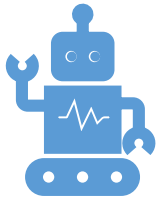
Use case of EVs fleet and Grid Optimization using Edge/Swarm Intelligence

HORIZON-CL4-2022-DATA-01-03 Programming tools for decentralised intelligence and swarms (RIA); Project: OASEES 101092702; Period: 01-01-2023 to 31-12-2025; EC contribution 7,9 mil. EUR.



Demonstrate the capability of deploying and coordinating the operation and management of swarms of IoT-based devices (e-vehicles), which will be coordinated and programmed through the OASEES SDK.

The EV fleet operator (Cloud operated) and respective EV drivers community manager (Edge operated), will **optimize EVs' recharging schedule** to address local technical requirements from the electricity grid operator, in presence of local congestion, or maintenance of electricity grid branches.

Support **trustworthy and robust** multi-party hybrid energy consumption **data sharing and governance** among DSOs, EV fleet operators and individual EV drivers, Charging Point Operator (CPO);

Provide **automated interaction** and coordination of smart contracts expressing individual EV drivers' preferences on daily routes and charging times through DLT/blockchain **decentralized marketplace. Reducing waiting times and optimizing energy grid load distribution.**

Technology Innovation

IoT and Real-Time Data Integration :

Sensors on the grid monitor power quality and usage in real-time.

MQTT Broker enables real-time data acquisition for live updates on charging stations.

Trend analysis and using Forecasting Tool.

Advanced Analytics:

Combines data from Wally three-phase analyzers, smart meters, and grid elements.

Forecasts electricity prices and energy consumption for electric vehicles.

Geospatial analytics to provide charging station location data and optimization.

emotion

dst.

ASM Terni S.p.A.

Available assets and infrastructure

ASM Terni buildings + 60 kW PV

180 kW PV

Power Quality Analyzers

Smart Meters

On-board Diagnostic Devices

3 Smart Charging Stations

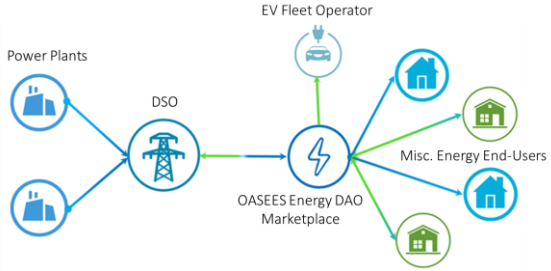
15 Electric Vehicles

Forecasting System for Electric Cars

- The energy forecasting module optimizes electricity grid operations through two main modules:
- **Training Submodule:**
  - Data Preparation: Process historical data and engineer features.
  - Model Training: Train and evaluate machine learning models.

- **Inference Submodule:**
  - Real-Time Predictions: Apply trained models to current data.
  - REST API Services: Expose predictions for integration with other systems.
  - Data Integration: Read from and write to external data sources.

- These modules aim to improve grid efficiency and support the integration of renewable energy sources



Electric mobility as flexibility provider

Pilot Benefits

Cost Savings for EV Fleet Managers:

- Optimization of EV charging schedules and locations based on real-time electricity prices and station availability reduces operational costs.

Increased Charging Station Efficiency:

- By dynamically routing EVs to the most efficient charging stations.

Scalable Business Model for eMSPs:

- The data product facilitates the business model of eMSPs by enabling them to offer competitive pricing, faster charging options, and strategic charging locations.

Reduction in Energy Costs:

- Utilizing forecasted data on PV production and grid availability allows for more cost-effective energy management, potentially reducing the overall energy costs associated with EV fleet charging.

