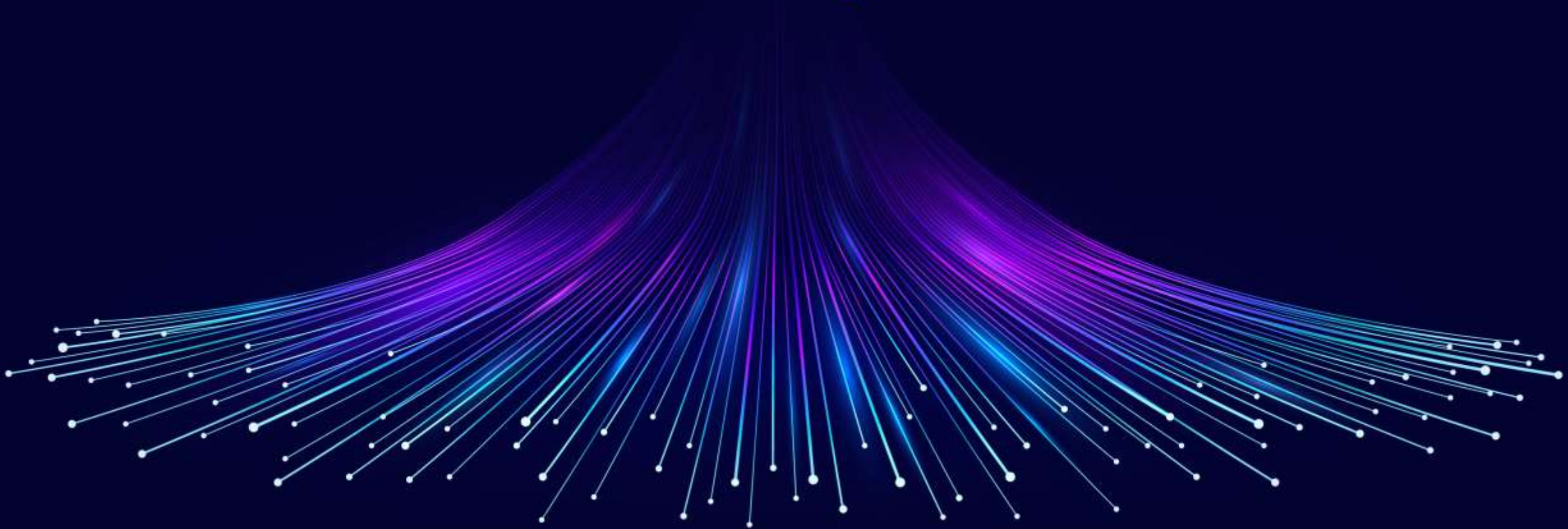




HYPER-AI

Revolutionising big data
applications with autonomous
cloud-to-edge resources

Thank you



- **Cognitive Continuum Architecture** enabling dynamic AI/ML deployment across Cloud, Edge, and IoT
- **Autonomous Smart Nodes** capable of self-management (self-configuring, healing, optimizing, protecting)
- **Computing Swarms** as decentralized, opportunistic clusters for resource sharing and app execution
- **Open-source orchestration stack**, based on Kubernetes and extended for the continuum
- **Security & Trust Layer**, including federated learning, decentralized identity, and DLT mechanisms
- Development of a dedicated **programming IDE** that supports semantic resource abstraction and optimized deployment workflows
- **Validated pilots** across diverse sectors (e.g. agriculture, health, manufacturing)
- **Frameworks for energy efficiency, privacy, scalability, and resilience** in distributed AI environments
- Toolkits for observability, workload management, and cognitive control loops

Backup



- **Decentralized** AI/ML across IoT, Edge, and Cloud layers
- **Self-management** capabilities: self-configuring, healing, optimizing, protecting
- **Context-aware**, cognitive decision-making at runtime
- **Continuous learning & inference** at the edge
- Dynamic **swarm formation** for flexible, autonomous collaboration
- Adaptive **resource orchestration** across heterogeneous nodes
- **Privacy-preserving** computation through federated and decentralized mechanisms
- **Trust, security & identity** management in distributed environments



INTEND

INTENT-BASED DATA OPERATION IN THE COMPUTING CONTINUUM

Project Overview

Thijs Metsch, Hui Song, et. al.

Intel, SINTEF

The INTEND Project

- Intent-based data operation in the computing continuum
- 2024-2026, ~6M EURO,
- Topic: “*Cognitive Computing Continuum: Intelligence and automation for more efficient data processing*” – RIA
- Part of EUCEI (Cloud Edge IoT) and ADRA (the AI partnership)

Participant organisation name
SINTEF AS (STF)
Sapienza Università di Roma (URO)
Technische Universität Wien (TUW)
Intel Deutschland GMBH (INTEL)
EMC Information Systems International (DELL)
NEXTWORKS (NXW)
Onlim GMBH (ONL)
Ericsson Magyarország Kommunikacios Rendszerek (ERI)
Ericsson AB (EAB)
CS-Group Romania (CSR)
MOG Technologies (MOG)
FILL GMBH (FILL)
Telenor ASA (TEL)
GATE Institute Sofia University (GATE)
Seoul National University (SNU)
<u>AiM Future, Inc (AF)</u>
Hanyang University (HYU)

Data processing in the cloud-edge continuum

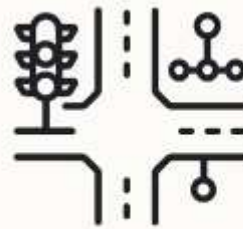
MOG

Green video streaming:
Optimize energy consumption of contents and processing distributed in the cloud and private servers



Machine data analytics:
End-user-friendly adaption of data analytics pipelines running on machine tools, edge servers, and cloud

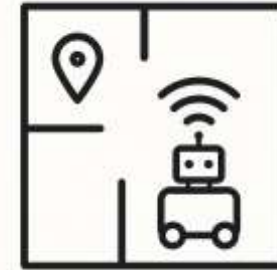
5G infra for data processing:
Manage customer applications running on telecom infrastructure with edge datacenters



Urban data space:
Adaptive edge-cloud platform for urban data space with real-time sensor data of the road and the traffic



Robotic systems:
Adaptive localization pipelines on the distributed robotic systems



The vision of INTEND

- To make the management of continuum-native data pipelines **easier**
 - **Scope:** the **management** of data pipelines running on the decentralized cloud-to-edge **computing continuum**, by data engineers and infrastructure providers
 - excluding: development of data pipelines, data quality management...
 - **Aim:** to make it **easier!**
 - e.g., simpler input from stakeholder, lower threshold, lower cost for stakeholder, wider scope of stakeholders...
- *The computing continuum should be as easy to use as the cloud*

Challenges and needs

The cloud-edge continuum with *heterogeneous resources, highly distributed architecture, and complex stakeholder involvement*, needs autonomous management, with **human-like intelligence**:



Adapt like human:
continuously **learn** how to
handle new situations and new
types of resources

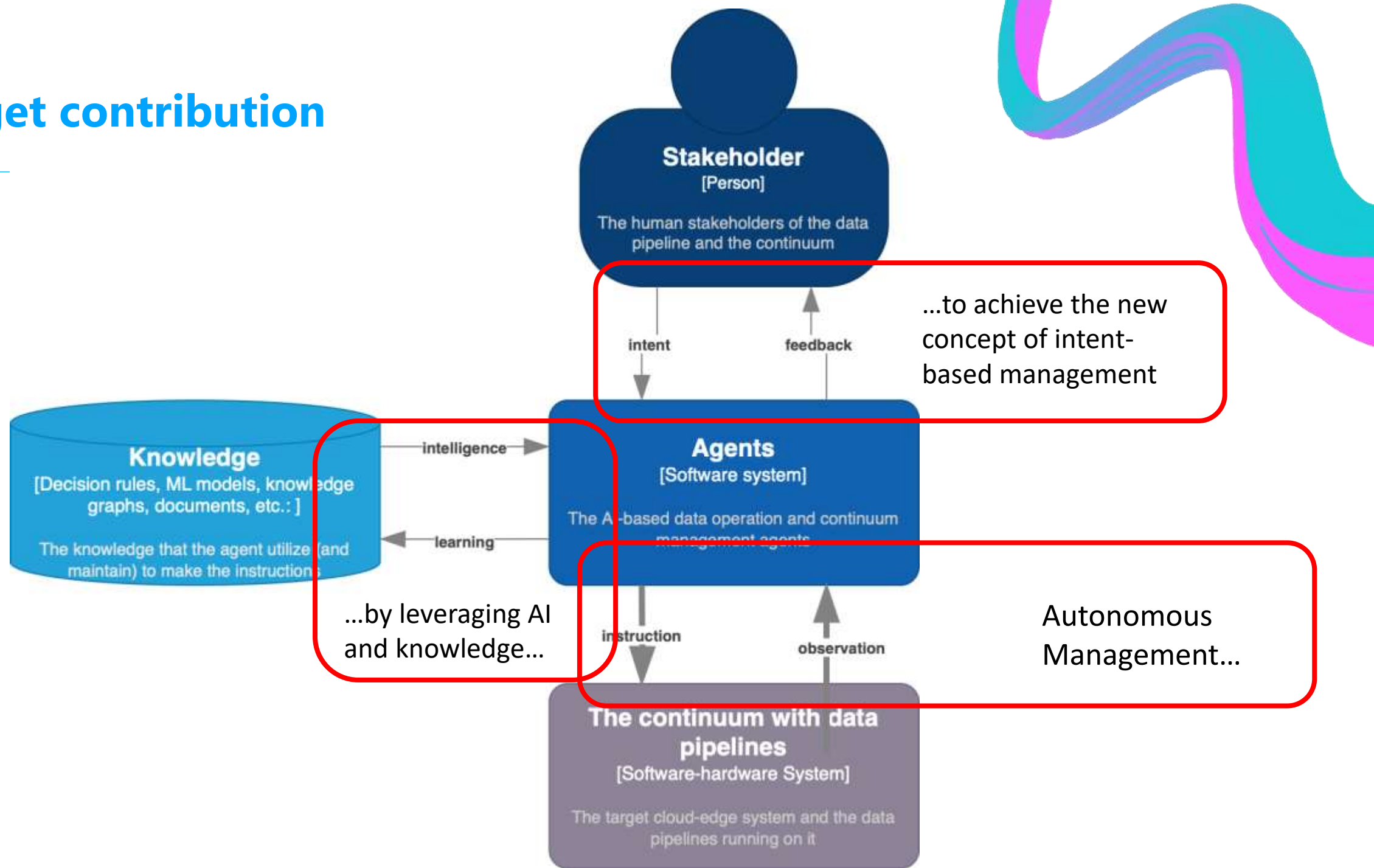


Think like human:
make **strategic** decisions for
the global continuum, with
decentralized inputs



Talk like human:
understand the **intents** of
stakeholders and **explain** its
own decisions, in a natural way

Target contribution



Standards, regulatory and policy alignment.

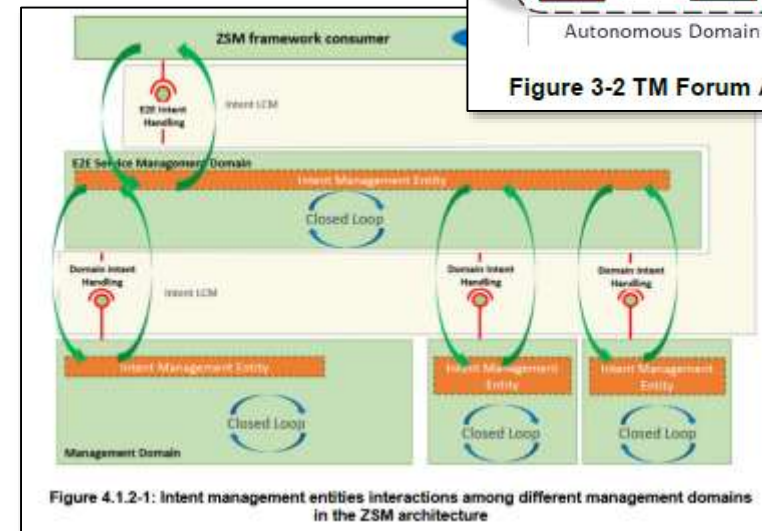
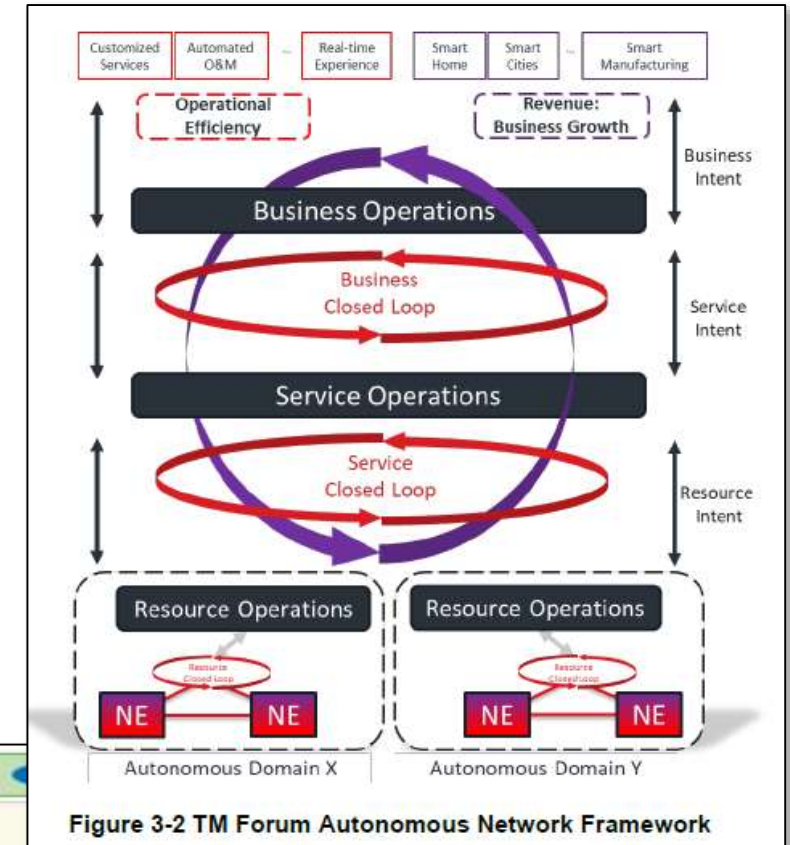


- Prioritized Standards Alignment:
 - We've identified and prioritized key specifications—including TM Forum TR299, TMF921A, and ETSI ZSM—as foundational to its architecture, demos, and use cases.
- Other SDOs & Ecosystem Engagement*:
 - Other include – but are not limited too - ETSI (ENI, MEC), and 3GPP, while also aligning with broader communities like AIOTI, BDVA, and 6G-IA.
- Regulatory Monitoring and Alignment:
 - Tracking key regulations (EU AI Act, Data Act, Cybersecurity Act) and ethical certification schemes (IEEE CertifAIEd), ensuring that systems are compliant, secure, and trustworthy by design.

