



Federated Architectures for Distributed Intelligence

Way Forward

Concertation and Consultation on Computing Continuum

Concertation Meeting

Brussels

10th May 2023



IntelliIoT

IoT-NGIN

NEXT GENERATION IoT

VEDL
Very Efficient Deep Learning in IoT

TERMINET

assist-iot

inGenious

Human-device interfaces

Hardware accelerators & low powered devices

Federated and distributed intelligence

VNFs and 5G edge processing

DLT enabled data management and cybersecurity



IoT



EUCloudEdgeIoT.eu

Parameter based pooling – Function as a Service

Abstraction layers for heterogeneous/mixed resources

Cognitive and automated orchestration platforms

Cloud based hardware/software acceleration & optimisation

Multicloud application development interfaces and tools



Edge

RAINBOW

SmartCLIDE

ACCORDION

CHARITY
Cloud for Holography and Augmented Reality

PHYSICS

AI SPRINT
AI IN SECURE PRIVACY PRESERVING COMPUTING CONTINUUM

SERRANO

Fog Protect



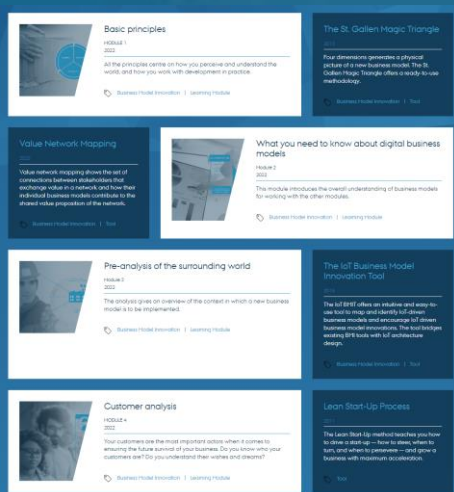
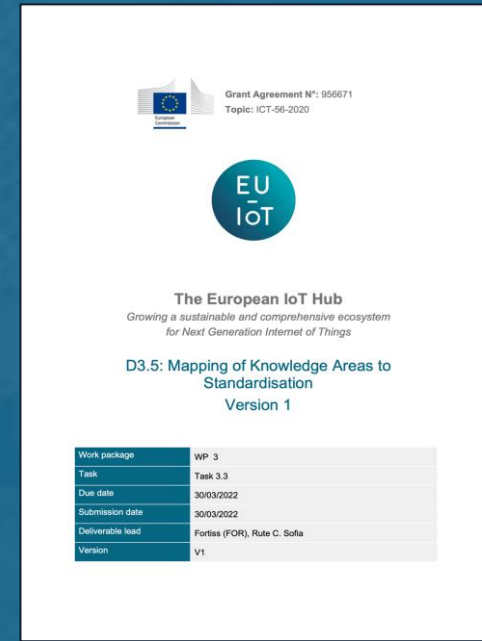
DataCloud
Enabling the big data pipeline lifecycle on the computer continuum

PLEDGER

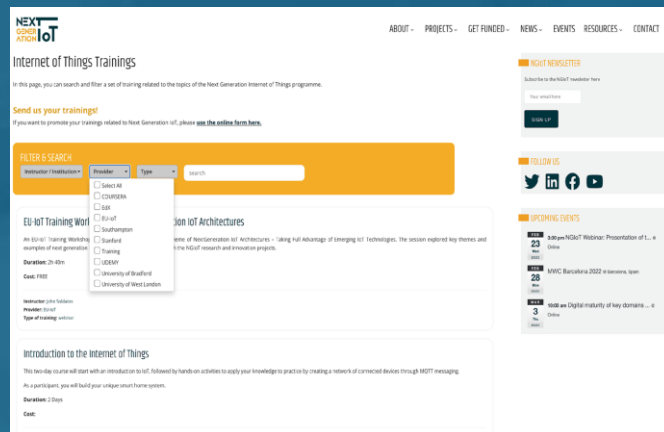
HORIZON CLOUD



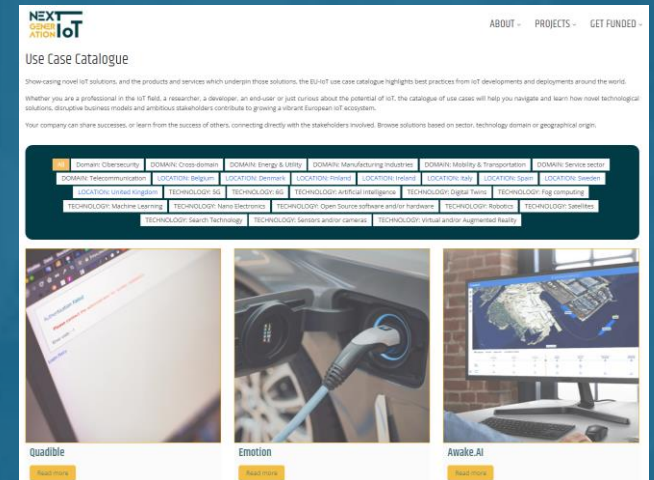
Cloud



E-Learning Platform – Business Models



Training Catalogue



Use Case Catalogue



The European IoT Hub
Growing a sustainable and comprehensive ecosystem
for Next Generation Internet of Things

