This Communication is part of a project that has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement Nº 101069732

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EUROPEAN IOT-EDGE-CLOUD

AEROS ENERGY EFFICIENT, HEALTH SAFE & SUSTAINABLE SMART BUILDINGS

Fofy Setaki, COSMOTE S.A

aerOS Project

EU CEI Energy Call 10th November 2023

EUCloudEdgeIoT.eu

The Concept

Energy Efficient, Health Safe and Sustainable Smart Buildings

Target

to minimize energy consumption and maximize health measures
with smart-seating recommendations and
automated housekeeping/building maintenance
leveraging the aerOS edge-cloud continuum concepts

Powered by aerOS partners COSMOTE, UPV, NCSRD, FOGUS, INFOLYSIS

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Context

By considering…

- the metrics received by a vast range of sensors
- historical data on energy consumption, CO_2 emissions
- historical data on employees' routine/ preference

The aerOS pilot:

Exploits AI to determine room health conditions and considers energy efficiency criteria to recommend the appropriate seating placement to the employee

Uses the sensors' data to actuate the ventilation, heating and air-condition systems as well as control luminosity

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Challenges & Innovations

With multiple IOT vendors and solutions, tech integration, so that sensors, systems, analytics work in sync is cumbersome

the aerOS architecture as a unique abstraction layer

Distinctive infrastructure characteristics of each building rationalizing autonomous and decentralized decision-making

the aerOS edge-cloud continuum

Energy Efficiency

IoT automations

swarm intelligence among the AEROS nodes to co-operate decentralized

5G SA IoT GWs with SDN, NFV, Network Apps Capabilities

Smart energy consumption calculation and forecast algorithms and systems

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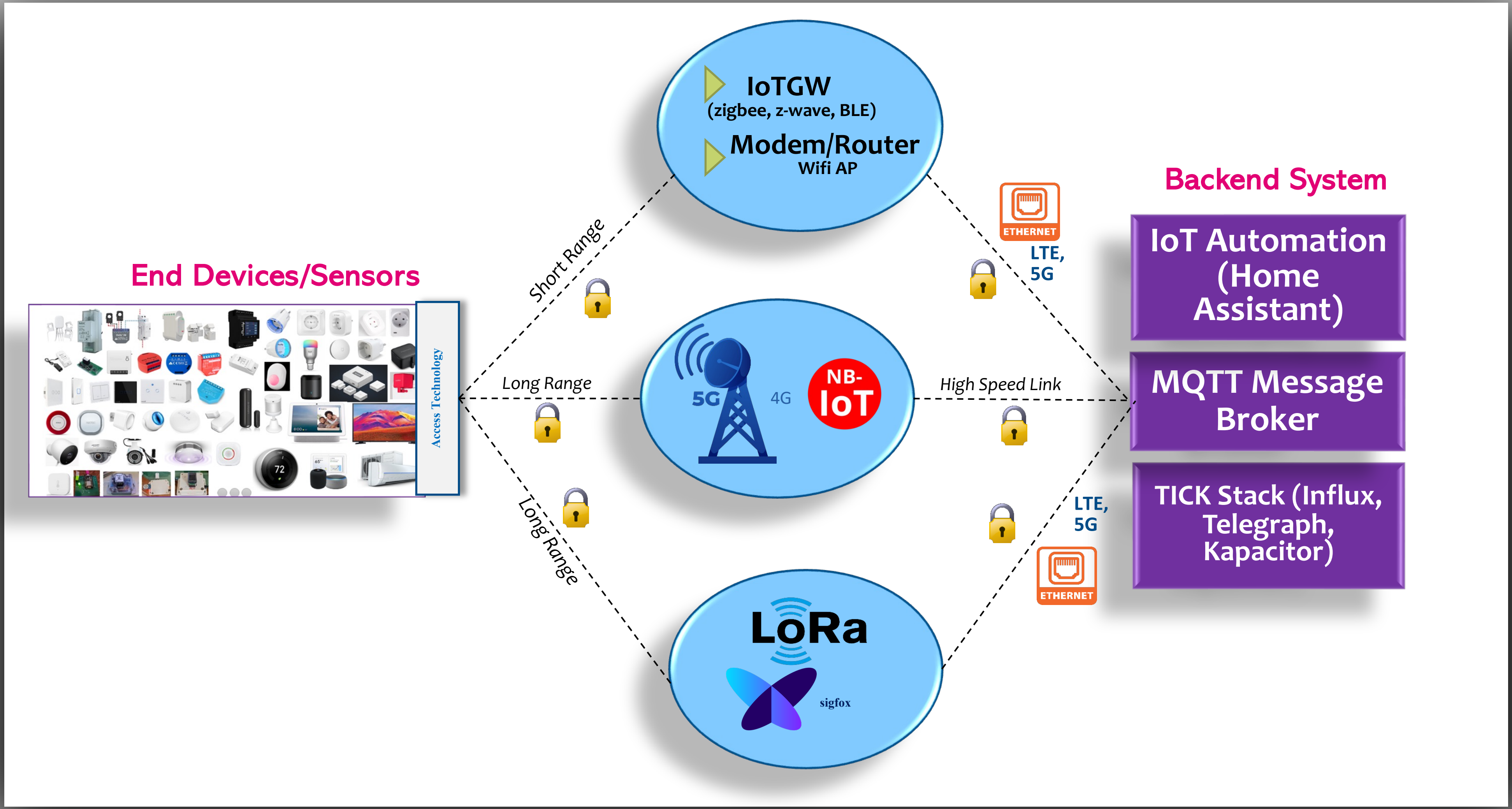
COSMOTE IoT Application Architecture