** Full list available on request.*

Essential SDO alignment.

- TM Forum TR299 – Intent Specification:
 - Standardized model for expressing high-level intents, enabling automation and interoperability in service management;
- TM Forum TMF921A – Intent Management API Profile:
 - Defines how systems interact using intent-based APIs within the Autonomous Networks framework;
- ETSI ZSM – Zero-Touch Network and Service Management:
 - Outlines a reference architecture for AI-driven, fully automated service orchestration;





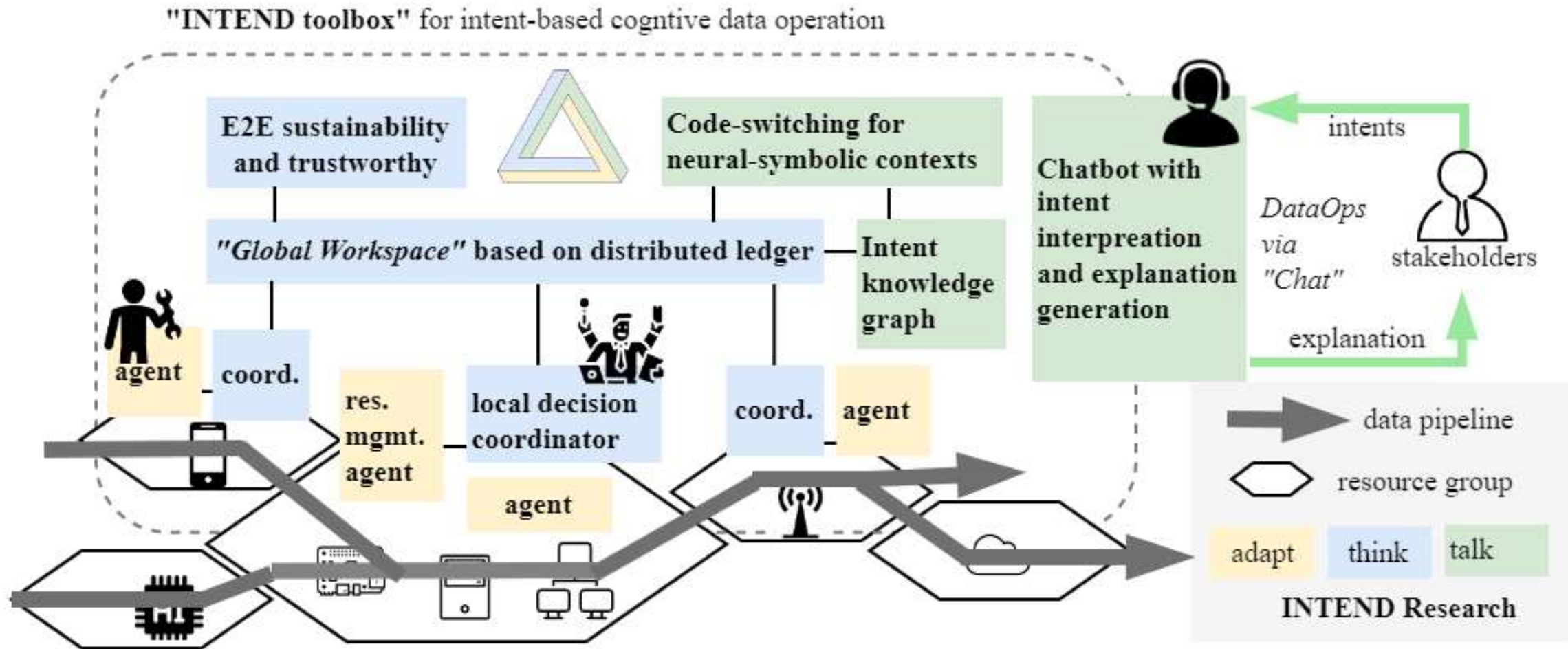
THANK YOU!



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135576, the Intend Project.

<https://intendproject.eu/>

The conceptual architecture





Efficient Edge-to-Cloud Workload Management

Standards and Standardization Activities in ENACT Project

Alexandros Nizamis – CERTH
01 July 2025

ENACT Project at Glance

ENACT -> Adaptive Scheduling and Deployments of Data Intensive Workloads on Energy Efficient Edge to Cloud Continuum



HORIZON-CL4-2023-DATA-01-04
GA number: 101135423
Type of action: RIA



Duration: 36 months
Starting date: 1 January 2024
Ending date: 31 December 2026



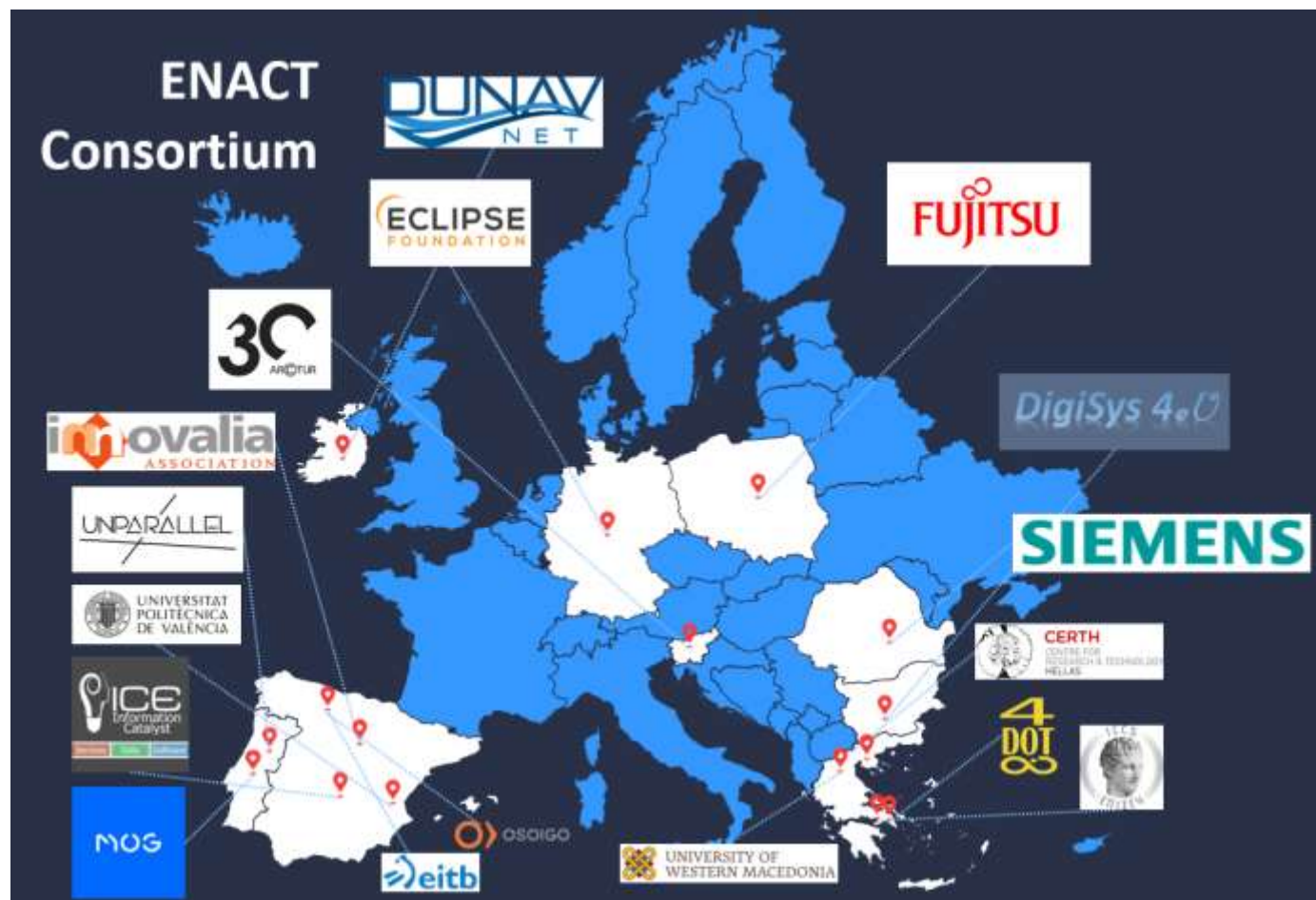
Budget: 5.055.074,00 €
EU funding: 5.055.074,00 €



17 partners



9 countries

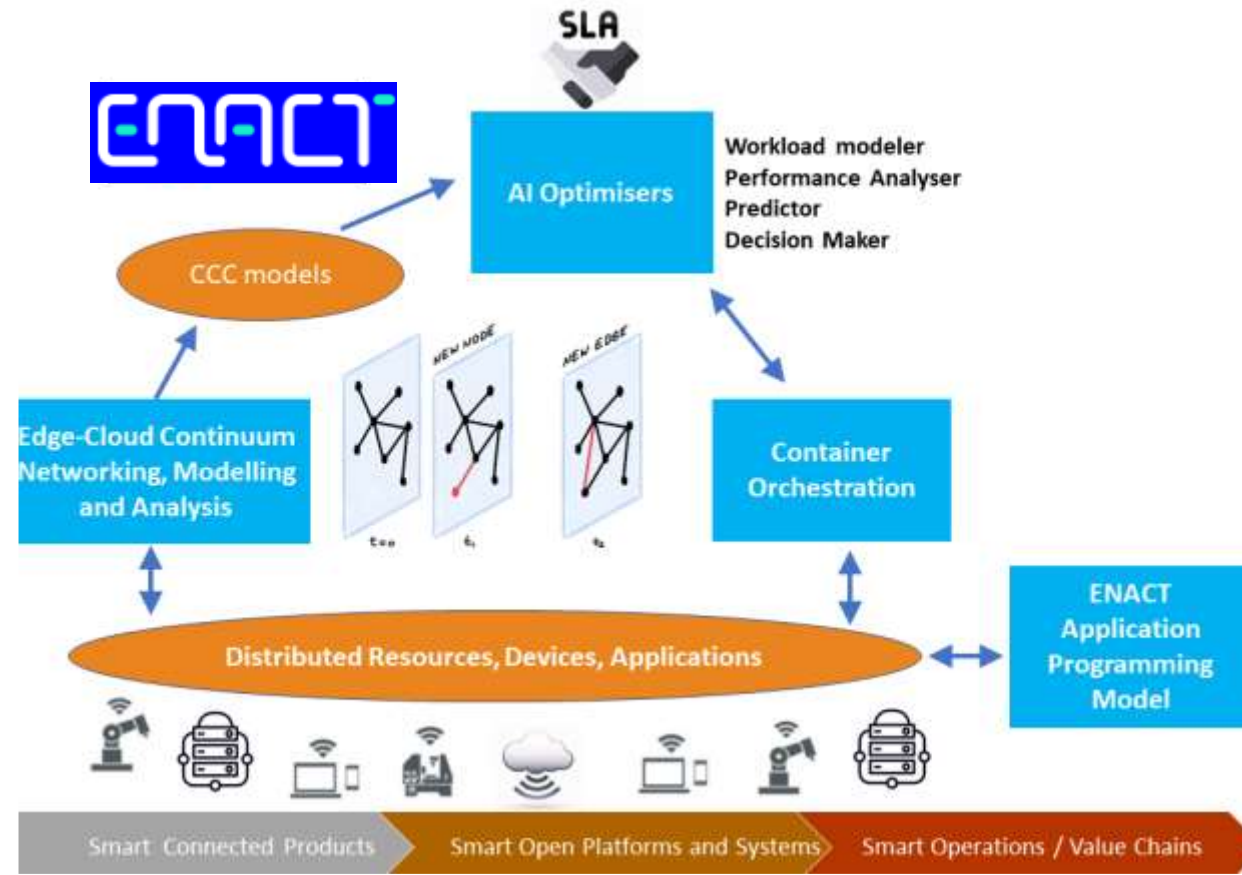


ENACT Approach

Tools to connect and discover distributed resources, devices and services across the compute continuum, characterize and model them to support complex application deployment needs

AI-powered orchestrator capable of deploying and managing applications across distributed (edge – cloud) nodes in an optimal way to support the energy efficiency and adaptations in applications