D2.6: NGIoT Roadmap and Policy
Recommendations v2

Revision: 1.0

Work package	WP 2
Task	Task 2.3

D2.6
Policy Guidance
and Mapping
6 SRIAs + > 590 Topics

1

SHARED DIGITAL FUTURES

Impact of Data Act, AI
Act Cyber Resilience
Act, Digital Services
Package on NGIoT

2

A FEDERATED FUTURE

Highlights and trends
across major SRIAs

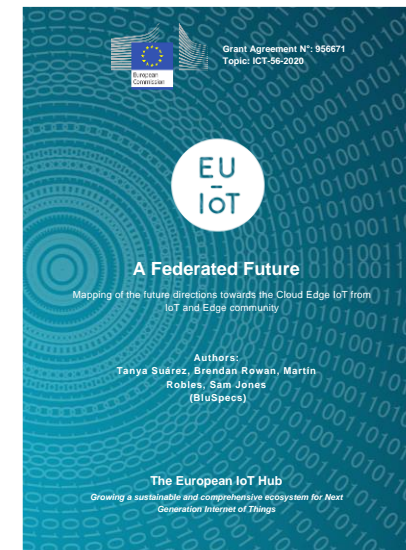
3

SRIA DATABASE

>650 abstracted and
categorised topics in
csv on Zenodo



bit.ly/eufutures



<http://bit.ly/EUSRIA>
<http://bit.ly/SRIADATA>

EU
IoT





	HUMAN INTERFACE	FAR EDGE	NEAR EDGE	INFRA STRUCTURE	DATA SPACES	ALL	
Networkworld Europe	8	8	6	127	2	24	175
AiOTI	29	67	31	23	15	4	165
ECS	54	20	39	33	10	3	159
ADRA	23	12	1	1	1	4	42
EFFRA	8	3	2	2	5	9	29
Data, Edge & Cloud		2	2	3	10	3	20



Overall observations

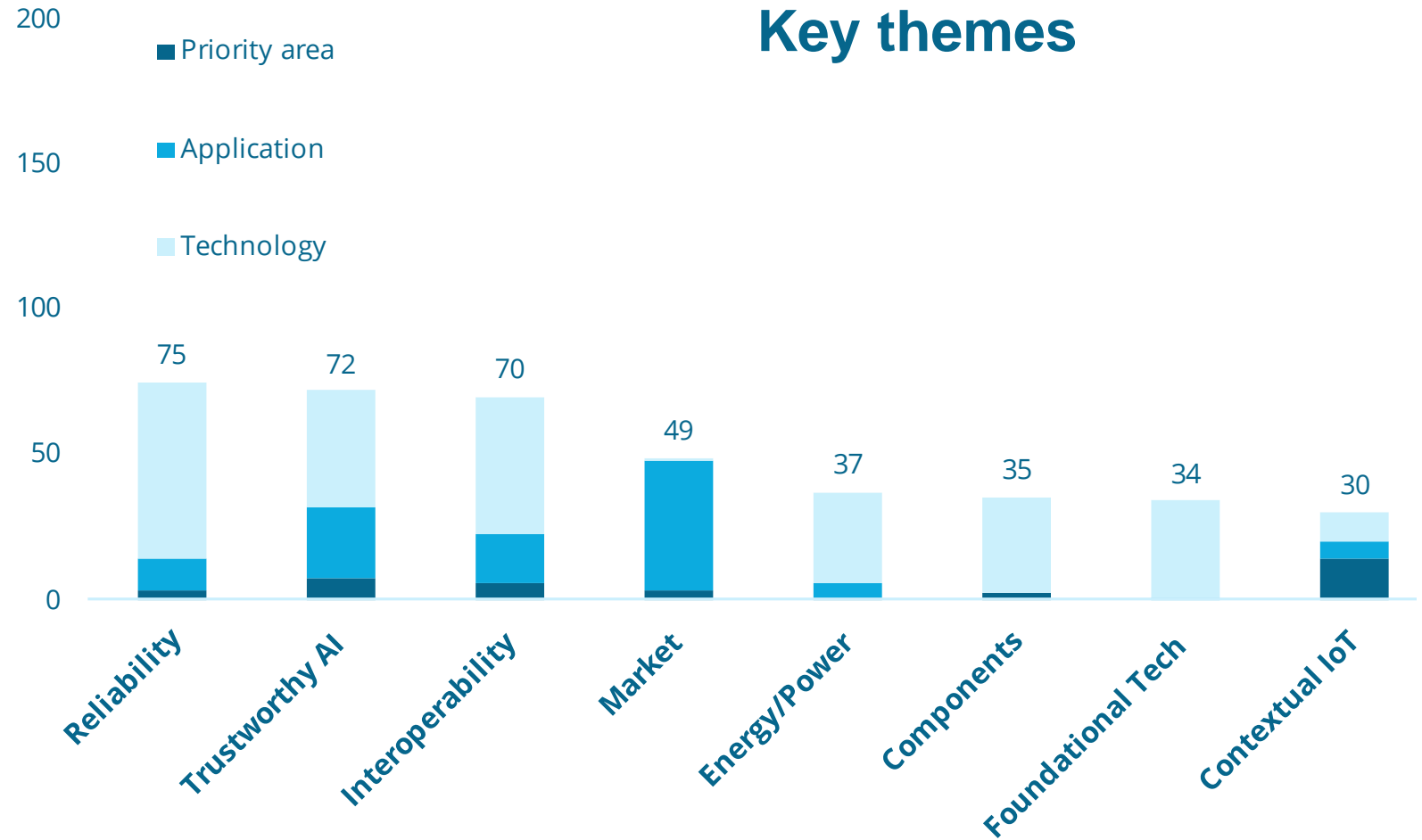
- Federated and heterogenous systems
- Trust and Performance
- Distributed intelligence and Federated Learning