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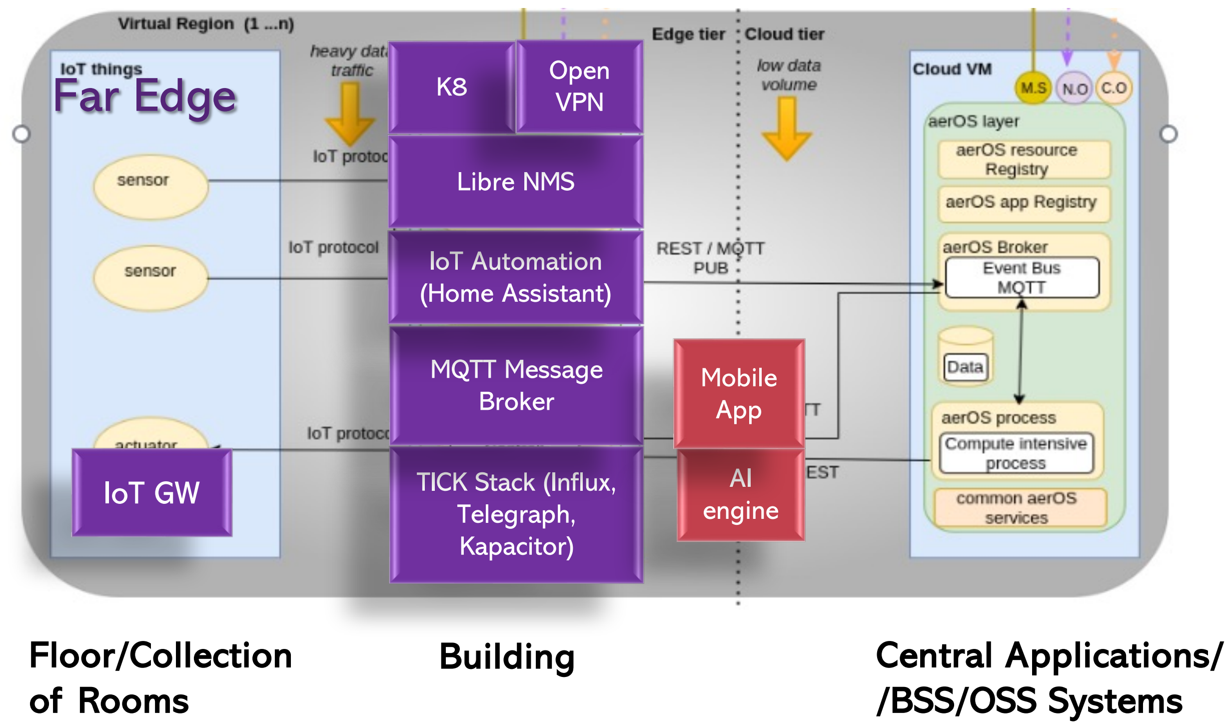
aerOS Use Case 5 Application Architecture



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IoT Application in aerOS architecture