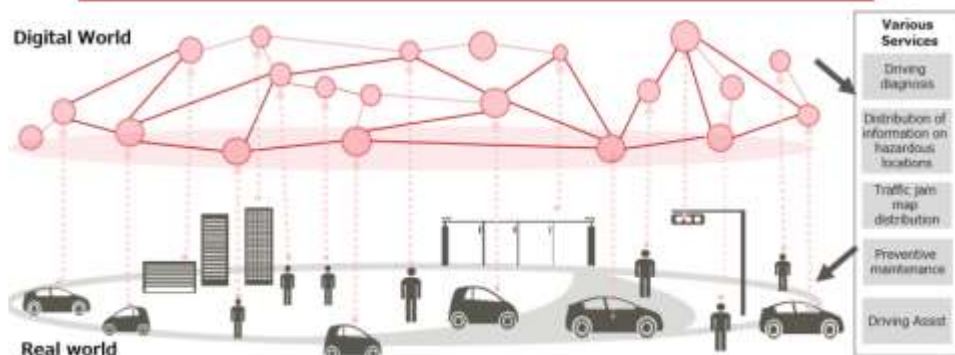
Application development toolkit for developing or adapting complex applications, making them distributed, responsive, robust and adaptive to changing environments



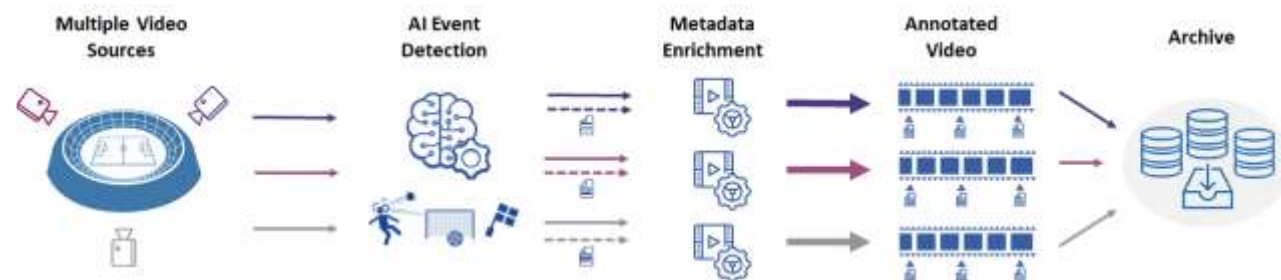
ENACT Deployment and Validations (Use Cases)

Pilot 1: Distributed Data Processing for Fujitsu's Mobility Digital Twin Initiative

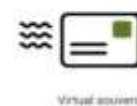
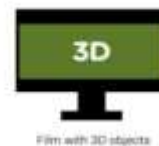
Reproduce/analyze/predict real-world information such as ever-changing vehicles and roads in real-time in the digital world



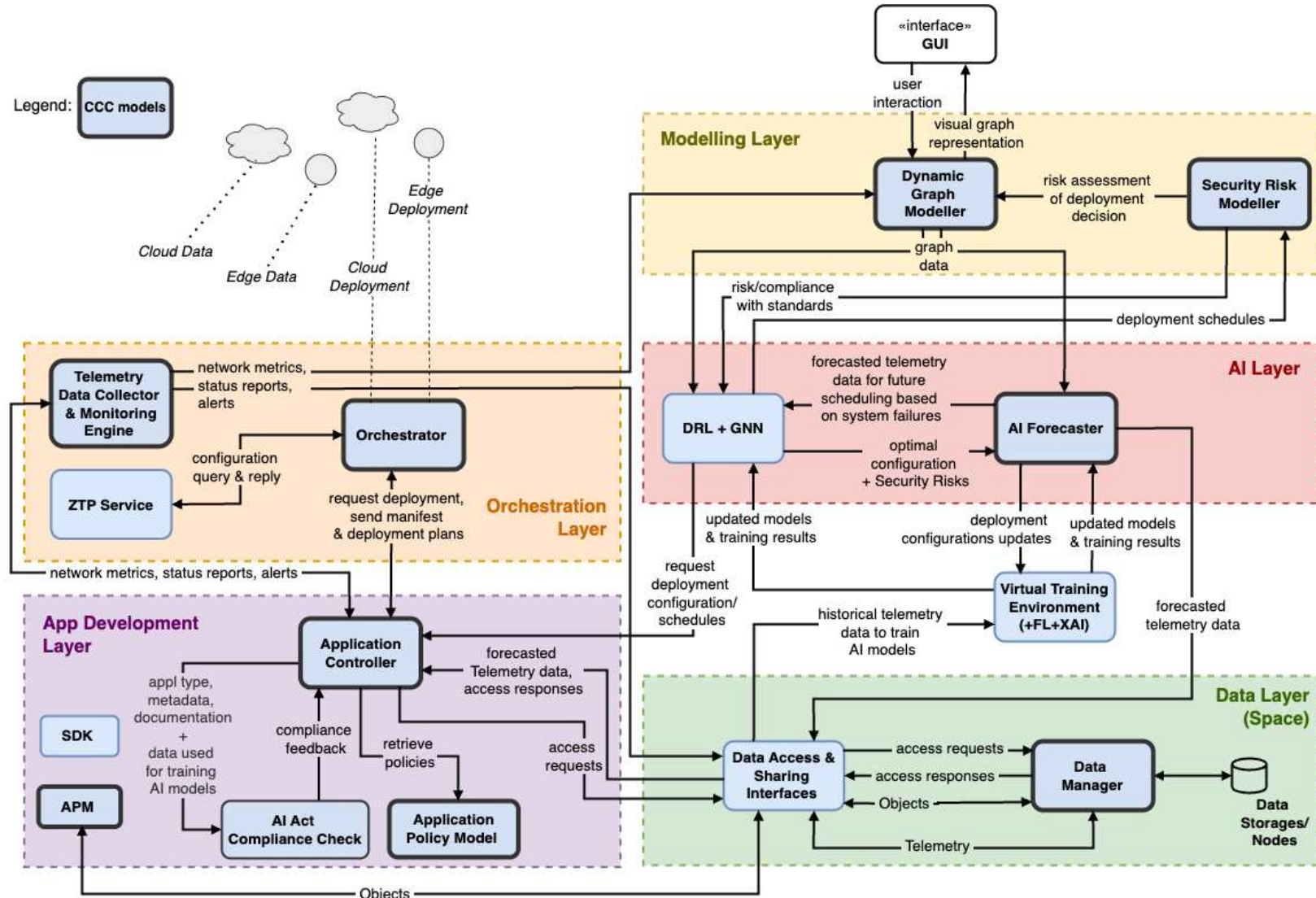
Pilot 2: Distributed Media and Entertainment Content Management



Pilot 3: Production and Distribution of Media Content for Cultural Heritage and Tourism Sectors



ENACT High Level Architecture



Orchestration Layer Standards

- **TOSCA** (Topology and Orchestration Specification for Cloud Applications) by OASIS Open

- A standard to **describe application deployment topologies and orchestrate services** across clouds and data centers



- **Kubernetes** (De Facto Orchestration Technology not an actual standard)

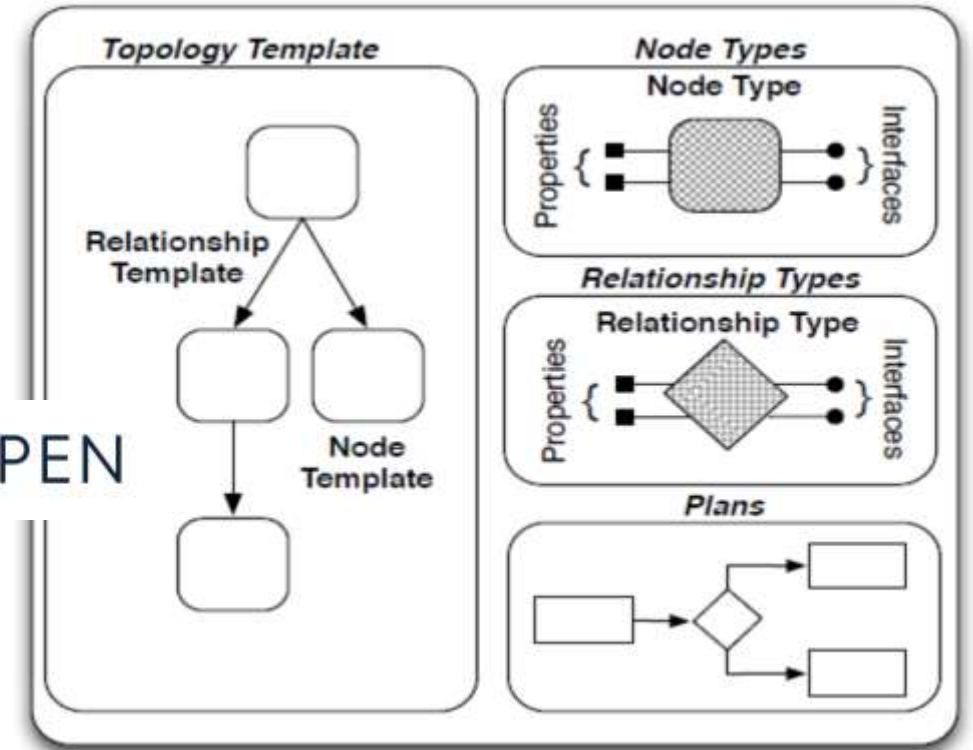


kubernetes

- Orchestrates containers and services across cloud and edge

- **DHCP** (Dynamic Host Configuration Protocol) by IETF (Internet Engineering Task Force)

- Network management protocol used to automatically assign IP addresses and other network configuration parameters to devices on a network



Orchestration Layer Standards – ENACT Extensions to TOSCA Model

- **Attributes from the ENACT CCC Models** such as the **Application Model** and the **Resource Model** can be used as custom fields in TOSCA.
- TOSCA already has several predefined Keys, but custom ones can be used by users for extending the functionality.
- The **Application Model** can be used for providing deployment requirements for applications. These application requirements (higher level) are reflected/mapped to resource requirements (lower level), which are covered by the **Resource Model**.

Custom Fields in
Tosca 2.0 Model

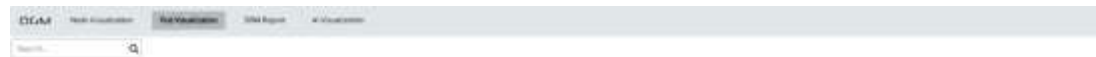
```
tosca_definitions_version: tosca-2.0 # Standard version declaration

model:
  types:
    my_nodes.WebApp: # Custom node type name
      type: node # Standard node type declaration
      derived_from: tosca.nodes.WebApplication # Inheriting standard type
      properties:
        app_version: string # Custom property
        use_ssl: boolean # Custom property
      interfaces:
        CustomLifecycle: # Custom interface name
          create: # Custom operation
            exec:
              primary: scripts/create_app.sh # Custom implementation
          upgrade: # Custom operation
            exec:
              primary: scripts/upgrade_app.sh
          destroy: # Custom operation
            exec:
              primary: scripts/delete_app.sh
      connections:
        database_connection: # Custom requirement name
          target: tosca.nodes.Database # Standard target node type
          capability: tosca.capabilities.Endpoint.Database # Standard capability
          relationship: tosca.relationships.ConnectsTo # Standard relationship

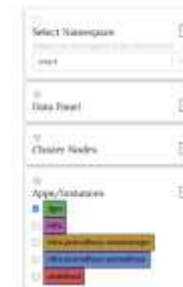
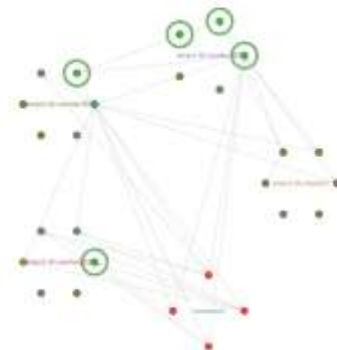
  instances:
    my_database: # Custom instance name
      type: tosca.nodes.Database # Standard node type
      properties:
        name: mydb # Custom value
        port: 3306 # Custom value
    my_web_app: # Custom instance name
      type: my_nodes.WebApp # Refers to your custom type
      properties:
        app_version: "1.2.3" # Custom value
        use_ssl: true # Custom value
      connections:
        database_connection: my_database # Finding custom requirement
      interfaces:
        CustomLifecycle: # Custom interface reuse
          create:
            exec:
              primary: scripts/custom_create.sh # Custom override
```

Modeling Layer Standards

- **Dynamic Graph Modeller (DGM)** is a core component of the ENACT architecture designed to provide a real-time representation of CCC
 - Front-end is based on widely used libraries like **React.js** and **Sigma.js** and **Typescript** language that is considered as a De Facto standard
 - Back-end is based on **Python** which is **a standard defined via PEPs** as standardized language and **FastAPI** which is based on **OpenAPI** that is a **formal standard** (standardized by the OpenAPI Initiative), specifically for describing RESTful APIs.