Key themes

Key themes and trends

Overall observations

- Federated and heterogenous systems
- Trust and Performance
- Distributed intelligence and Federated Learning





netcompany

intrasoft



fortiss



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WAY FORWARD

Federated Architecture for Distributed Intelligence



Tanya Suárez

BluSpecs
EU-IoT



Panagiotis Sarigiannidis

U. Western Macedonia
TERMINET



Carlos Palau

Technical University Valencia
AerOS



Akis Kourtis

Demokratis
OASEES



NGIoT
2020-2023

IoT architecture through software-defined networking as an uniform layer, based on advanced AI and federated learning

Agriculture, Energy, Health, Supply Chain



MetaOS
2022-2025

Platform-agnostic, zero-touch Meta OS that follows a collaborative IoT-Edge-Cloud architecture supporting flexible deployments

Agriculture, Energy, Social, Ports, Manufacturing



Swarm AI
2023-2026

Fully open-source, decentralized, and secure Swarm programmability framework for edge devices and leveraging various AI/ML accelerators

Health, Energy, Manufacturing



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next gEneRation sMArt INterconnectEd ioT

Prof. Panagiotis Sarigiannidis – University of Western Macedonia

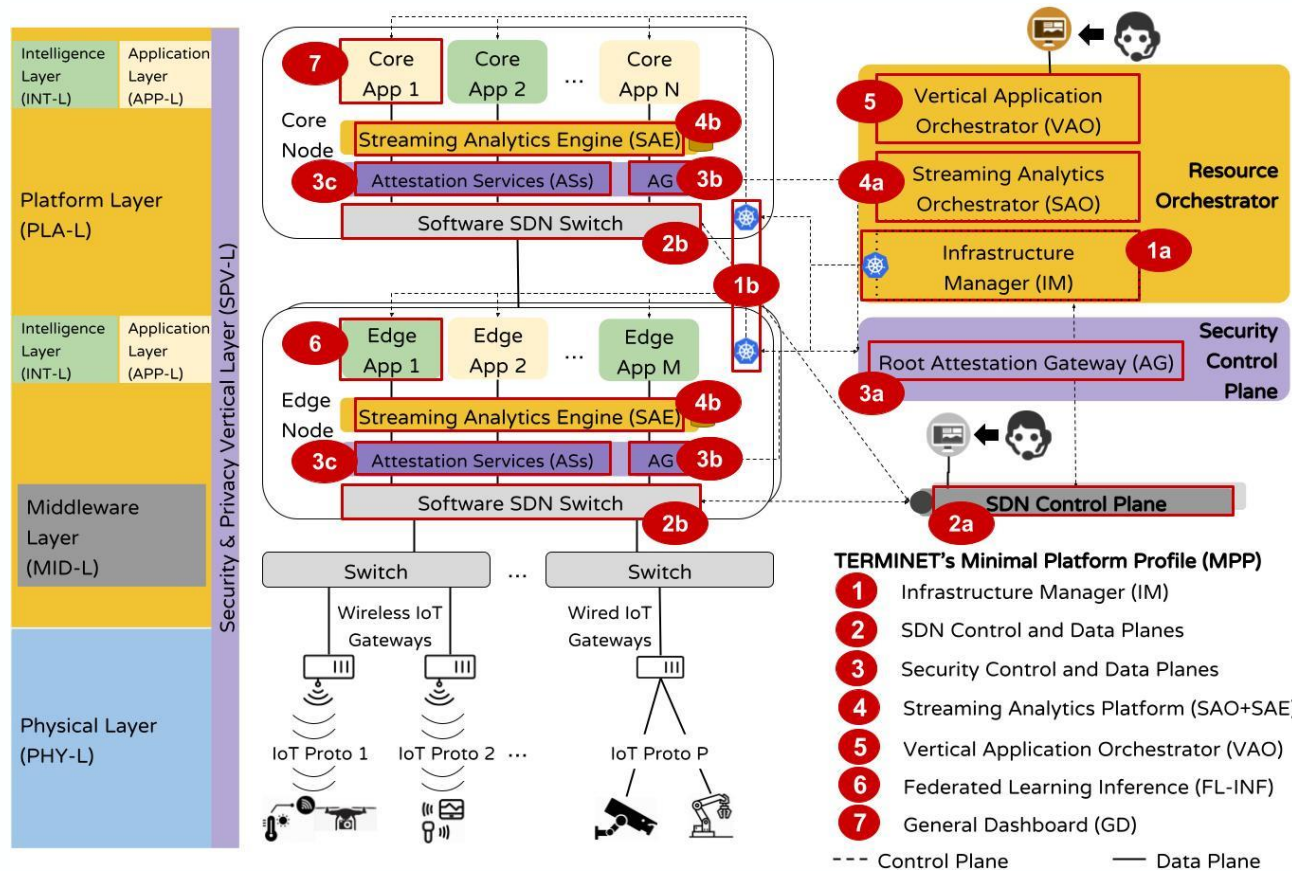
Project Coordinator

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

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

Organized by: **Open Continuum** | Supported by: Unlock CEI and SWForum

TERMINET Reference Architecture

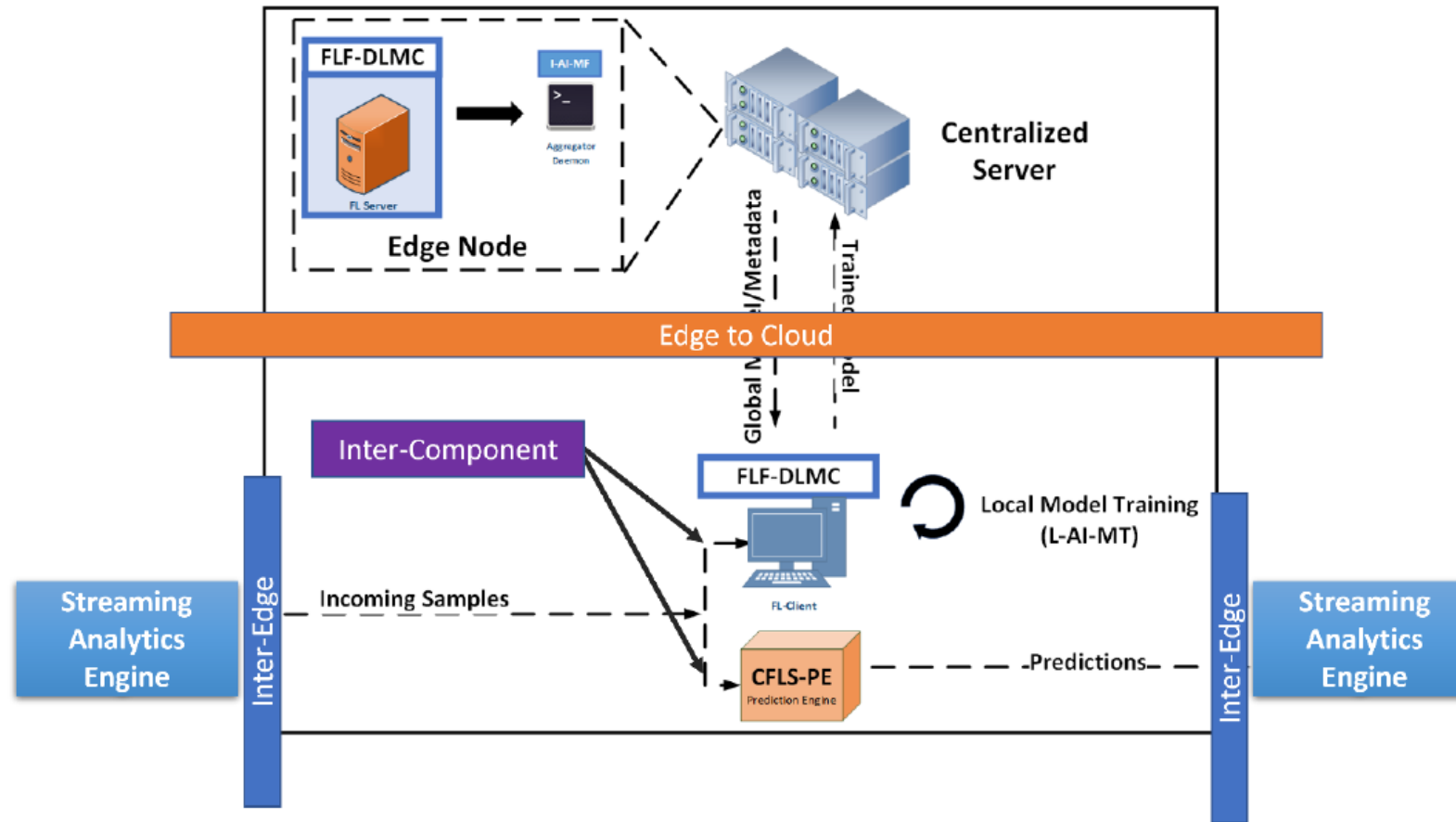


- *Microservice-oriented* application deployment across edges and the continuum
 - Resource Orchestration Components
 - Vertical and Dynamic Resource Orchestrator
 - Storage and Streaming Analytics Components
 - Streaming Analytics Orchestrator for real-time data pre-processing and caching
 - Security and Privacy Components
 - Attestation Gateway
 - Application Components
 - Federated Learning Framework for privacy-preserving ML model training
 - Dashboard