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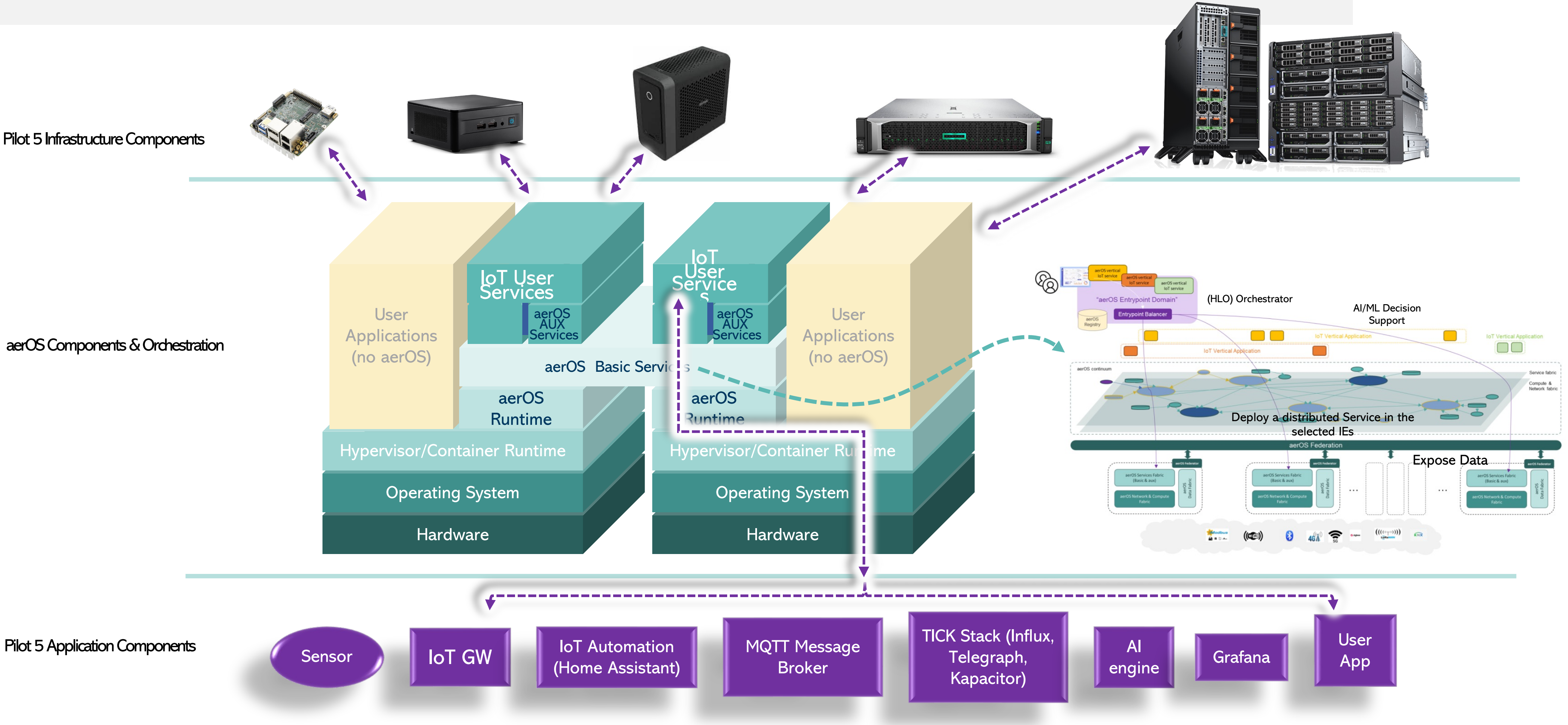

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Health Index (Hi)

What do we consider a healthy office space ?

Hi

Thermal Comfort

- Temperature: 19 °C - 25 °C
- Humidity: 30% - 50%

Air Quality

- CO: 30 ppm (1h)
- CO2: < 1350 ppm
- Particulate Matter (PM2.5): 25 mg/m^3 (24h)

- Settimo, G.; Manigrasso, M.; Avino, P. Indoor Air Quality: A Focus on the European Legislation and State-of-the-Art Research in Italy. *Atmosphere* **2020**, *11*, 370. https://doi.org/10.3390/atmos11040370
- Indoor Environmental Input Parameters for Design and Assessment of Energy Performance of Buildings Addressing Indoor Air Quality, Thermal Environment, Lighting and Acoustics, B S I Standards, 2008
- http://bpie.eu/wp-content/uploads/2018/10/The-Inner-value-of-a-building-Linking-IEQ-and-energy-performance-in-building-regulation_BPIE.pdf

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AI

Future

Time Series F. Model	Predict →	Temperature
Time Series F. Model	Predict →	Humidity
Time Series F. Model	Predict →	CO
Time Series F. Model	Predict →	CO_2
Time Series F. Model	Predict →	Particulate Matter
Time Series F. Model	Predict →	Energy Consumption