DGM UI for App distribution among the different cluster nodes



Open API
Specification



Swagger

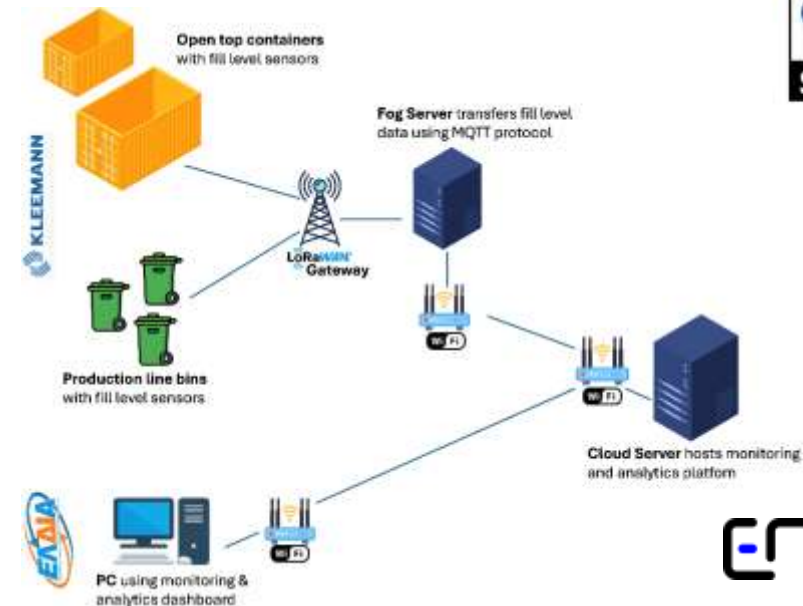
Modeling Layer Standards (2)

- **Security Risk Modeler (SRM)** is a design-time risk assessment tool that checks for security threats and vulnerabilities in (distributed and integrated) ICT systems.
 - It is based on the risk assessment approach of the **ISO/IEC 27005 standard** that defines best practices for the management of information security risks
 - Front-end is based on widely used library **React.js**
 - Back-end is based on **Python** which is **a standard defined via PEPs, Resource Description Framework (RDF) (W3C Standard)** for knowledge and system modeling and **SPARQL (W3C Standard)** for querying RDF triple store



Assets & Risks were defined in alignment with the ISO 27005 standard

Consequences and their Impact (493)				
Show filters Reset sort				
Consequence	Asset	Direct Impact	Likelihood	Direct Risk
LossOfTimeliness	ELDIA Planning Man...	Low	Very High	Medium
LossOfReliability	ELDIA Planning Man...	Low	Medium	Low
CorruptSnoozable	EFPP WireLAN	Negligible	Negligible	Very Low
CorruptSnoozable	ELDIA WireLAN	Negligible	Negligible	Very Low
CorruptSnoozable	Internet	Negligible	Negligible	Very Low
CorruptSnoozable	KLEEMANN WireLAN	Negligible	Negligible	Very Low
Loss Of Control	EFPP Server	Negligible	Very High	Very Low
Loss Of Control	EFPP Router	Negligible	Very High	Very Low
Loss Of Control	EFPP/COMPOSITIO	Negligible	Very High	Very Low
Loss Of Control	Fill Level Sensors	Negligible	Negligible	Very Low



Beyond ENACT: SRM was applied in a real world scenario to assess the risks/threats for data sharing among 2 Greek companies



AI Layer Standards

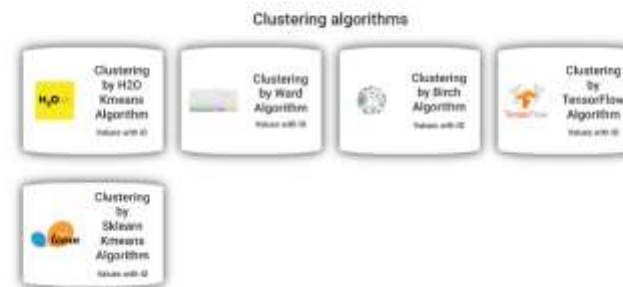
- ENACT AI layer includes tools to support intelligent orchestration for CCC
 - **AI Forecaster and Anomaly Detection tools** that are based on LSTM architectures
 - **GNN + DRL Agent** to optimize task scheduling
 - **Python** which is a **standard defined via PEPs** used for the development and **De Facto Standards** like **PyTorch, NumPy, Pandas** etc.



- A **Virtual Training Environment (VTE)** is also developed to support training needs of the project
 - **Python, Typescript and Java** used for the development and **De Facto Standards frameworks and libraries** like **Angular, Node.js, TensorFlow, PyTorch, Pandas** etc.



ENACT VTE Environment



TensorFlow



Data Layer Standards

INTERNATIONAL DATA
SPACES ASSOCIATION

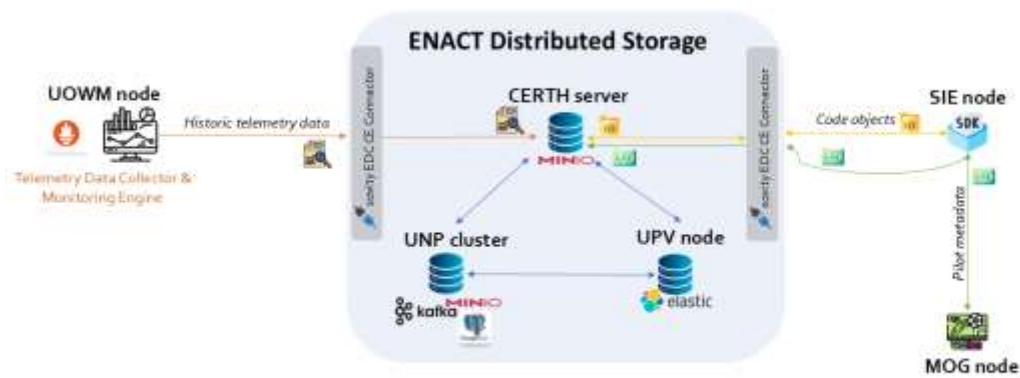
OpenID

SOVITY

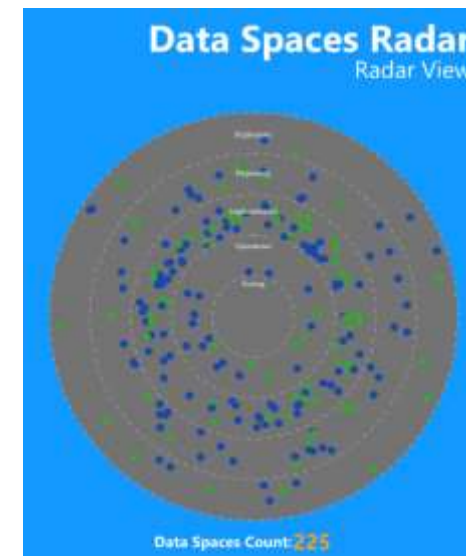
KEYCLOAK

JWT

- **ENACT Data and Object Space**
 - It enables the secure and sovereign data and code objects sharing among CCC participants
- Core components are:
 - **Sovity** implementation of **Eclipse Data Space Connectors** that are based on **Data Space Protocol (DSP)** is submitting to the **ISO/IEC Joint Technical Committee 1** for final standardisation
 - **Keycloak** framework that implements **standards** like **OAuth 2.0**, **OpenID Connect**, **JWT** etc.



ENACT Data and Object Space

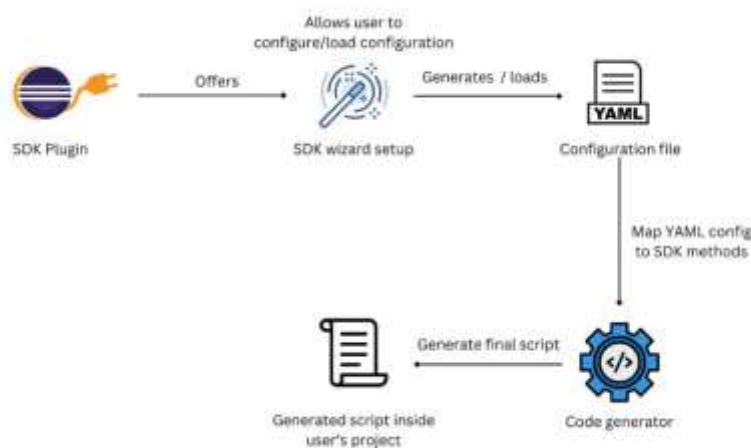


ENACT has submitted an application for the inclusion of its Data & Object Space to IDSA Radar

ENACT

App Development Layer Standards

- ENACT **Application Programming Model (APM)** and **Software Development Kit (SDK)** (available as plugin of **Eclipse IDE**) have been implemented to enable faster coding for flexible CCC apps
- Core implementation technologies:
 - **Python** which is **a standard defined via PEPs**
 - **Java** and **JARs** defined in the **Java SE** platform as **formal specification / standard**
 - **YAML** an **open standard** for data serialization that has **formal specification** (YAML 1.2 spec)



ENACT SDK Plugin Architecture

```
import com.siemens.enact.apm.stp_libs.ITPComponent;

public class RunMe {

    private static ITPComponent stpService = new ITPComponent();

    public static void main(String[] args) throws IOException, InterruptedException {

        //query all available machines
        List<ITPComponent.MachineInformation> allMachines = stpService.retrieveAllMachines();

        //select random machine
        ITPComponent.MachineInformation randomMachine = allMachines.get(new Random().nextInt(allMachines.size()));
        String randomMachineId = randomMachine.machineId;
        System.out.println("Random machine id: "+randomMachineId);

        System.out.println("Power state: "+randomMachine.powerState);

        //perform "powerOn" action on randomMachine
        stpService.performAction("powerOn", randomMachineId);

        //update randomMachine information
        randomMachine = stpService.retrieveMachine(randomMachineId);
        System.out.println("Power state: "+randomMachine.powerState);

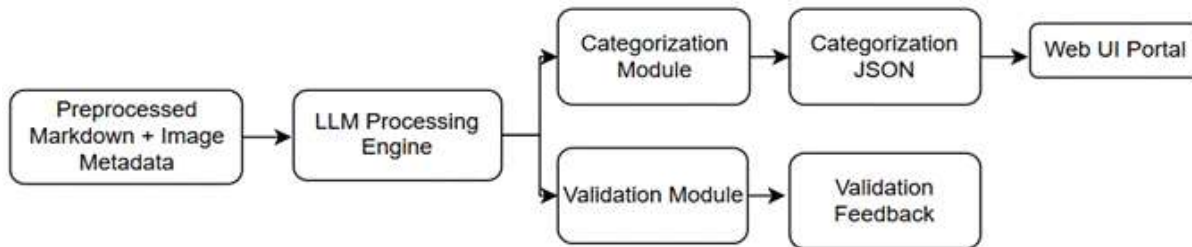
        return;
    }
}
```

Sample code of using the ENACT APM

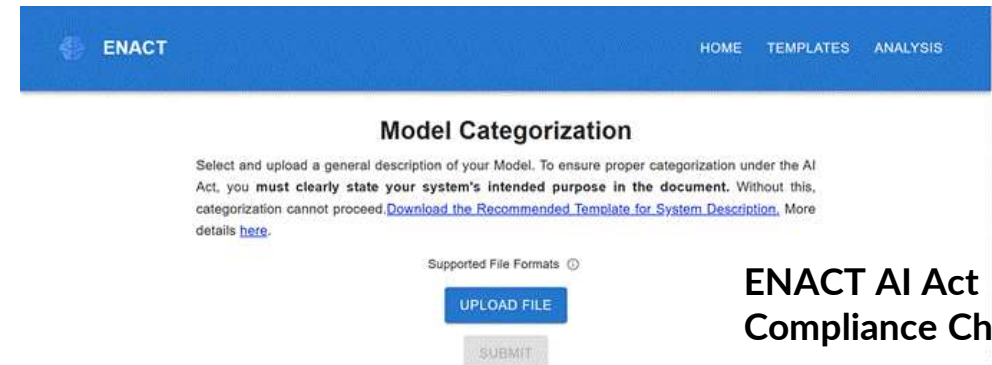


App Development Layer Standards (2)

- ENACT **AI Act Compliance Checker** designed to process user submissions, classify AI systems, and validate compliance documentation in alignment with the AI Act.
- Core implementation technologies:
 - **Python** which is **a standard defined via PEPs**
 - Various supported formats for input documents by user
 - **.docx** that is an **ISO/IEC 29500 standard**
 - **.txt** that is based on standardized character encodings **Unicode, ASCII, IETF**
 - **.pdf** that is an **ISO 32000 standard**
 - **GPT-4 Vision** for text and image analysis
 - **Azure Blob Storage to store/manage documents** and LLM to validate submitted documents against the regulatory requirements of the applicable category
 - Structured **JSON (ECMA & IETF standard)** with classification results and detailed reasoning as output



ENACT AI Act Compliance Checker Architecture



ENACT AI Act
Compliance Checker UI



ENACT AI Act Compliance Checker as New Working Item to European Telecommunications Standards Institute (ETSI)

- ENACT presentation at *ETSI 11th UCAAT - User Conference on Advanced Automated Testing* and discussions with ETSI Board Members regarding ENACT AI Act Compliance Checker, *Thessaloniki Greece 1-3 April 2025*
- *ENACT proposal* for **New Working Item (NWI)** was presented by CERTH during the **ETSI Technical Committee (TC) Methods for Testing and Specification (MTS) Plenary Meeting #95**, which was held at the ETSI Headquarters in Sophia Antipolis, *France 21-22 May 2025*

ENACT ETSI Working Item

Title: *Ensuring AI Compliance through Advanced Verification*

Scope: Definition of an approach to assist AI providers in assessing compliance with the EU AI Act. This includes the description of an AI Act Compliance Checker service, focusing on the following core functionalities: AI system categorization, Document validation, and Compliance evaluation.

Type: Technical Report (TR)

Rapporteur: Alexandros Nizamis, CERTH

Supporters: CERTH, Fraunhofer FOKUS, University of Goettingen



- *To be finally approved during the TS MTS Plenary Meeting #96*, which is scheduled for 22-23 October 2025, in Mainz, Germany and then a **12-month plan** will be followed for the **NWI delivery**



Partners





Thank you!