Use case of Smart Energy harvesting and Predictive Maintenance Wind turbines using Disease Edge/Swarm Intelligence

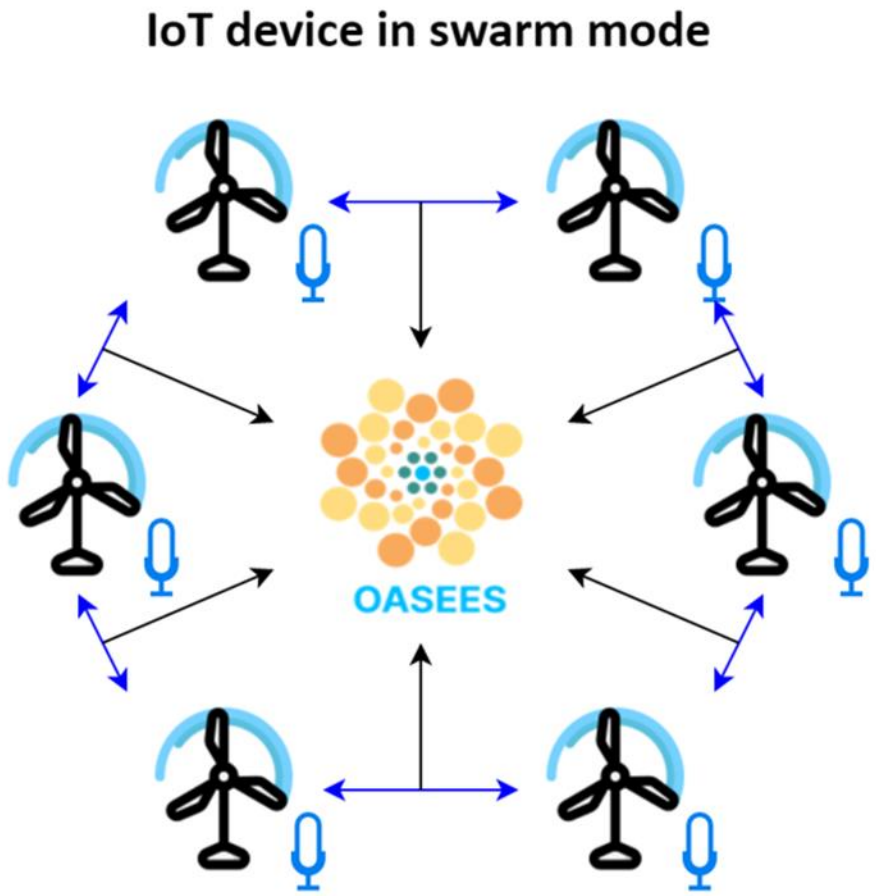
HORIZON-CL4-2022-DATA-01-03 Programming tools for decentralised intelligence and swarms (RIA); Project: OASEES 101092702; Period: 01-01-2023 to 31-12-2025; EC contribution 7,9 mil. EUR.

The use case aims to extend the capabilities of **wind turbines, to be able to function as an IoT device in swarm mode in order to reduce the costs of maintenance.**

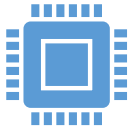
Simultaneous capture and data processing from several smart edge nodes at the wind turbines' location, reducing processing time.

The acquired data will be **processed at the edge**, and analyzed using machine learning algorithms so that the sensors are able to **learn from each other** (improved calibration, noise suppression, etc.)

Using federated learning based on cloud and edge nodes, to improve and obtain better metrics while optimizing the **failure prediction on the blades of the wind turbine**.



Technology Innovation



A decentralized swarm system for monitoring wind turbine blade acoustics using edge computing and neural networks.

Distributed learning algorithms process data locally on edge devices, reducing latency and ensuring **real-time anomaly detection.**

Leverages advanced signal processing methods to extract relevant features from acoustic data.

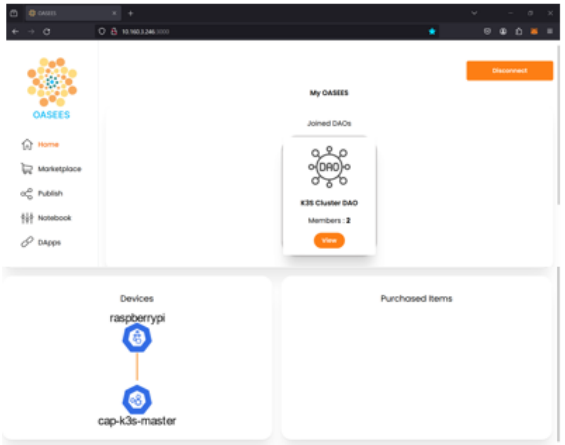
Capgemini

Economic Benefits

- Cost Reduction:
  - Reduces operational expenses by enabling predictive maintenance, minimizing unplanned downtime.
  - Lowers maintenance costs by detecting issues early through non-intrusive acoustic monitoring.
- Efficiency Improvements:
  - Improves wind turbine performance and longevity through proactive anomaly detection.
  - Reduces the need for costly manual inspections by enabling remote monitoring.