Interoperability through multi-access distributed edge networks supported by novel orchestration schemes

- Papanikolaou, V. K., Mitsiou, N. A., Diamantoulakis, P. D., Ding, Z., & Karagiannidis, G. K. (2021). Hierarchical Multiple Access (HiMA) for Fog-RAN: Protocol Design and Resource Allocation. *IEEE Transactions on Wireless Communications*, 21(2), 960-975.
- Diamantoulakis, P. D., Bouzinis, P. S., Sarigiannidis, P. G., Ding, Z., & Karagiannidis, G. K. (2021). Optimal Design and Orchestration of Mobile Edge Computing with Energy Awareness. *IEEE Transactions on Sustainable Computing*, 7(2), 456-470.

Federated Approach – Privacy by Design



TERMINET Project Identity & Consortium

- ✓ Call: H2020-ICT-2018-20
- ✓ Topic: ICT-56-2020
- ✓ Type of action: RIA
- ✓ Total Budget: € 8.000.000,00
- ✓ Active period: 1 Nov 2020 – 31 Oct. 2023



TERMINET aims at providing a novel **next generation reference architecture** based on cutting-edge technologies such as Software Defined Networking (SDN), multiple-access edge computing (MEC), and virtualisation for next generation IoT. In addition, TERMINET introduces **new, intelligent IoT devices** for low-latency, market-oriented use cases. Finally, TERMINET intends to bring more **efficient and accurate decisions to the point of interest to better serve the final user.**

Consortium

TERMINET USE CASES



1. UC #1: User-Centric Devices in Smart Farming
2. UC #2: Pathway of Personalized Healthcare
3. UC #3: Smart, Sustainable and Efficient Buildings
4. UC #4: Prediction and Forecasting System for Optimizing the Supply Chain in Dairy Products
5. UC #5: Group Training Surgery Using VR enabled IoT Technologies
6. UC #6: Mixed Reality and ML Supported Maintenance and Fault Prediction of IoT based Critical Infrastructure



EUCloudEdgelot.eu is supported by the Open Continuum and Unlock CEI and both received funding from the European Union's Horizon Europe Research and Innovation Programme under the Grant Agreement numbers 101070030 and 101070571.



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<https://terminet-h2020.eu/>



<https://www.linkedin.com/company/terminet/>



EUCloudEdgeIoT.eu



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957406.

Thank you for your kind attention!

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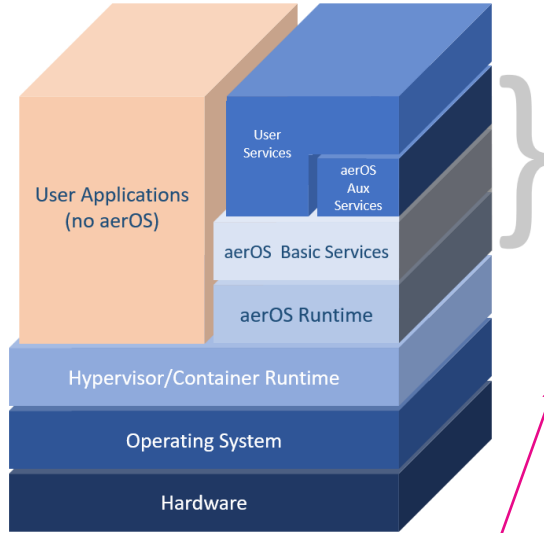
DISTRIBUTED INTELLIGENCE ARCHITECTURE IN aerOS

EU CEI Concertation Meeting

Brussels, May 10th, 2023

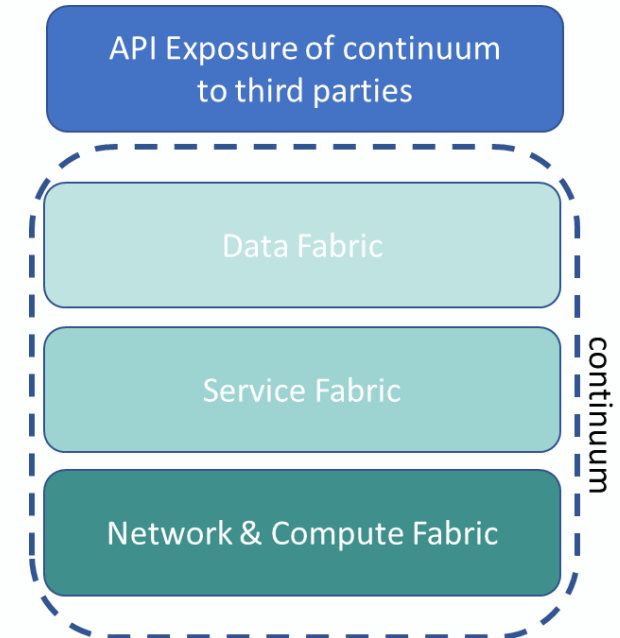
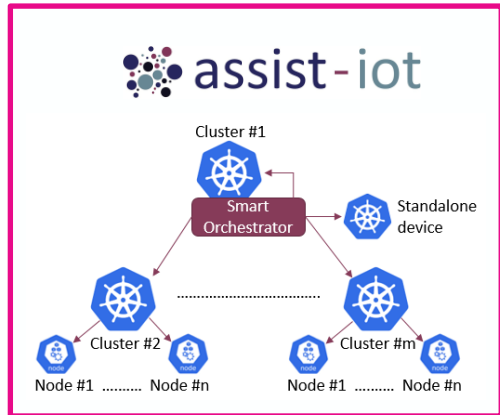
Prof. Carlos E. Palau (UPV) – Project Coordinator