<https://enact-horizon.eu/>



<https://linkedin.com/in/enact-horizon-1798122b8/>



This project has received funding from the European Union's H2020 Programme Under Grant Agreement No 101135423

MYRTUS @ Cognitive Computing Continuum cluster 's Joint standardization webinar (June- July2025)

MYRTUS Consortium



Multi-layer 360° **dY**namical orchestration and interope**R**able design environment **T** for compute-contin**U**m Systems

- Horizon Europe project involving 16 organizations belonging to both the academic and the industrial world, grouped in clusters from 7 different countries, focusing in Cyber-Physical Systems (CPS)
- Establishing a solution for adaptive hybrid computing, cognitive clouds, fog and edge intelligence.
- Started on January 1st, 2024 for 36 months



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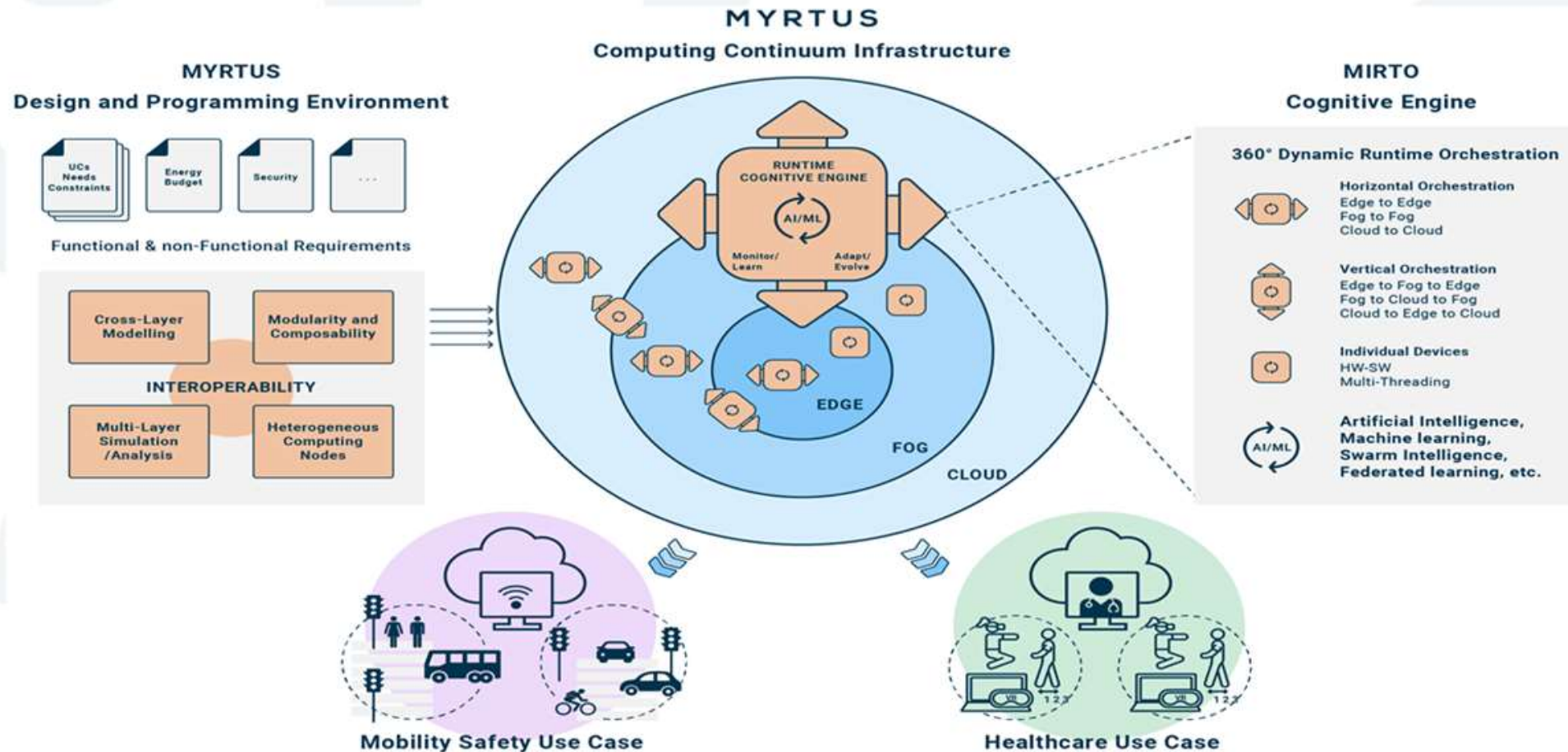
SOFTEAM
UNE MARQUE DE DOCAPOSTE

aruba.it



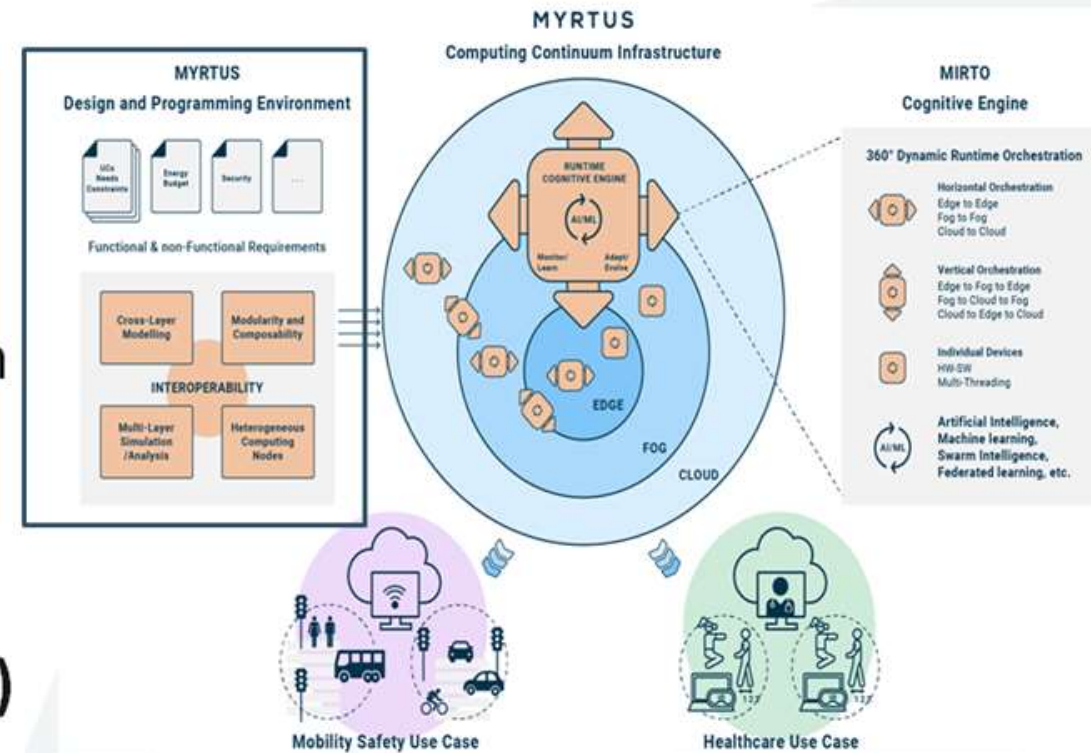
Challenges & Technical Pillars

- MYRTUS Provide a solution for efficient computing continuum management, leveraging AI technologies



Ambition in a nutshell

- In MYRTUS we will define a computing continuum infrastructure composed of heterogeneous resources
- MIRTO, the AI-powered cognitive engine that represents the project's core and where swarm and federated strategies are meant to be exploited to orchestrate workflow and resources.
- A **design and programming environment (DPE)** will be conceived to facilitate the efficient deployment and programming of such a complex and dynamic infrastructure



MYRTUS Standardization Activities Overview

- **Standardization activities carried out by the MYRTUS team during the first 18 months of the project**
 - **OASIS TOSCA & OMG UML (SOFT)**
 - **RISC-V & OpenHW Foundation (UPM)**
 - **GAIA X (TNO)**
 - **Potential future activities**

OASIS TOSCA Implementation in Modelio

- **Modelio is an open source UML modeling tool extended to support TOSCA concepts.**
- **Benefits:**
 - **UML-based interface familiar to architects**
 - **Seamless transition from high-level design to deployable topology**

OASIS TOSCA Standard

- **Topology and Orchestration Specification for Cloud Applications** : is a standard by OASIS (Organization for the Advancement of Structured Information Standards)
 - **Highly extensible**
 - **Enabling portability of cloud services across multiple platforms and vendors**
 - **Language that describes :**
 - **Cloud computing services and their components**
 - **Relationships**
 - **Orchestration processes**

TOSCA Designer

- **Supports TOSCA Standard version 1.3**
 - Provides a user-friendly GUI/IDE for seamless design and modeling.
 - Comprehensive Template Management
- **Graphical modeling of:**
 - Topology templates,
 - Node types,
 - Relationship types,
 - Policies and requirements.
 - Export capabilities:
 - .tosca files (from Node Types and Topology Templates)
 - .csar files (experimental support)

TOSCA Designer: Node Types for Mobility Use Case

Modelio 5.4

Fichier Edition Configuration Vues Aide

Projet Diagrammes Recherche Perspectives Macros

Smart City Traffic Management

Service Template diagram

Tosca service topology

- Tosca model diagram
 - Service Template
 - Service Template diagram
 - compute_nodes
 - EdgeCamera
 - FogNode
 - CloudInstance
 - software_component_nodes
 - object_detection
 - + algorithm : string
 - + accuracy : string
 - + dockerImage : string
 - Requirements
 - + host
 - image_processing
 - + processingRequirement : float
 - + dockerImage : string
 - Requirements
 - + host
 - object_tracking
 - + dockerImage : string
 - Requirements
 - + host
 - traffic_data_analysis
 - + trafficDataSources : string
 - + trafficDataRepository : string
 - + dockerImage : string
 - Requirements
 - + host
 - security_countermeasure
 - + host

Commun

Types

Node_Templates

Artifact_Templ...

Plans

Requirements

Others

compute_nodes

CloudInstance

- + processingCapabilities : string
- + memory : string
- + networkBandwidth : string
- + storageCapacity : string
- + highCpuThreshold : float
- Capabilities
 - + host

FogNode

- + processingCapabilities : string
- + memory : string
- + networkBandwidth : string
- + storageCapacity : string
- Capabilities
 - + host

EdgeCamera

- + processingCapability : string
- + memory : string
- + networkBandwidth : string
- + cameraSensorSpec : string
- + location : string
- + cpuUtilization : float
- + frame_rate : integer
- + baselineAveragePowerConsumption : float
- + minPowerConsumptionThreshold : float
- + maxPowerConsumptionThreshold : float
- + lowPowerMode : boolean

software_component_nodes

object_detection

- + algorithm : string
- + accuracy : string
- + dockerImage : string
- Requirements
 - + host

image_processing

- + processingRequirement : float
- + dockerImage : string
- Requirements
 - + host

security_countermeasure

traffic_data_analysis

- + trafficDataSources : string
- + trafficDataRepository : string
- + dockerImage : string
- Requirements
 - + host

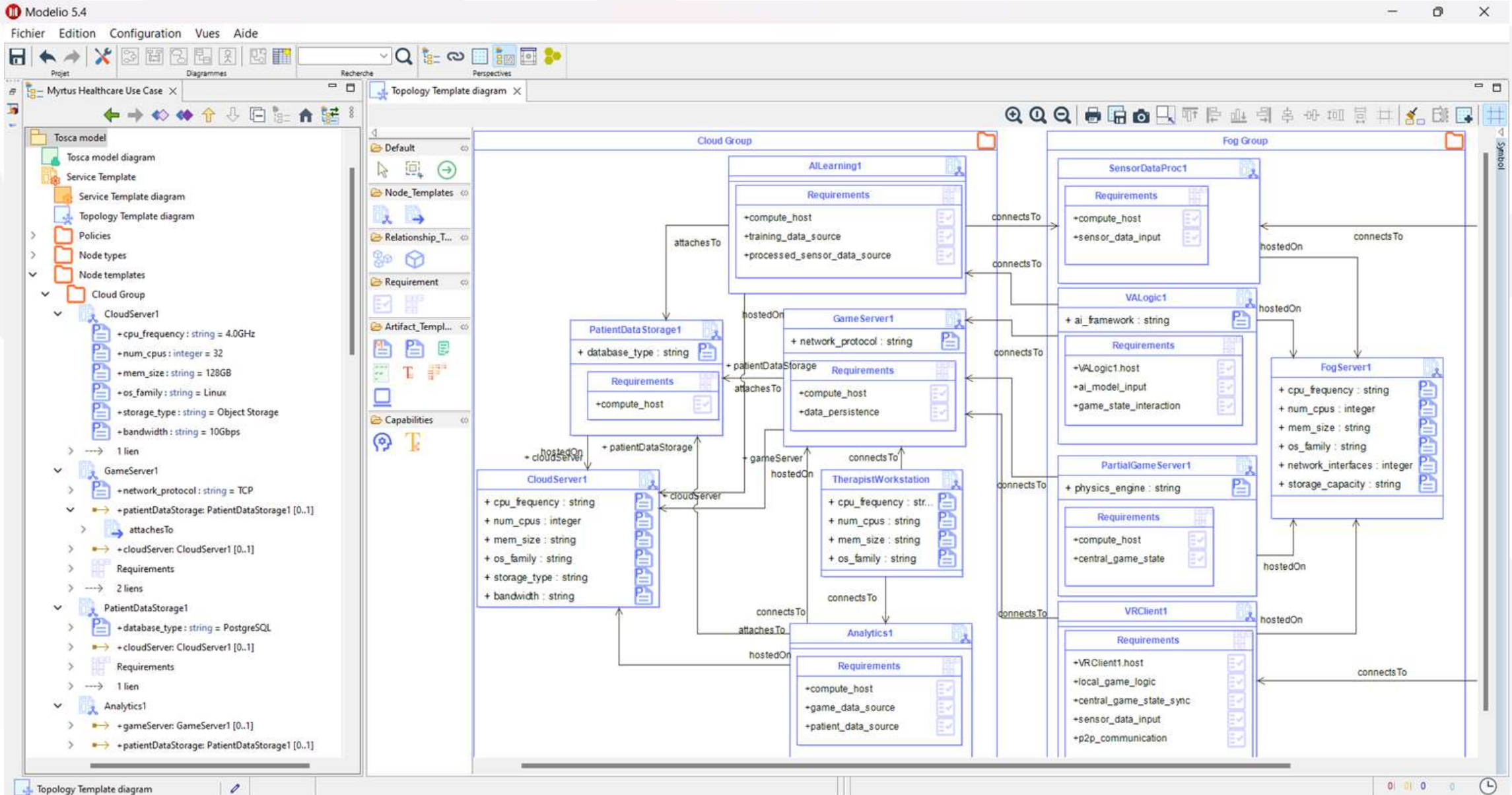
object_tracking

- + dockerImage : string
- Requirements
 - + host

ToscaAttributePage

Propriété	Valeur
Name	host
Capability	Compute
Node	CloudInstance
Relationship type	hostedOn
Upper Bound	1
Lower Bound	1

TOSCA Designer: Topology Template for Healthcare use case



TOSCA and UML Standardization actions

OASIS TOSCA & OMG UML :

- The TOSCA standard TOSCA Simple Profile in YAML Version 1.3 OASIS Standard 26 February 2020 has been used without modification and 80% of it is already covered by the Modelio TOSCA Designer. No direct standardization activities are to be reported during this period , the standard web page and material have been studied and used thoughtfully though .
- On May 15 SOFTEAM followed up the OMG Europe Information Day - Standards for Industrial Systems Hosted by Object Management Group Member SLB at the SLB R&D Center, Clamant, France, OMG 's UML and SysML were presented

Gaia-X Trust framework

Gaia-X has engineered its **Trust Framework** to enable end-to-end verification of claims and processes across digital ecosystems to advance the EU's objectives for:

- Transparency
- Digital sovereignty
- Privacy
- Security
- Legal (normative) control of digital services and operations

Gaia-X Ontological Modules



Verifiable Credential Data Model is designed to be extensible.