Ruled Based Approach

→

Threshold

Control HVAC

- Heating
- Ventilation
- Air Conditioning

Healthy Office

Energy Efficiency

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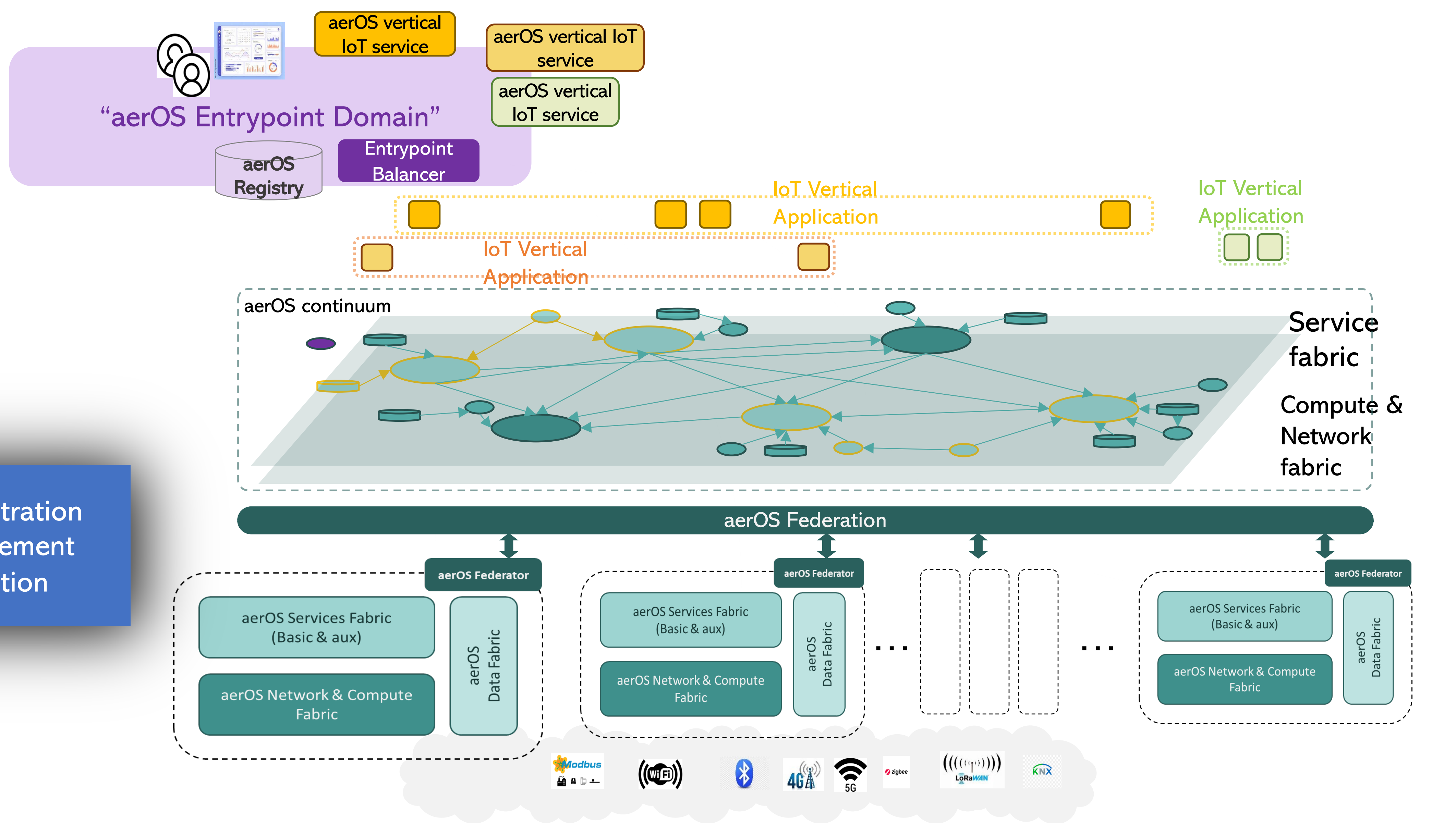
aerOS High Level Architecture



- ✓ Orchestration
- ✓ Management
- ✓ Federation

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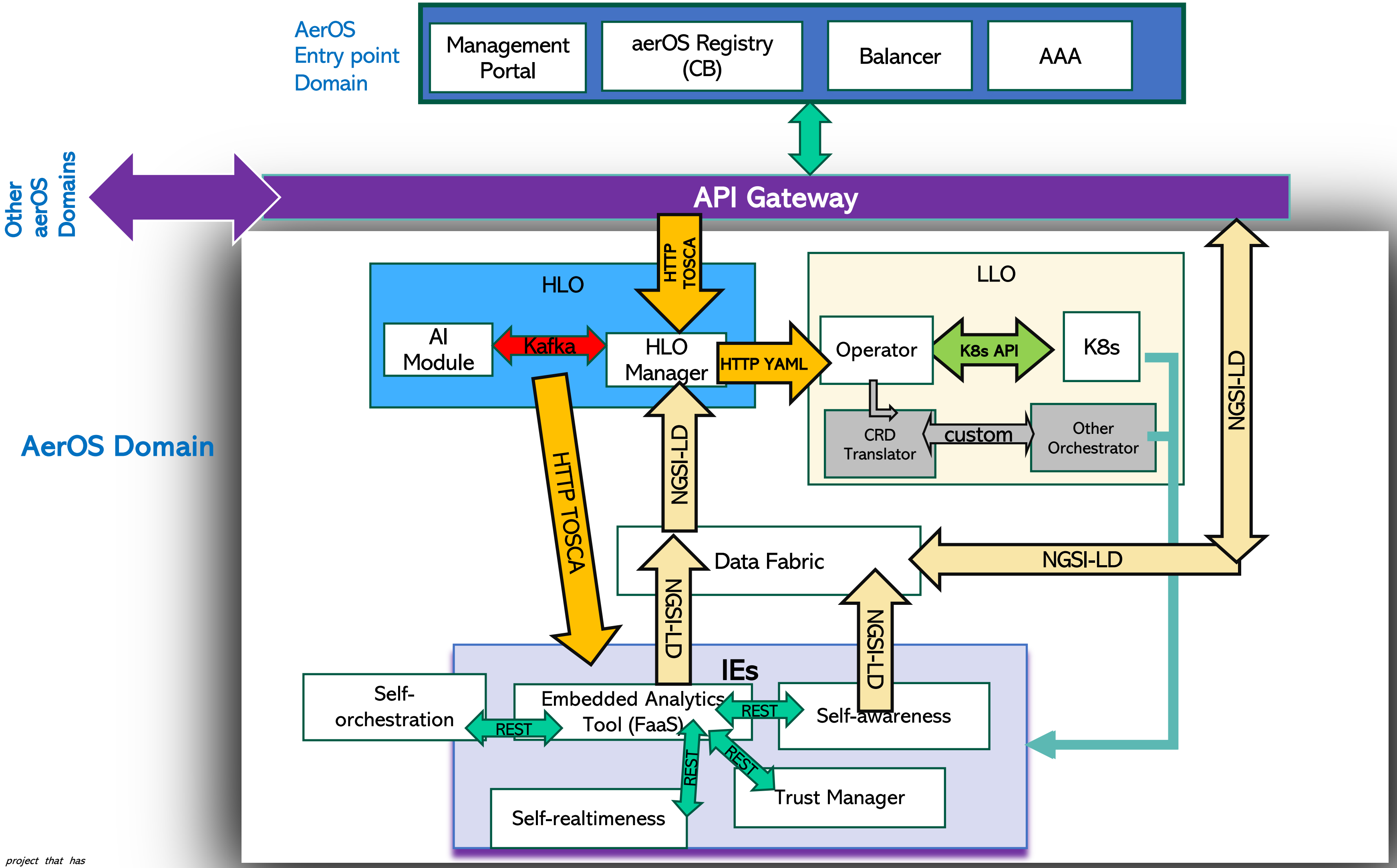