Pilot Overview Testbed - Demo

Step 1- OASEES On-Boarding



Step 2 – Swarm IoT Devices Detecting Blade Anomalies

Step 3 – Tech Report Elaboration and IPFS Storage

Use case of Smart Energy harvesting and Predictive Maintenance Wind turbines using Disease Edge/Swarm Intelligence

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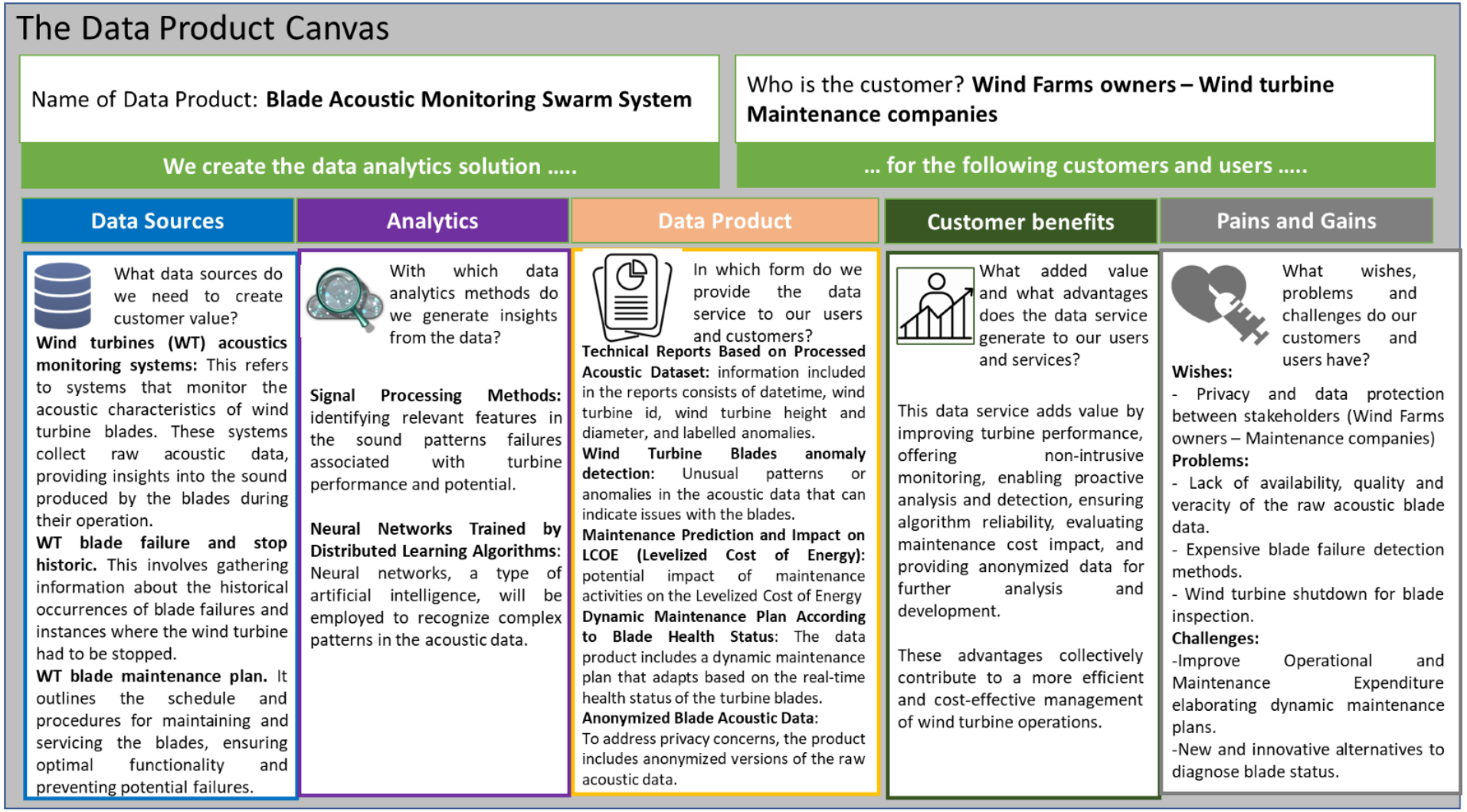