Gaia-X builds on the Verifiable Credentials (VC) Data Model by introducing a dedicated ontology that adds domain-specific concepts (e.g., **gx:LegalParticipant**, **gx:integrity**, **gx:version**).



Gaia-X host these definitions in a shared registry. This ensures that all stakeholders reference the same vocabulary when issuing, presenting, and validating credentials.

Gaia-X Standardization monitoring actions

- TNO participated in the Gaia-X Market-X Hackathon 2025 and emerged as second place winner with the solution to automate the auditing process for obtaining ISO certifications within the Gaia-X Trust framework of the Gaia-X ecosystem.
- SOFTEAM followed up the Hub France Plenary Program on March 24, 2025 in Bercy with particular focus on the presentations on the Gaia-X Trust Framework.

RISC-V & OpenHW Foundation (UPM)

- As committed in MYRTUS, UPM has become a member of the **RISC-V international** and the **Open hw foundation**, the two organizations which are more relevant for standardization in RISC-V at the international level.
- At the spanish level, UPM is also a member of the RISC-V Network of excellence (**Red RISC-V**), and the **Spanish Open Hardware Alliance (SOHA)**, being part of the board of directors of the latter.



<http://red-riscv.org/>



[SOHA Spanish Open Hardware Alliance](#)



RISK- V Standardization actions

RISK V & OpenHW Foundation (UPM) :

- UPM followed up the **RISC-V Summit Europe** in 2024 (June 24-28, Munich) and 2025 (June 12-15, Paris), where the activities around RISC-V from within and outside MYRTUS were presented as posters:
Integration of a CGRA Accelerator with a CVA6 RISC-V Core for the Cloud-edge Reconfigurable Processor-Centric Accelerators for Safety-Critical Applications
- UPM hosted a workshop with participants from EPFL and the OpenHW Foundation in February 2024, and also co-organized a workshop with some of its members in DATE 2024 (March 25-27, Valencia), and in DATE 2025 (March 31 - April 2, Lyon).

On use cases: medical devices (UNICA) & mobility (CANON RESEARCH CENTRE FRANCE)

- Health UC :

- The available data are not subject to standardization but common data formats can be adopted (as EDF).
- The European Data Format (EDF, and the more recent EDF+) is a is not a formal standard, but rather a format that became the de-facto standard for data exchange in scientific studies on electroencephalograms (EEGs) and polysomnography (PSG) recordings. Because of its popularity and the free nature, MYRTUS Health UC will use EDF for electrophysiological and biomechanical data.

- Mobility UC:

- Position and velocity of detected road users is exchanged using the Collective Perception Message (CPM) standard [ETSI TS 103 324 V2.1.1 \(2023-06\)](#)
- Static structure of the road and traffic light status is exchanged using the MAPEM and SPATEM messages, following the standard [ETSI TS 103 301 V2.2.2 \(2024-11\)](#).

MYRTUS has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135183.





swarmchestrator

Standardisation Activities in TOSCA

Jay DesLauriers, Research Fellow (University of Westminster)

Standardisation in the Cognitive Computing Continuum, 1 July 2025, Online

Project Details



- Budget: ~ EUR 5.8 Million
- Co-funded by EU Horizon Europe, UKRI and South Korea
- Duration: 3 years (1 January 2024 – 31 December 2026)
- 15 project partners from 10 countries across Europe and South Korea
- Combination of academic and industry partners
- Project coordinator: [Dr Robert Lovas](#) (HUN-REN SZTAKI / Institute for Computer Science and Control, Hungary)
- Project Scientific Coordinator: [Prof. Tamas Kiss](#) (University of Westminster, UK)

Project Background



Co-funded by
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Swarmchestrator Objectives



- Develop an **application-level decentralised orchestration framework**, utilising Swarm-based distributed intelligence
- Dynamically create and manage a **set of interconnected Swarms** across the distributed Cloud-to-Edge infrastructure
- Develop **matchmaking algorithms using decentralised AI** methods to optimise energy efficiency and effectiveness
- Develop trusted, reliable, secure and transparent **knowledge management**
- Develop a **simulation environment** based on the novel decentralised orchestration concept of the project
- Implement **real-life application demonstrators** utilising Swarmchestrator services in realistic scenarios

Swarmchestrate Demonstrators



Read more: swarmchestrate.eu/flood-prevention/



Read more: swarmchestrate.eu/digital-twin-of-natural-habitat/

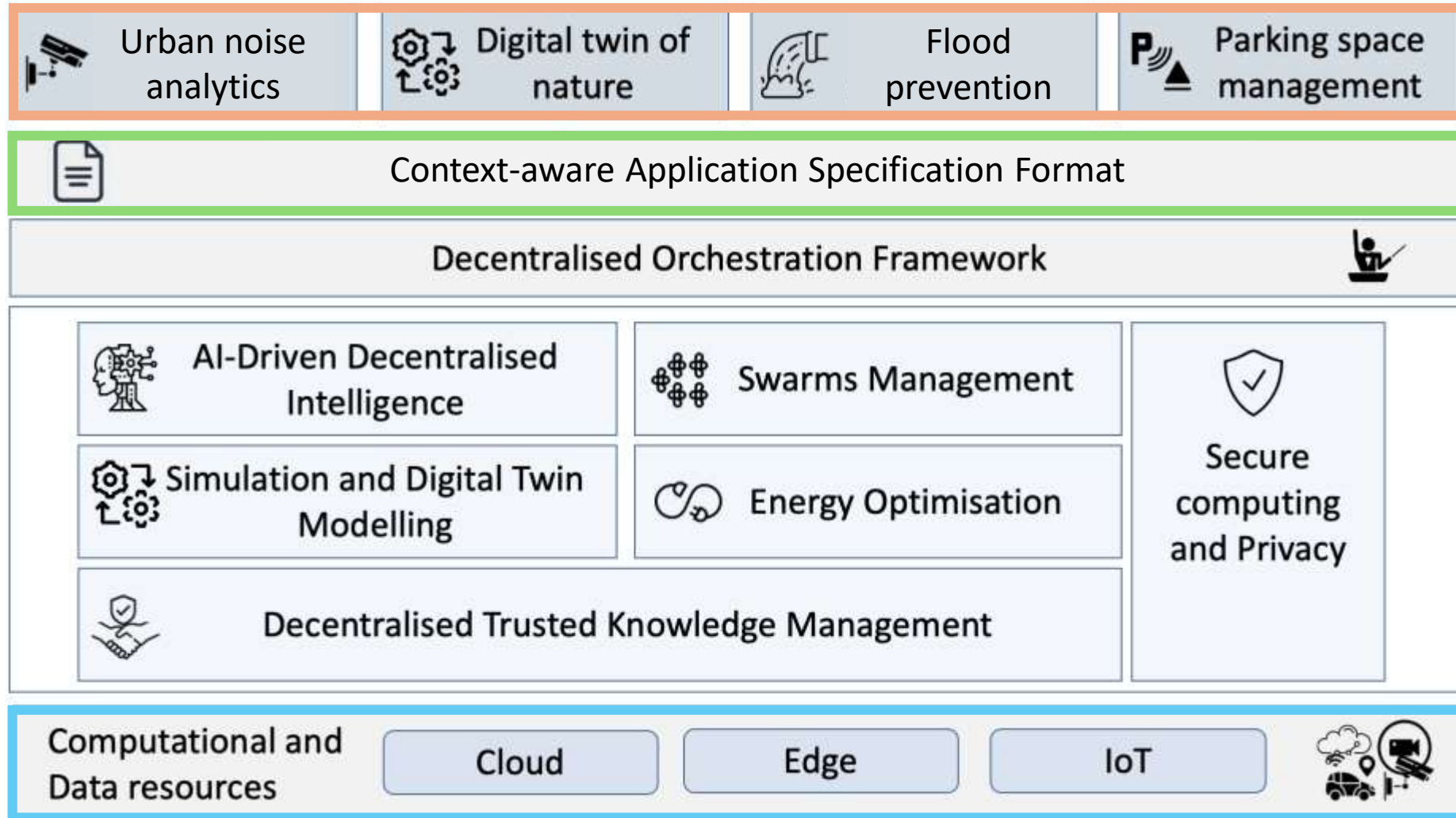


Read more: <https://www.swarmchestrate.eu/urban-noise-classification/>

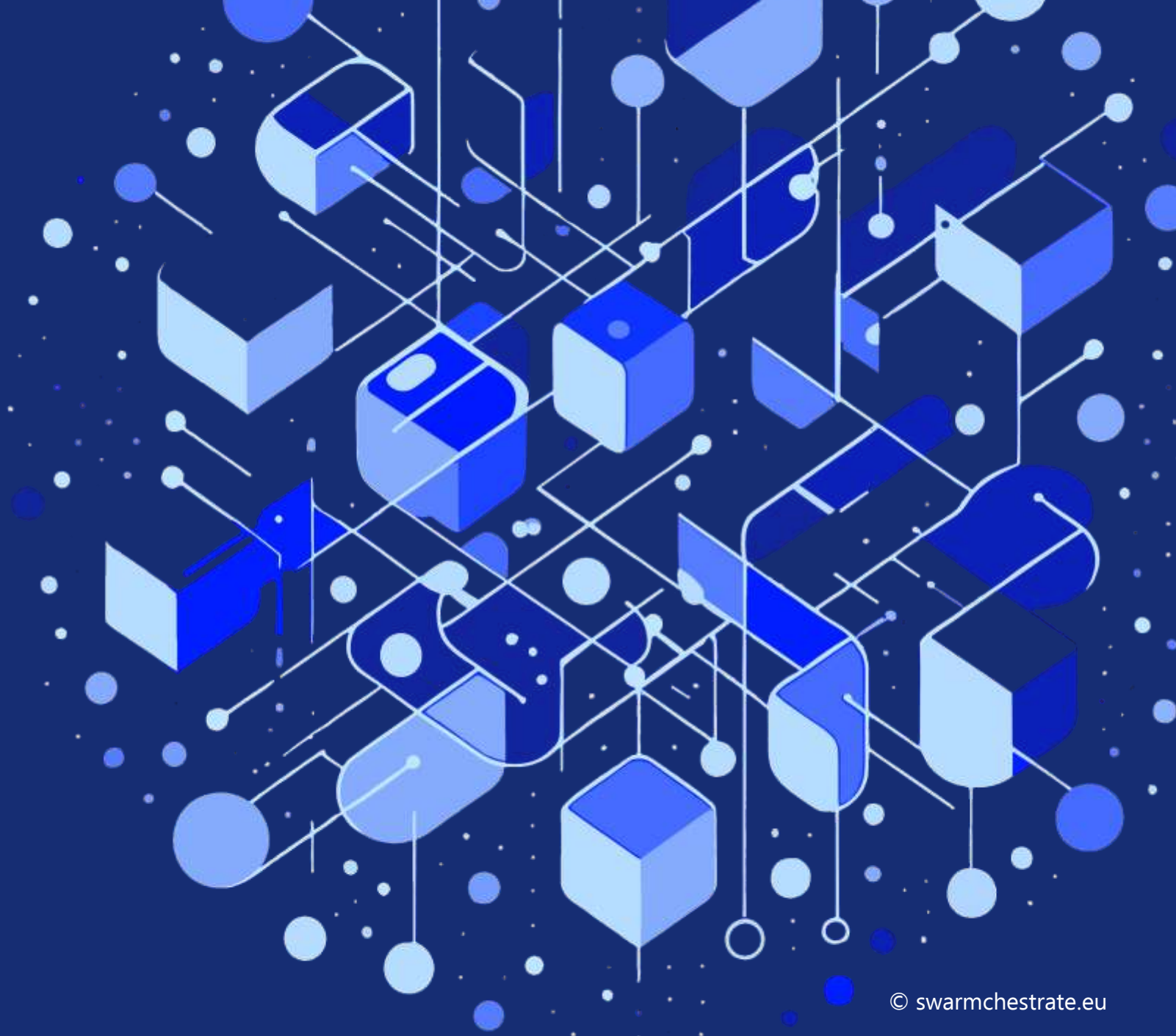


Read more: swarmchestrate.eu/parking-space-management/

Swarmchestrator Components



TOSCA



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About TOSCA



Topology & Orchestration Specification for Cloud Applications

- Language for describing cloud workloads
 - Define application structure and runtime behaviour
- TOSCA Templates describe:
 - Software, virtual machines, storage,
 - Inter-dependencies, requirements,
 - Security rules, monitoring policies.