GLOBAL ARCHITECTURE PERSPECTIVE



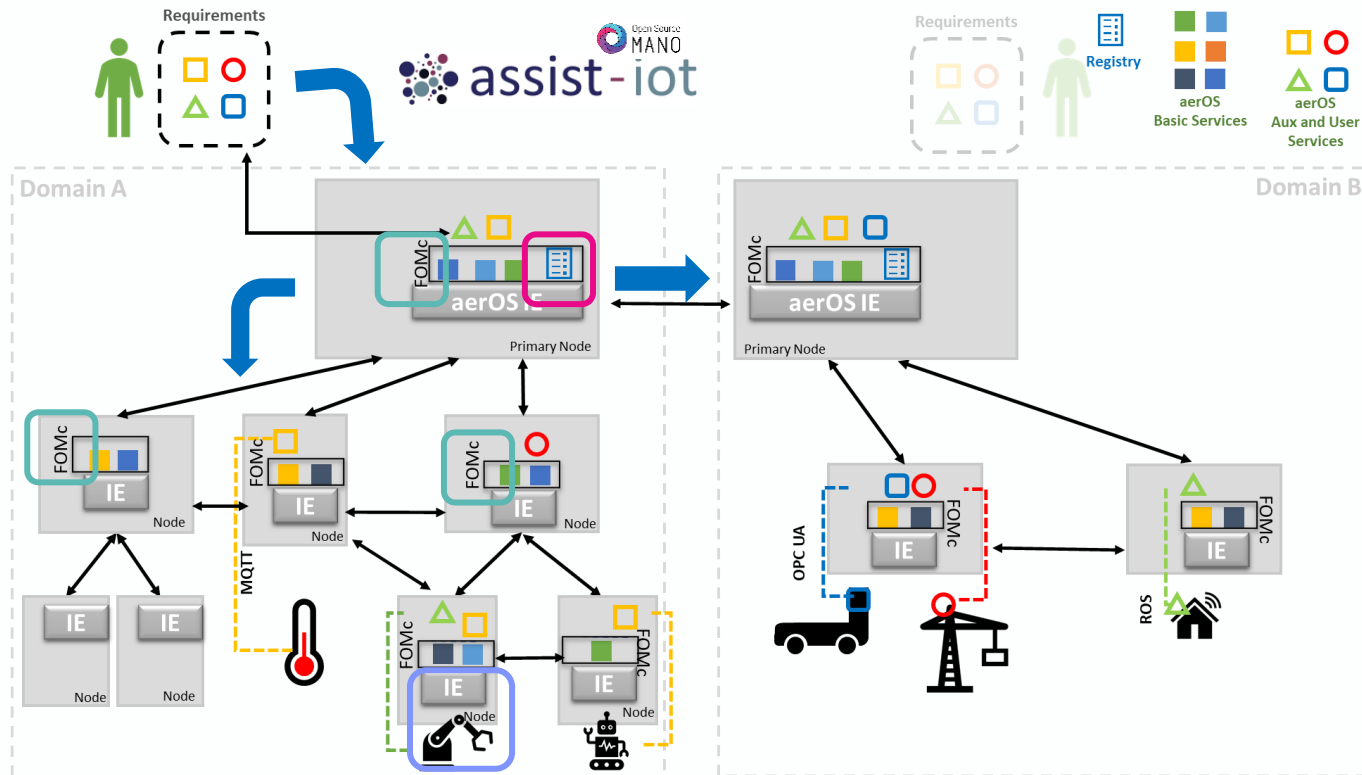
aerOS creates a network-compute fabric, on top of which **reusable** distributed IoT applications can be deployed on aerOS **service fabric** following an **AI-driven service placement**, consuming the IoT data, that are discovered in the **aerOS data fabric**.

- Service deployment and management **following cloud-native principles** (K8s, Helm charts, KubeEdge and beyond).
- **Federated orchestration** in multi-stakeholder environments
- **Event mesh and serverless** to connect services and apply AI for the orchestration in the continuum.
- **Frugal AI/ML** techniques for managing services lifecycle
- Data fabric, service fabric and network and compute fabric.



FEDERATED ORCHESTRATION IN aerOS

- aerOS continuum is composed of Infrastructure Elements in various domains.



Resources and services
deployment (Day-0)

Registry of underlying IEs and peers IE.

Every IE contains a Federated Context Broker (FIWARE ORION)

The far-end IEs directly connect to IoT devices

How the continuum is orchestrated:

An application must be deployed in the continuum.