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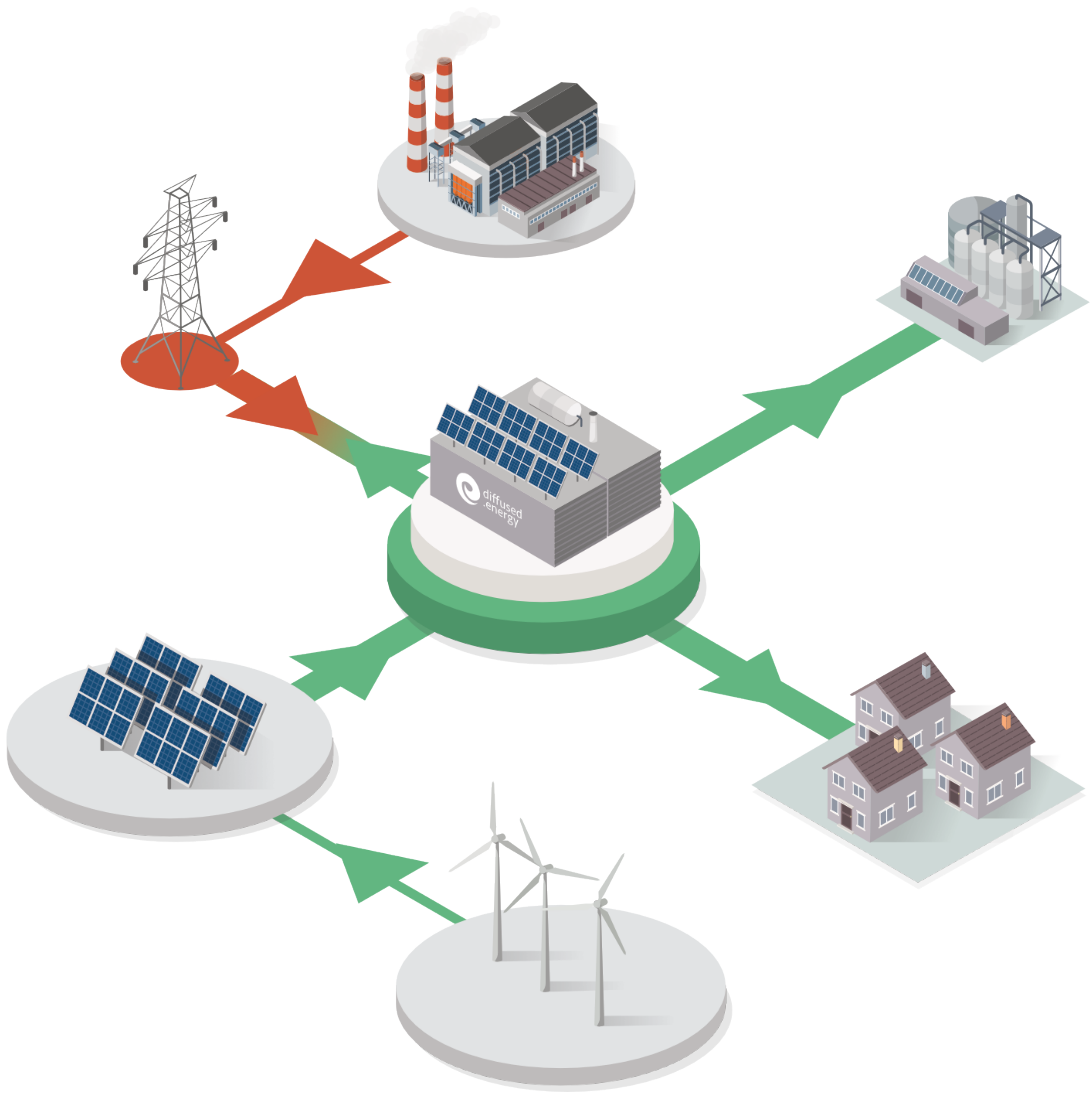
aerOS Pilot