ENERGY USE CASE
Multi-level smart charging & Grid Balancing (EDP)

Rafael Oliveira Rodrigues
EDP NEW

TaRDIS Swarms projects workshop, Brussels
05/09/2024

Multi-level smart charging & Grid Balancing

Energy Concept

The Baseline for Grid energy has two inconveniences:

- expensive energy cost for customer
- carbon intensive sourced.

Solution (I):

Build Energy Communities

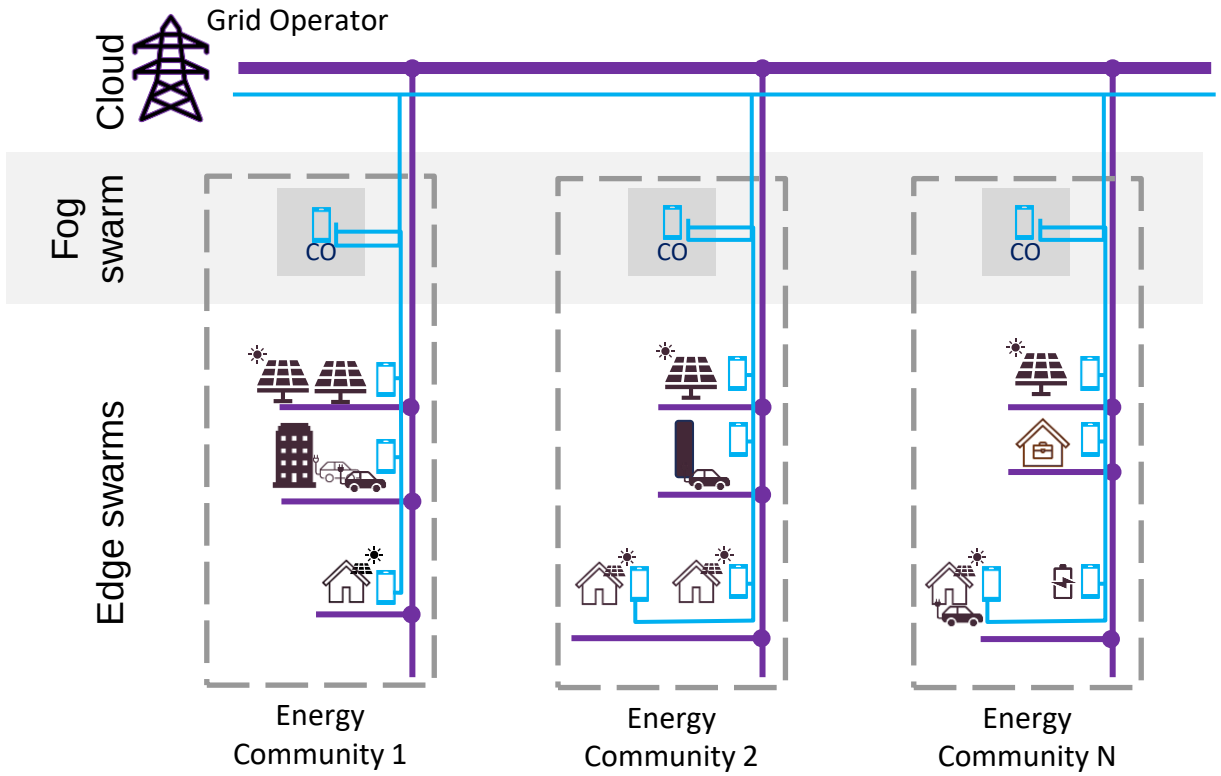
- Cheaper Energy since is coming from neighbour Renewables through micro-grids
- Almost carbon neutral
- Still can use main grid as backup

Inconveniences:

- Need a Community Orchestrator (CO) to managed deficit or surplus of energy and faults
- It Is complicated for the CO to manage all the members in the community

Solution (II):

Handle the peers in the Energy Community as a heterogeneous swarm and let them talk!