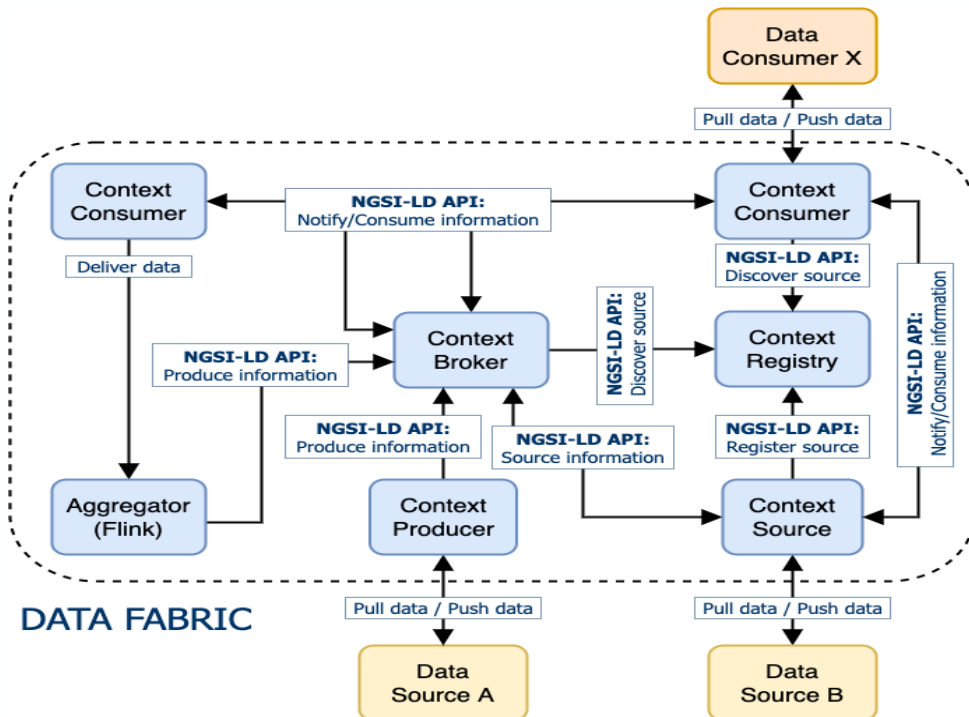


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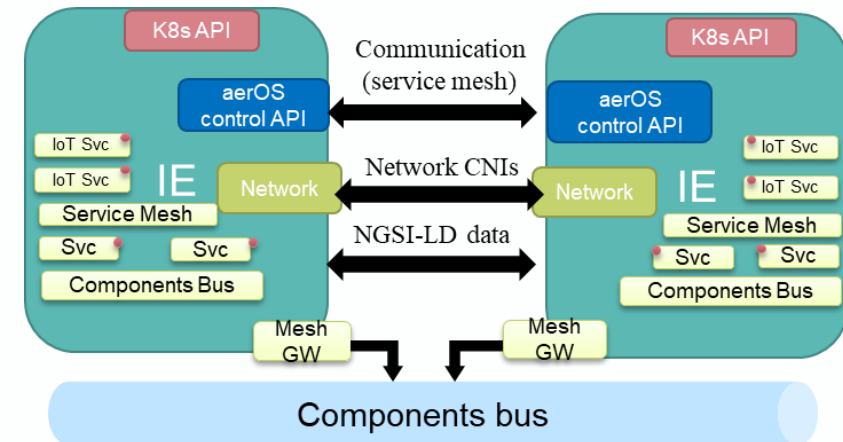
DATA FABRIC and EVENT MESH

Service connection and interaction (Day-1)

- aerOS proposes an innovative way of managing that can reside anywhere across the continuum.
 - Data Fabric forming a data continuum allowing distributed intelligence.



- Service mesh principles (e.g., Istio) enhanced with Dynamic structure (Event mesh).
- Customized AI models via OpenFAAS, serverless functions.





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THANK YOU!

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Objectives



Obj 1

- Design a decentralized, agile and secure architecture for collaborative smart nodes at the edge backed by the Decentralized Autonomous Organization (DAO) paradigm integration.

Obj 2

- Native device support by integrating Self Sovereign Identity (SSI) for a portable digital identity. OASEES Decentralized device identity will be a new class of identifier that fulfils all four requirements: persistence, global resolvability, cryptographic verifiability, and decentralization.

Obj 3

- Build rapid development kits (RDks) for an open programmable framework across different smart edge nodes, while incorporating efficient cloud-to-edge continuum intelligence across heterogeneous target environments.