High Performance Computing on Edge

KPIs & Evaluation Framework

Electrum Induce Ltd. September 2023

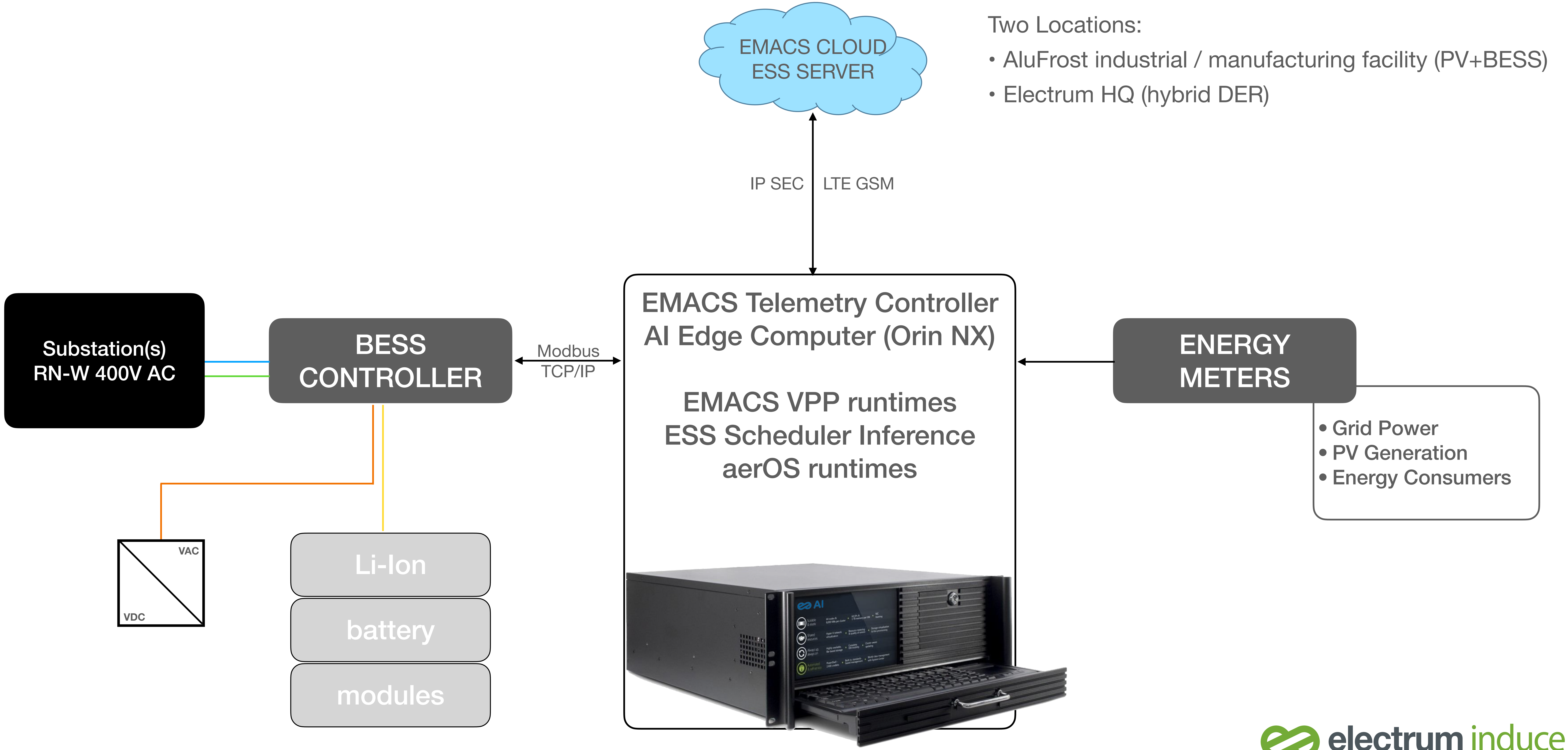
Pilot Project Description (DER Industrial Site)



The Electrum’s deployment of the aerOS pilot project is based on an advanced IT solution designed for distributed energy resources that allows for increasing energy efficiency and ensuring continuity in the cyber-secure data stream from IoT (sensors) through Edge (edge computers, data concentrators) to the Cloud.

The aim of the project is to examine metrics related to the energy efficiency and computational performance of a solution in which continuous machine learning processes use the computing power of an edge device installed directly on premises. In order to test the metrics/KPIs in the pilot, it is necessary to transfer data inference of the ESS Scheduler application to the edge computer with a neural network accelerator, such as the Electrum’s Industrial AI Edge Computer.