Multi-level smart charging & Grid Balancing

What does the swarm need to work?

- **Forecast** each peer energy consumption and production:

Fedra, a tool that enables the decentralized federated learning of ML models that are deployed locally on several edge devices (NKUA).

- Enable **reliable communication** support:

Babel, Java framework designed for developing distributed protocols, serving as the communication backbone (NOVA)

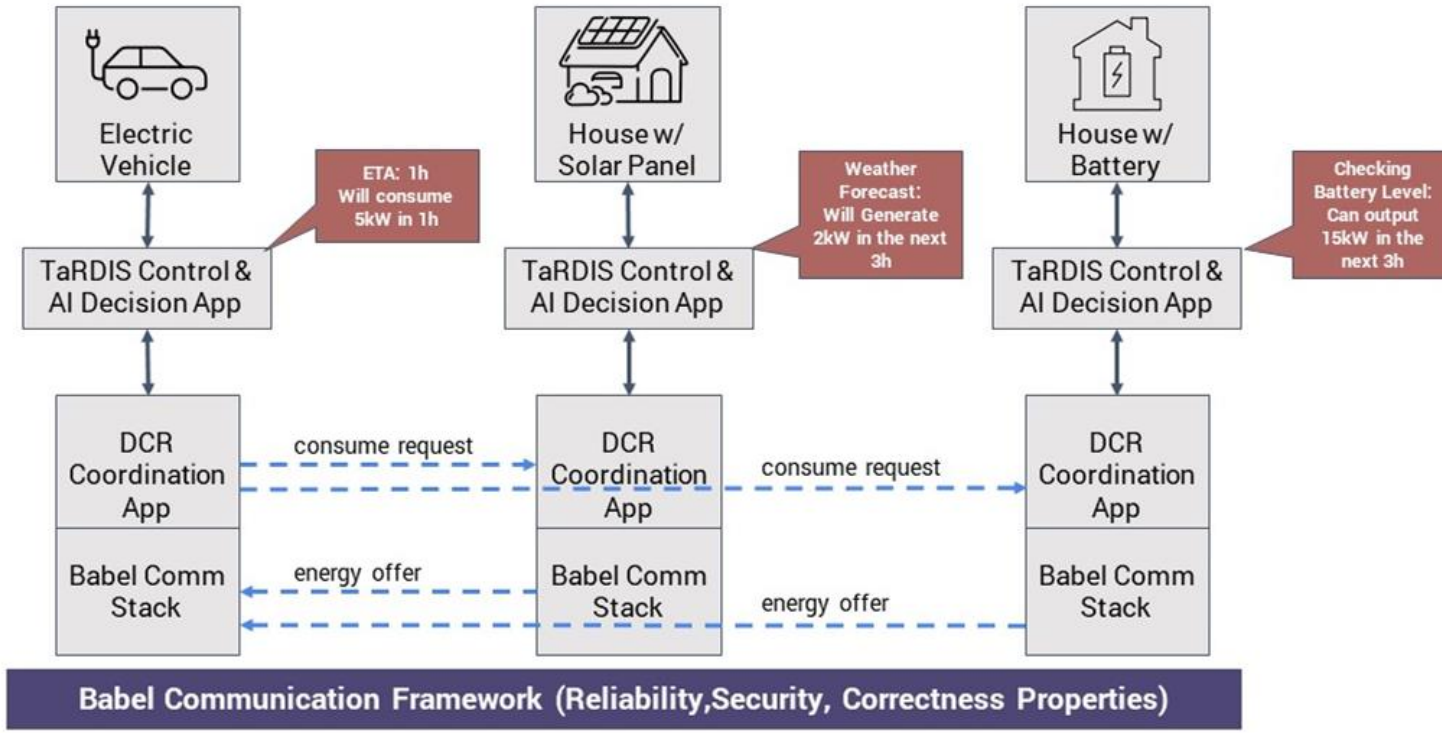
- Assure **security** within agreements:

IFChannel, an information flow analysis checks that secret data does not “flow” into less secret sources (DTU).