Obj 4

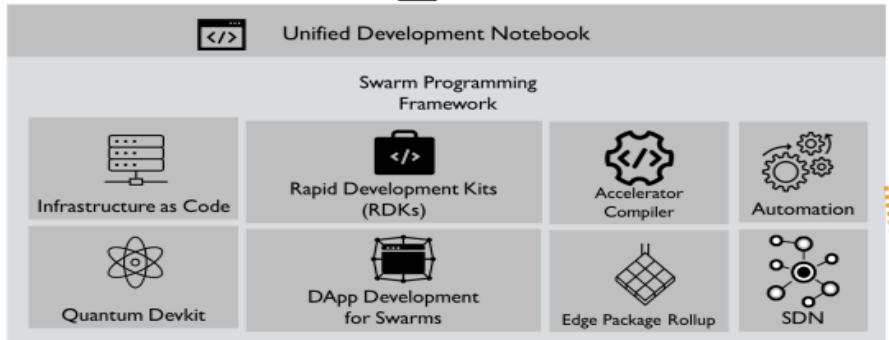
- Demonstrate the framework and programmability toolkit in a set of different vertical use cases and evaluate the benefits across different sectors.

Obj 5

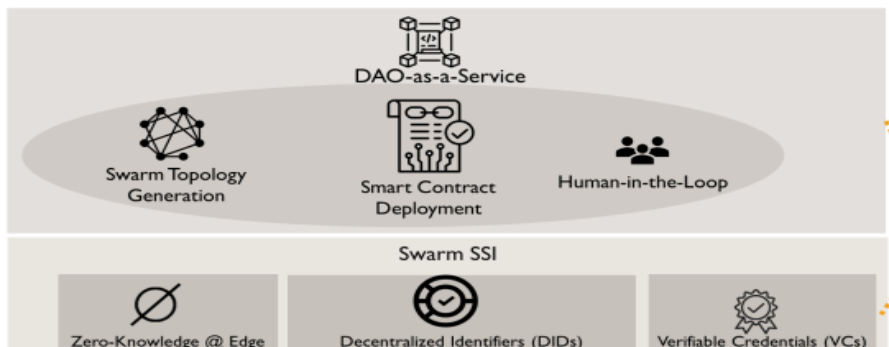
- Maximize the impact of the OASEES results. Foster the creation of an open-source community around the OASEES solution, engaging a diverse set of stakeholders



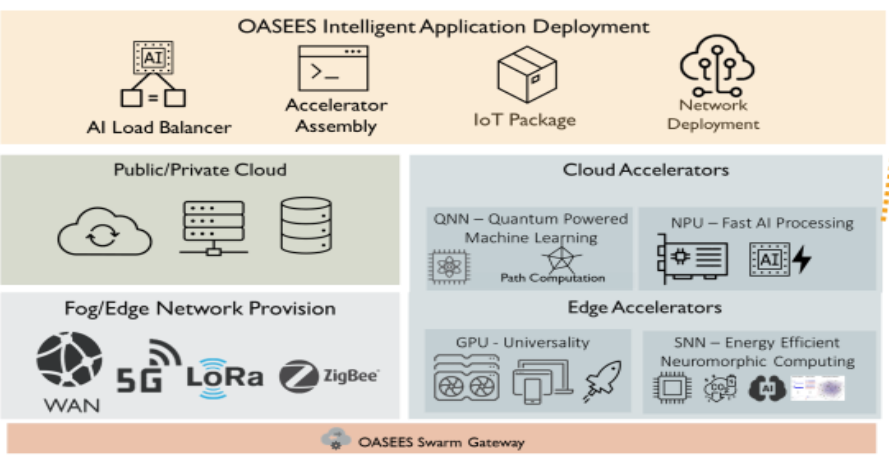
Programmability Layer



Swarm Organization & Identity Layer



Deployment & Execution Layer



Data Federation Layer



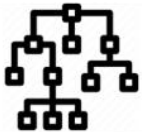
x-Sensors/Devices



x-Networks



x-ML-Algorithms



x-Specialist



01

SSI: DIDs, VCs



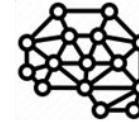
02

Create their DAO
- Organize through it



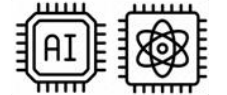
03

Choose/Define their AI
model/optimization



04

Use the preferred
Accelerator



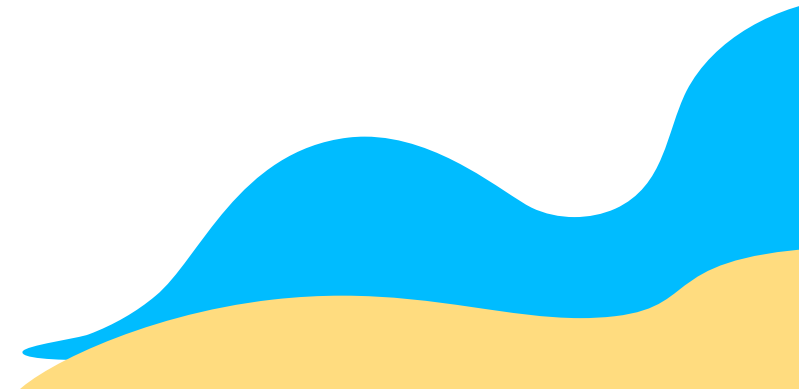
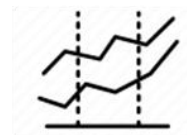
05a

Automated Decision
Making/HITL



05b

Optimize & Collect
KPIs





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