An example

TOSCA describes components

Each component is of a specific **type**

The type of `nginx` specifies:

an application container (e.g. *Docker*)

It **requires** `worker`, whose type specifies:

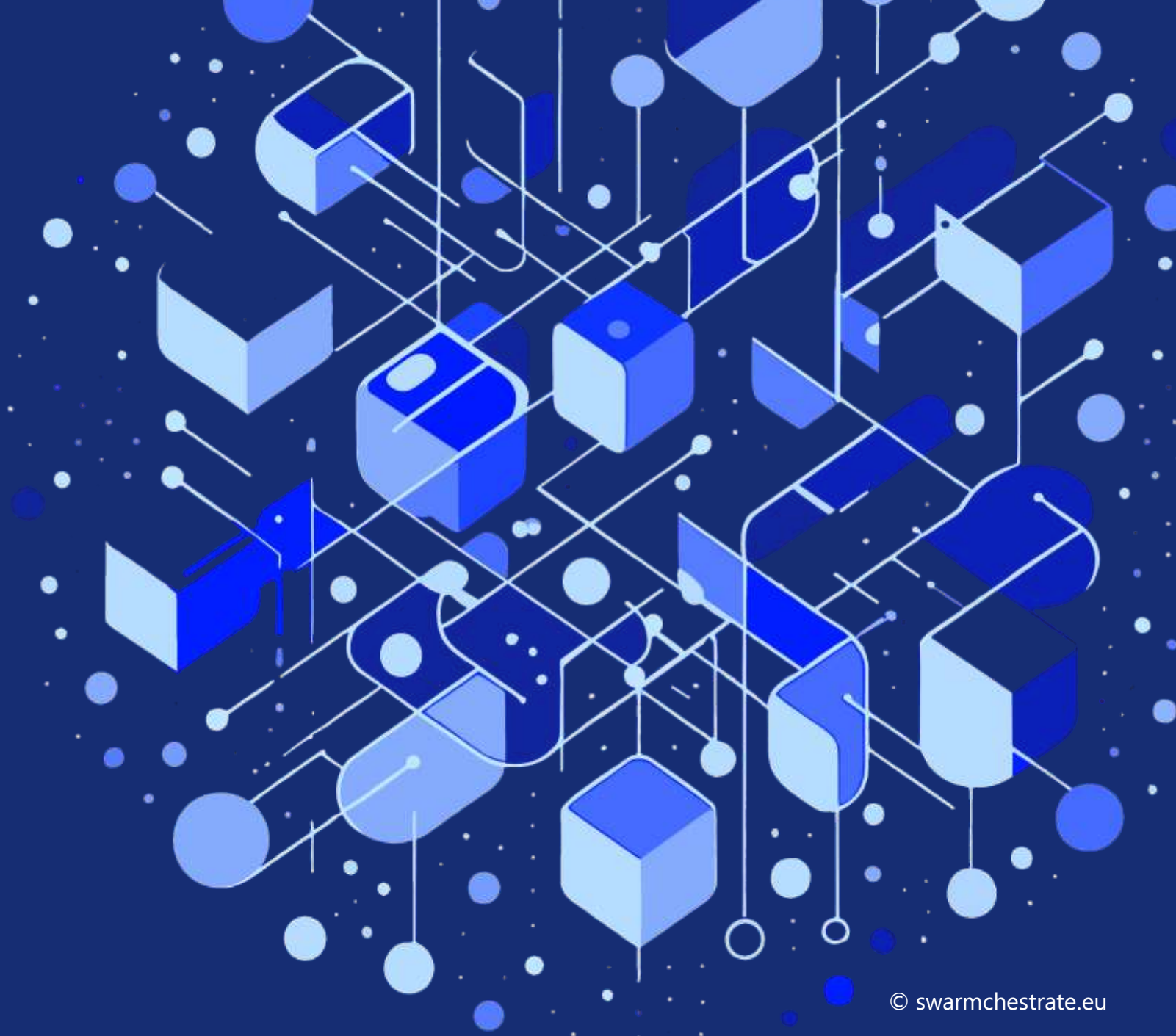
an Amazon Web Services EC2 instance

```
topology_template:
  node_templates:

    nginx:
      type: micado.Application.OCI.Deployment
      properties:
        image: nginx:latest
        ports:
          - port: 80
      requirements:
        - host: worker

    worker:
      type: micado.EC2.Compute.Terraform
      properties:
        image_id: ami-ubuntu_64_x86
        instance_type: t2.large
```

Collaborating on Standardisation



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TOSCA Technical Committee



- OASIS operates in technical committees
 - Members co-create and co-develop specifications
- University of Westminster is a member
 - Since June 2021
- Actively developed TOSCA examples and use-cases in previous EU projects
- Renewed activity in Swarmchestrator

TOSCA Version 2.0



- Released as a Committee Specification at the end of 2024
- More flexibility, more adaptable to different domains and use cases
- Using the momentum of this release, TC efforts to:
 - Showcase this new ethos,
 - Reach wider audiences,
 - Build examples in different domains

Our input



- Working towards a common collection of TOSCA types
 - To be used across domains and use cases
- Working towards a TOSCA profile for Swarm Computing
 - To be used across the cloud-to-edge continuum
- Working towards design patterns in TOSCA
 - To create examples of idiomatic TOSCA

Collaborations



- Weekly meetings both inside and outside of the TC schedule
- Discord channel for discussing ideas and topics
- GitHub issues for proposed amendments/additions to the specification
- Sharing and evaluating TOSCA tools and software

Stay
updated!



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Jay DesLauriers, Research Fellow
University of Westminster



Views and opinions expressed are however those of the author(s) 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.

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PARTNERS



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www.cognets.eu



CoGNETs

Continuums of Game Nets

Project Standardization Activities

Webinar: Standardization Activities in the Cognitive Computing Continuum

Presenter - Angel Cațaron

Affiliation - Siemens

Date - July 1st, 2025

Location - Online



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Schweizerische Eidgenossenschaft
Confédération suisse
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Swiss Confederation

Federal Department of Economic Affairs,
Education and Research EAER
State Secretariat for Education,
Research and Innovation SERI

Grant Agreement
no 101135930



Summary

1. Project overview and vision
2. Standardization strategy and approach – Targeted Standardization Bodies
3. Standardization activities



Project Overview

www.cognets.eu



HORIZON-CL4-2023-DATA-01-04
GA number: 101135930
Type of action: RIA



Duration: 36 months
Starting date: 1 June 2024
Ending date: 31 May 2027



Budget: 6.696.703 €
EU funding: 5.679.536 €

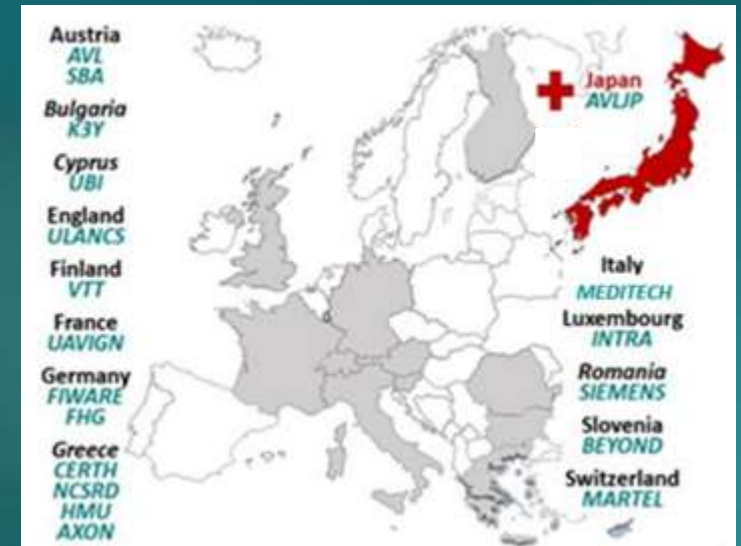


19 partners

- i. 5 big Industries (SIEMENS, AVL, AVLJP, INTRA, MEDITECH)
- ii. 6 innovative SMEs (FIWARE, AXON, BEYOND, K3Y, UBI, MARTEL)
- iii. 4 RTOs (CERTH, FHG, NCSRD, SBA)
- iv. 4 Universities (VTT, ULANCS, HMU, UAVIGN)



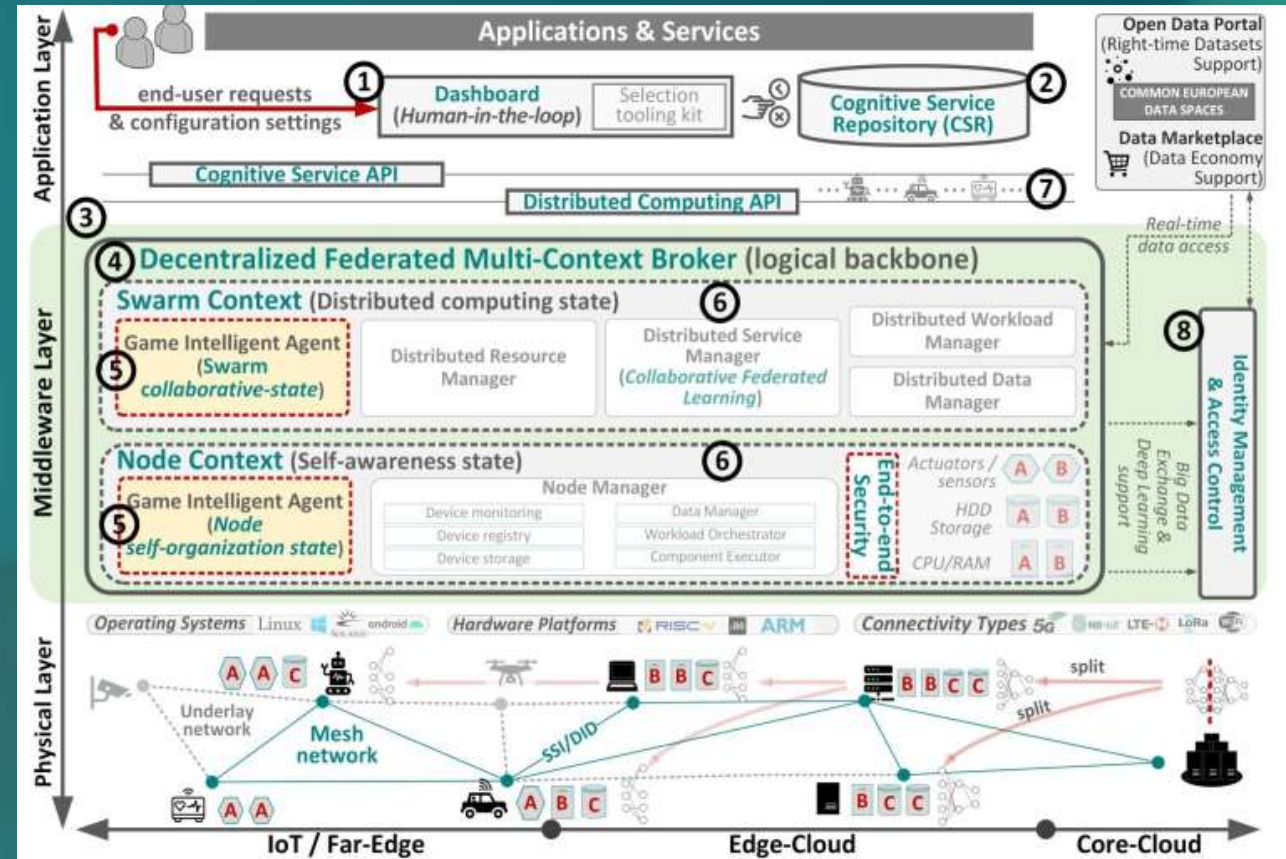
14 countries





Project Vision

- CoGNETs aims to develop a **Middleware Framework** that will empower **IoT, Edge, and Cloud** devices to autonomously organizing dynamic **IoT-to-Cloud swarm continuums** for optimal data processing and seamless service provisioning
- To promote “**self-organization**” and “**collaborative-learning**” of devices via **Asymmetric Multi-Player Competitive Games** containing self-organizing “**Pricing**”, “**Bidding**”, and “**Auctioning**” properties





Standardization Strategy and Approach

Targeted Standardization Bodies (1/2)

- **ETSI/FIWARE NGSI-LD Group** accessible via FIWARE
<https://www.etsi.org/>, <https://ngsi-ld.org/>,
https://fiware-datamodels.readthedocs.io/en/stable/ngsi-ld_howto/index.html
Aspects related to
 - integration of IoT devices & frameworks via NGSI IoT Agents
 - creation of new Data Models or modifications/configurations of the existing NGSI-LD Data models (extensions) to support swarm dynamicity/mobility and make collaborative federated learning applicable in resource constrained IoTs
 - participation in the ETSI ISG CIM Group to translate new functionalities required during the execution of the project.
- **FIWARE NGSI IoT Agents** - share new MQTT data marshalling integration blueprints over IoTs using NGSI IoTAgent standard
- **Smart Data Models Program** via FIWARE (<https://www.fiware.org/smart-data-models/>) - translate the defined CoGNETS data models to be reused after the project ends.
- **ETSI-MEC** (<https://www.etsi.org/technologies/multi-access-edge-computing>) - contribute new practices on AI-based service lifecycle management and continuity for 5G/B5G architecture, as well as function virtualization practices potentially used in virtualized radio access networks.