- Swarm **easily programmed**:

DCR choreographies, an event-based programming model (NOVA).

- Fail safe!



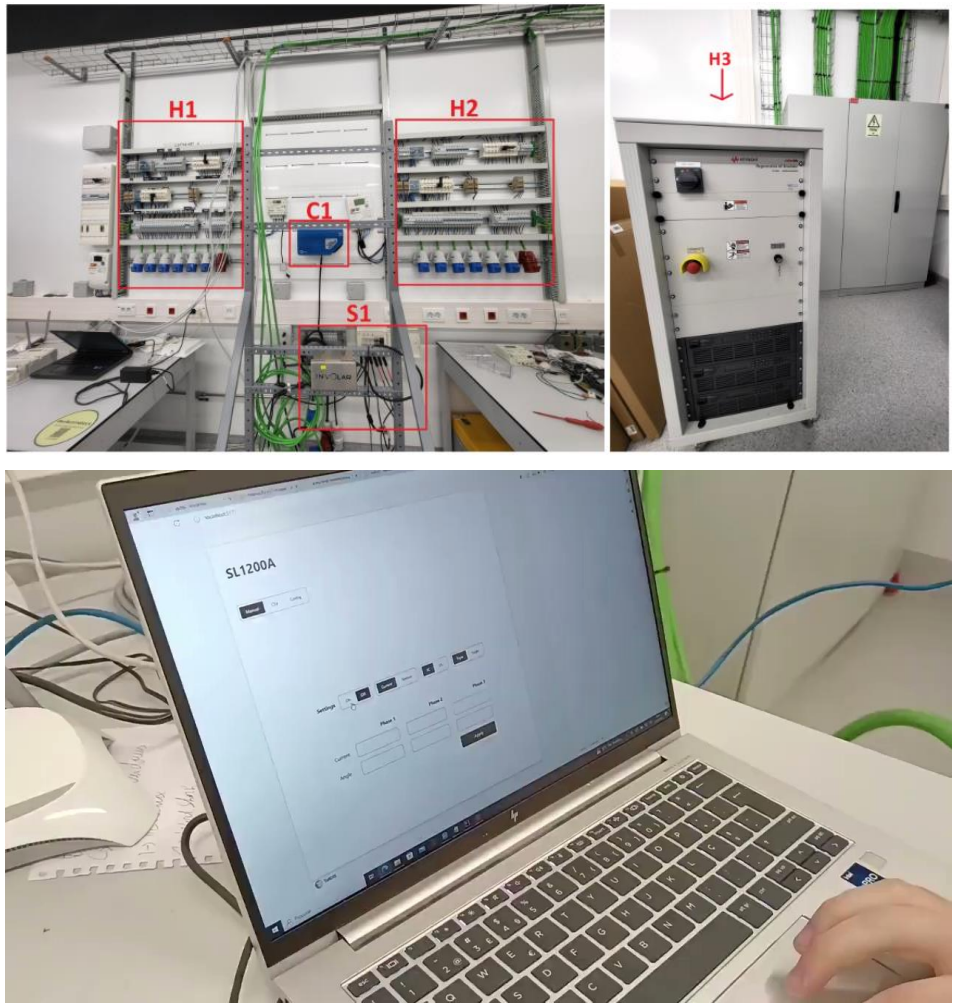
All of this is fulfilled by the TaRDIS toolbox!