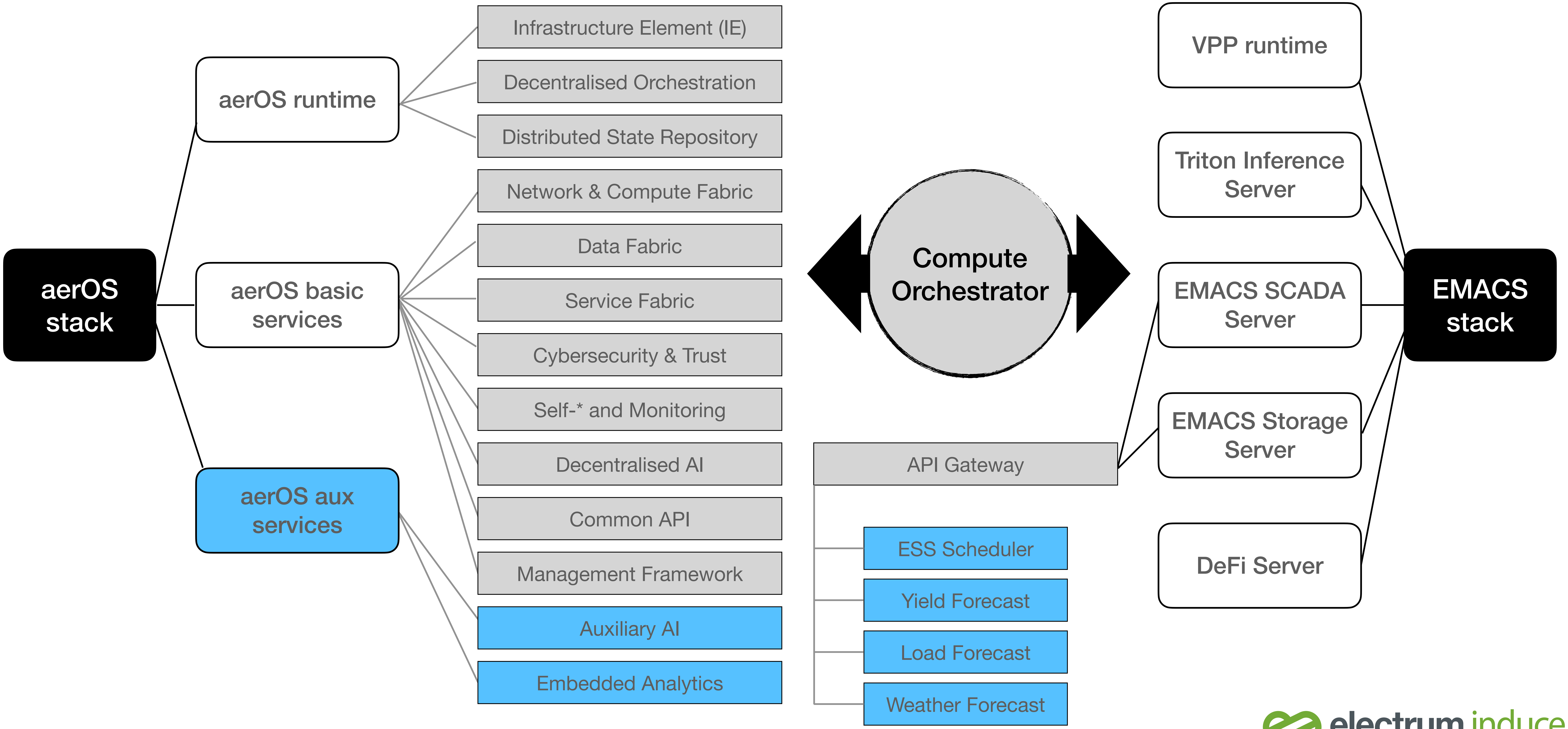
Pilot Project Diagram (DER Industrial Site)



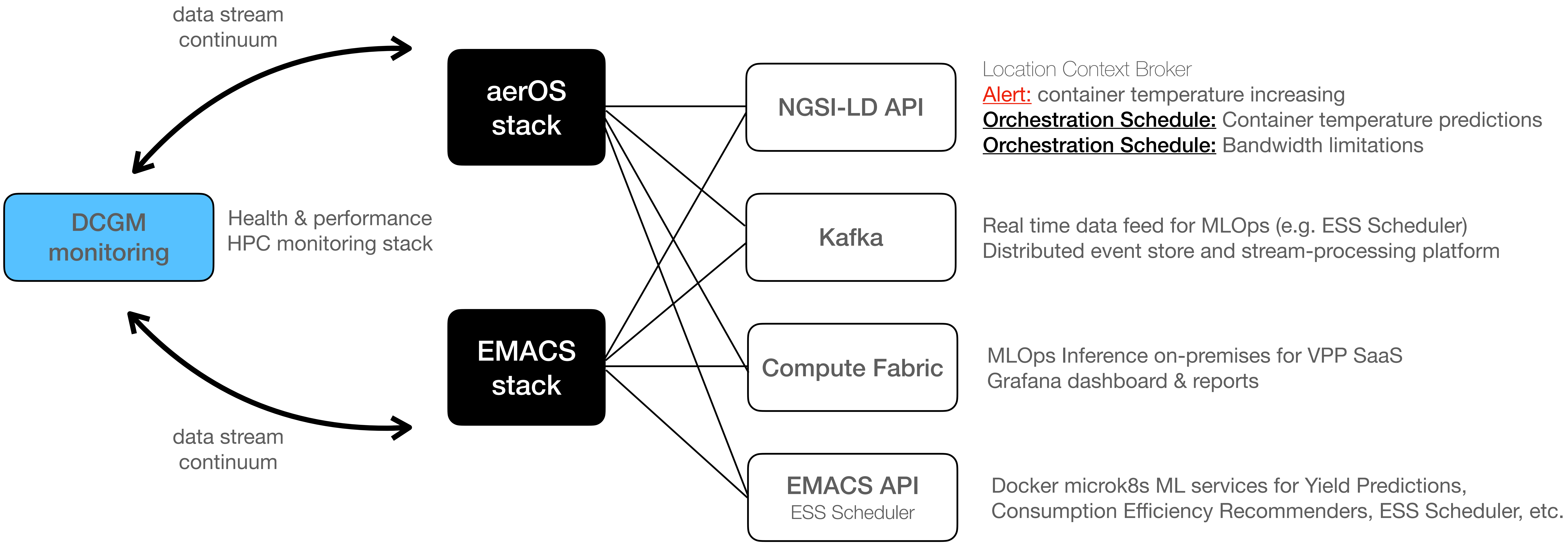
Two Locations:

- AluFrost industrial / manufacturing facility (PV+BESS)
- Electrum HQ (hybrid DER)

aerOS metaOS & EMACS VPP Integration



Evaluation Flow Diagram



Evaluation Framework

Comprehensive Evaluation Framework for Meta Operating Systems in Distributed IoT-Edge-Cloud Infrastructure.

In the rapidly evolving landscape of IoT-Edge-Cloud infrastructure, the development and deployment of meta operating systems play a pivotal role in ensuring efficiency, scalability, and resilience. To assess the effectiveness and suitability of these meta operating systems, a comprehensive evaluation framework is essential. This framework is designed to rigorously test and measure multiple technical, economical, and social key performance indicators (KPIs) to ensure that the meta operating system aligns with the evolving needs of modern distributed IoT-Edge-Cloud ecosystems.

The evaluation framework aims to achieve the following objectives:

Technical Evaluation:

- Scalability: Assess the system's ability to scale horizontally and vertically to accommodate a growing number of IoT devices and edge nodes.
- Reliability: Evaluate the system's uptime, fault tolerance, and failure recovery mechanisms.
- Security: Analyze the security measures in place to protect against cyber threats and data breaches.
- Latency and Responsiveness: Measure the response time and latency for data processing and communication within the infrastructure.
- Interoperability: Assess compatibility with various IoT devices, edge devices, and cloud platforms.
- Resource Efficiency: Evaluate resource utilization, including CPU, memory, and network bandwidth.

Economic Evaluation:

- Total Cost of Ownership (TCO): Calculate the overall cost of implementing and maintaining the meta operating system, including hardware, software, and operational expenses.
- ROI and Cost Savings: Assess the return on investment and potential cost savings achieved through the deployment of the meta operating system.
- Scalability Costs: Analyze how costs scale as the infrastructure expands.
- Resource Optimization: Measure resource utilization efficiency to reduce unnecessary expenses.

Social Evaluation:

- Usability: Evaluate the user-friendliness of the system, including configuration, monitoring, and maintenance.
- Accessibility: Assess the system's inclusivity and its ability to serve diverse user groups.
- Community Engagement: Gauge the level of community support, open-source contributions, and collaboration around the meta operating system.
- Environmental Impact: Analyze the environmental sustainability of the infrastructure and the meta operating system's contributions to reducing energy consumption.
- Ethical Considerations: Examine ethical aspects such as data privacy, consent, and responsible AI integration.

Evaluation Framework

Comprehensive Evaluation Framework for Meta Operating Systems in Distributed IoT-Edge-Cloud Infrastructure.

Methodology:
The evaluation framework employs a combination of quantitative and qualitative methods, including benchmarking, simulation, surveys, and real-world testing. It incorporates both laboratory-based assessments and field trials to ensure a comprehensive evaluation.

Key Performance Indicators (KPIs):
The evaluation framework defines a set of KPIs specific to each objective, allowing for precise measurement and comparison of meta operating systems. These KPIs are regularly updated to reflect the evolving needs of the industry.

Reporting and Decision-Making:
The results of the evaluation are presented in a clear and concise report that includes recommendations for improvement or adoption. Stakeholders can use this information to make informed decisions regarding the deployment and optimization of meta operating systems in their IoT-Edge-Cloud infrastructure.

Conclusion:
The Comprehensive Evaluation Framework for Meta Operating Systems in Distributed IoT-Edge-Cloud Infrastructure is a critical tool for assessing the technical, economic, and social viability of these systems. It ensures that meta operating systems not only meet technical requirements but also contribute positively to the broader ecosystem while being economically viable and socially responsible.

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Key Performance Indicators

AREA	INDICATOR	DESCRIPTION	UNITS
Technical	Healthchecks	System uptime [%], Cron Job Monitoring, Microservice Readiness Scans	%
	Latency	Average response time (ping) between IoT and Edge vs IoT and Cloud	ms
	HPC Performance	PFLOP/s constant measurement (DCGM), SQL DB for avg. 1hrs	PetaFlops
Economical	Energy Savings	Energy consumed by IoT-Edge-Cloud GPU system vs energy consumed by IoT-Cloud CPU system	kWh, %
	Bandwith Savings	MLOps data transfer: Edge-Cloud vs IoT-Cloud	Mb, %
	CAPEX Savings	TBD	
Social / Safety	Data Privacy		
	Data Security		
	Public Safety		

DRAFT

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