Standardization Strategy and Approach

Targeted Standardization Bodies (2/2)

- **Internet Public-Private Partnership Programme** (<https://www.fi-ppp.eu/>) - disseminate the new Computing-vs-Energy-vs-Security KPI modelling methods/proofs to harmonize EU platforms with beyond state-of-art technologies and relevant policy/legal/regulatory frameworks.
- **3GPP AI/ML Model Transfer WG** (<https://www.3gpp.org/>) - specify distributed learning AI service models over pruning/splitting profiles and analytics.
- **3GPP SA1/SA2/SA5 WGs** - specify threat data management and function orchestration extensions for virtualized distributed units
- **3GPP Security Assurance Specifications WG (NESAS)**
 - identify potential gaps in current NESAS requirements and bring in new requirements to 3GPP SA3 filling said gaps
 - liaise/explain CoGNETs documentation to enhance the GSMA NESA Scheme



Standardization Activities

- Exchange of contributions, reports and best practices
- Analysis of project innovations' standardization potential
- Integration with existing standards - e.g., NGSI-LD, FIWARE, GAIA-X
 - Examples
 - Two ETSI NGSI-LD APIs for Context and Agent communications, i.e., (i) the Distributed Computing API to discover the data in the distributed swarm, and (ii) the Cognitive Service API to manage Broker policies over the user service requests.
 - The Identity Management (IDM) & Access Control module to provide data access control over the platform and enable Contexts accessing external data bases (FIWARE Data Models, GAIA-X, etc.) with trusted & reliable data for AI processing



Thank you!

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[CoGNETs](#)

The CoGNETs project received funding from the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement No 101135930. This work has received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI).



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TRUSTWORTHY, COGNITIVE AND AI-DRIVEN COLLABORATIVE ASSOCIATIONS OF IOT DEVICES AND EDGE RESOURCES FOR DATA PROCESSING

empyrean-horizon.eu

Call: HORIZON-CL4-2023-DATA-01-04: Cognitive Computing Continuum: Intelligence and automation for more efficient data processing (AI, data and robotics partnership)

Type of action: Research and Innovation Action (RIA)

Duration: 01 February 2024 - 31 January 2027

Project ID: 101136024

Webinar: Standardization in the Cognitive Computing Continuum

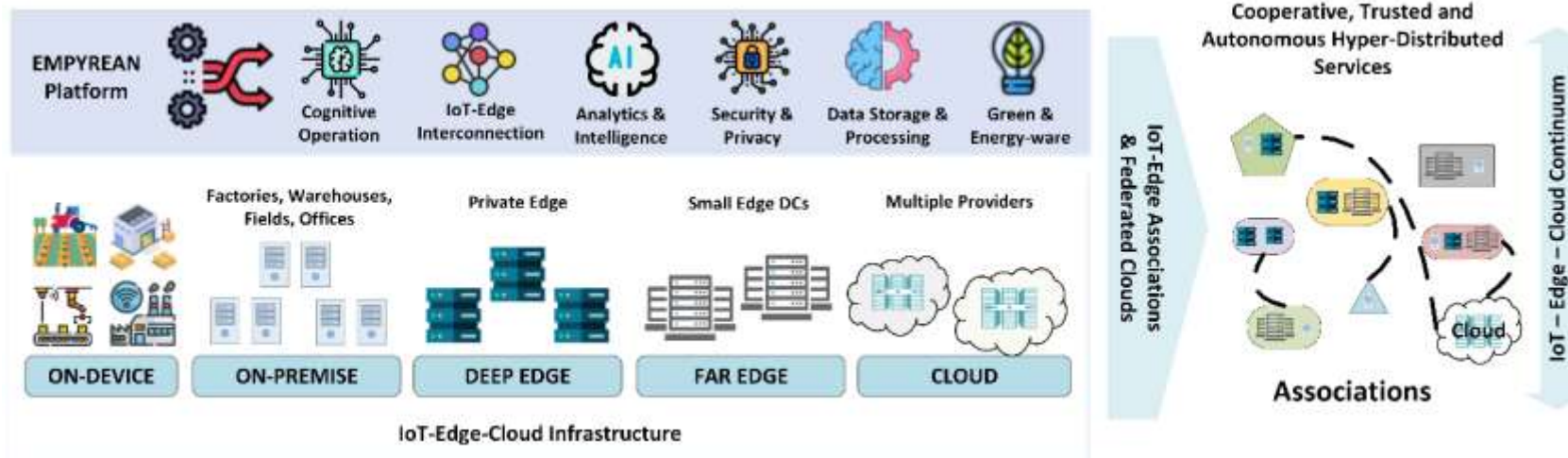
Panagiotis Kokkinos, Institute of Communication and Computer Systems (ICCS) / NTUA

01/07/2025

EMPYREAN – Vision – CCC Challenges



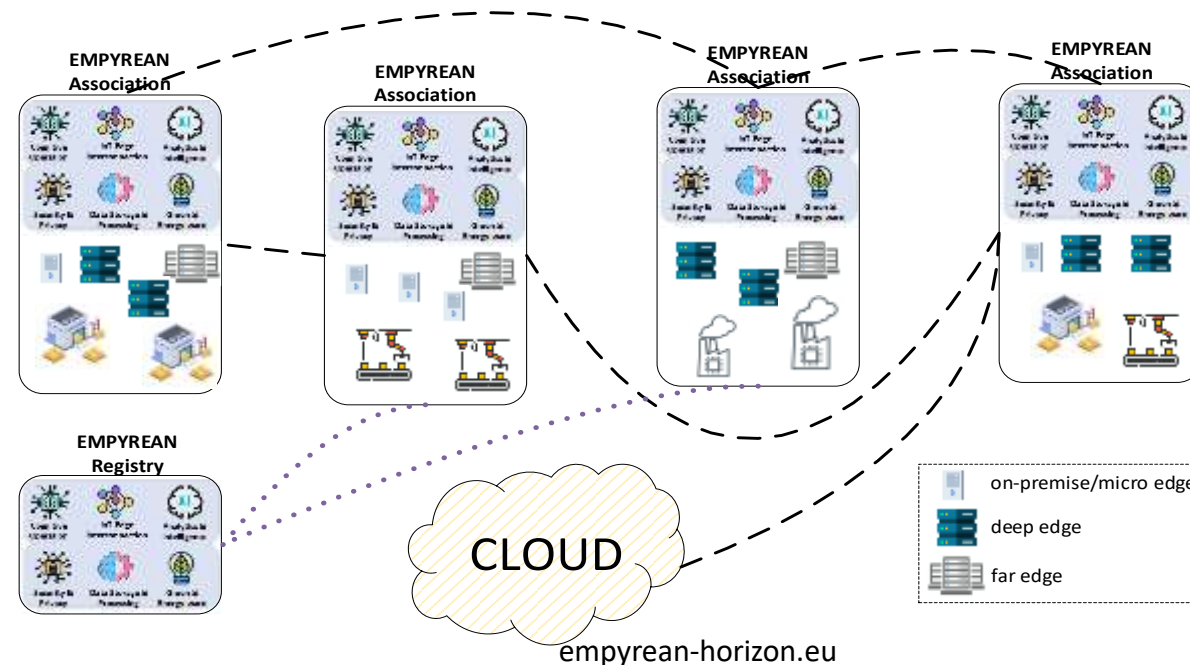
- ❑ The IoT-Edge-Cloud continuum when implemented as a monolithic pipeline cannot efficiently serve the emerging hyper-distributed and AI/ML-based applications
- ❑ It is clear that more local decisions and a collective logic that leads to system-wide welfare optimality is needed in order to accommodate the explosive growth of IoT
- ❑ EMPYREAN transforms the IoT-Edge-Cloud continuum into a collaborative autonomous computing ecosystem



EMPYREAN - Concept



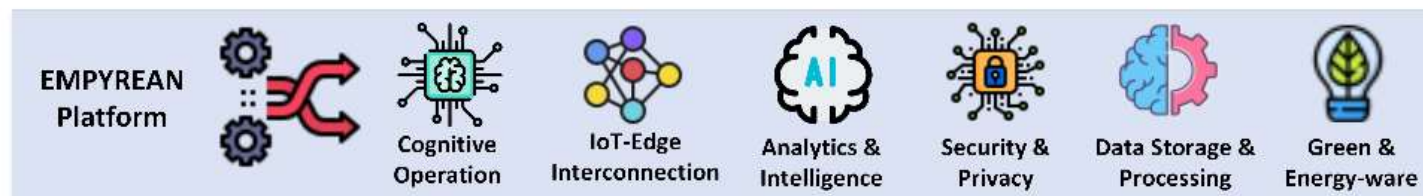
- ❑ EMPYREAN envisions an autonomous computing ecosystem over heterogeneous resources
- ❑ This ecosystem is based on federations of collaborative resources, IoT devices and robots, the Associations
- ❑ Association-based continuum will balance computing tasks and data locally inside an Association as well as between federated Associations
- ❑ An Association-based Continuum is created



EMPYREAN - Advances beyond the state of the art



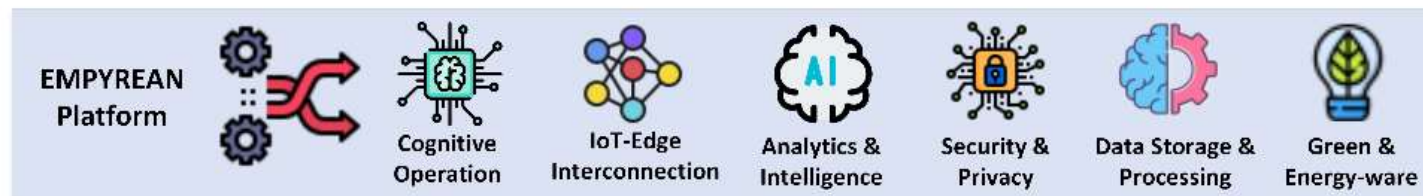
- ❑ EMPYREAN introduces and integrates into a single platform several key innovations.
- ❑ Security and Privacy:
 - Distributed Trust Management and Verification
 - Advanced Access Control and Secure Shared Data Management
 - Cyber Threat Intelligence
- ❑ Data Storage and Processing:
 - Secure Edge Data Storage
 - Analytics-friendly IoT Erasure Coded Data Query
 - Cross-platform and Lightweight Container Packaging
- ❑ IoT-Edge Interconnection:
 - Distributed Data Communication Management
 - RDMA for Edge Nodes Supporting IoT-based Sensor Data



EMPYREAN - Advances beyond the state of the art



- ❑ Cognitive Operation
 - Collaborative Continuum's Management
 - Game Theory and Multi-Agent Orchestration
- ❑ AI-enabled Application Development & Deployment:
 - AI-based Workload Autoscaling
 - Workflow-based Continuum-native Application Design
 - Application Deployment Based on Unikernels
- ❑ Energy-aware orchestration



EMPYREAN's Standardization Activities

- ❑ The robotics community has selected one of EMPYREAN's data management components, the Eclipse Zenoh communication protocol and APIs as the alternative communication middleware that could overcome many of the limitations of the default Data Distribution Service (DDS) protocol.
- ❑ ROS Middleware interface Rmw_zenoh comes with the latest Robot Operating System (ROS) 2 release, the Jazzy Jalisco, which was introduced as an alternative option, built on the Zenoh protocol.

EMPYREAN's Standardization Activities

- The Circular Buffer I/O dispatch interface is in the process to be funneled to the following NVIDIA internal projects
 - GPUdirect for storage in Magnum I/O stack
 - NVIDIA DOCA library for DPU network architectures
- Upon wide user usage within these NVIDIA libraries standardisation is will be pursued in the form of IETF drafts related to infiniband networking.

EMPYREAN's Standardization Activities

- ❑ RYAX leverages a suite of modern, standardized tools and practices to ensure interoperability, security, and scalability.
- ❑ Several standards are being used and new standards are currently being integrated (OpenAPI, JWT, YAML workflow definitions, Helm, NIX functional package manager)

EMPYREAN's Standardization Activities



- ❑ Align with Open Sustainable Interoperability Stack (OSiS) by integrating W3C Verifiable Credentials Data Model v2.0, W3C Decentralized Identifiers (DIDs) v1.0, and OpenID standards
- ❑ Establish a secure, interoperable trust framework for identity, authentication, and access control across Associations
- ❑ Inline with Governance model for data spaces (such as GAIA-X)

EMPYREAN's Standardization Activities

- ❑ OCI specifications for interoperable application packaging and interoperable execution
- ❑ GDPR-compliant file storage and sharing solution through the SkyFlok service
- ❑ Secure Storage Service follows the Simple Storage Service (S3) storage interface provided by Amazon Web Services (AWS)
- ❑ Communication related standards: MQTT, MODBUS, OPC-UA, JSON

EMPYREAN's Standardization Activities



- ❑ urunc (<https://www.cncf.io/projects/urunc/>) bridges the gap between traditional unikernels and containerized environments, enabling seamless integration with cloud-native architectures.
- ❑ urunc was accepted to Cloud Native Computing Foundation (CNCF) on May 22, 2025 at the Sandbox maturity level.

Questions ?

- Visit our website: **empyrean-horizon.eu**
- Or email us: **Panagiotis Kokkinos, kokkinop@mail.ntua.gr**