Multi-level smart charging & Grid Balancing

Impacts and benefits

- Energy use within the community could **reduce** by **>30%** electricity coming from **carbon intensive sources** through the grid.
- The application of swarms to Energy communities' management **might reduce faults by >60%**

- **The Customers are empowered** to choose the best **trading** option : self-consumption, buy from grid vs from neighbour, discharge EV to home…
- **The Retailer/Aggregator** is in fact the **CO** the advantages are:
  - **1-** Moving its business from **HW** (home devices monitoring) to **SW** (overlay network management)– better margin and reducing asset management risk;
  - **2- Trading** (risk) is moved to the final user;
  - **3-** Ability to engage the storage elements, namely EVs, into **grid service** in a transparent way for customers.
- **The Grid Operators** will be able to improve QoS due to faster response of swarm agents at Fog level and better visibility about the resources available for grid service.



Use case testbed @ EDP LABELEC Smartlab

TaRDIS

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THANKS

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Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

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

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INCODE

AA1: LOGISTICS AND TRANSPORT QUALITY VALUE CHAIN

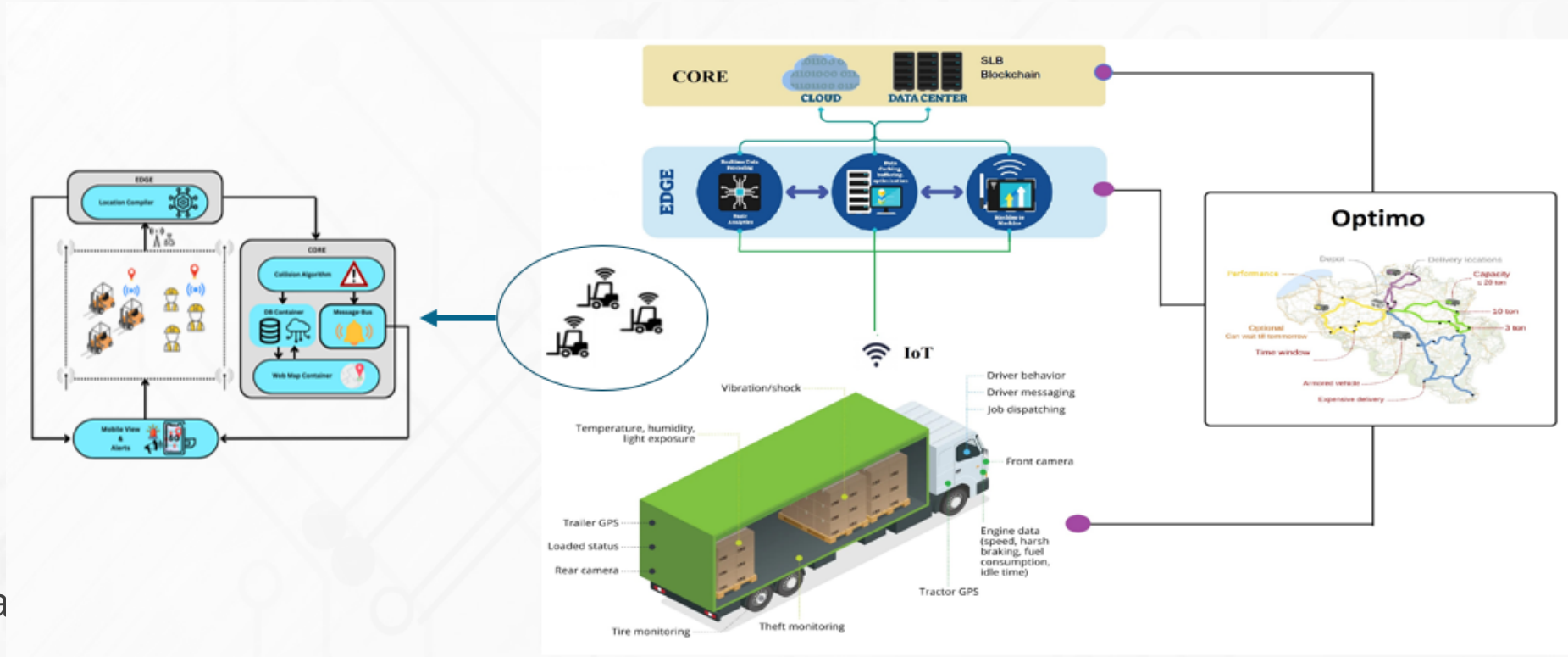
[iLINK New Technologies]

2024-09-05

incode-project.eu

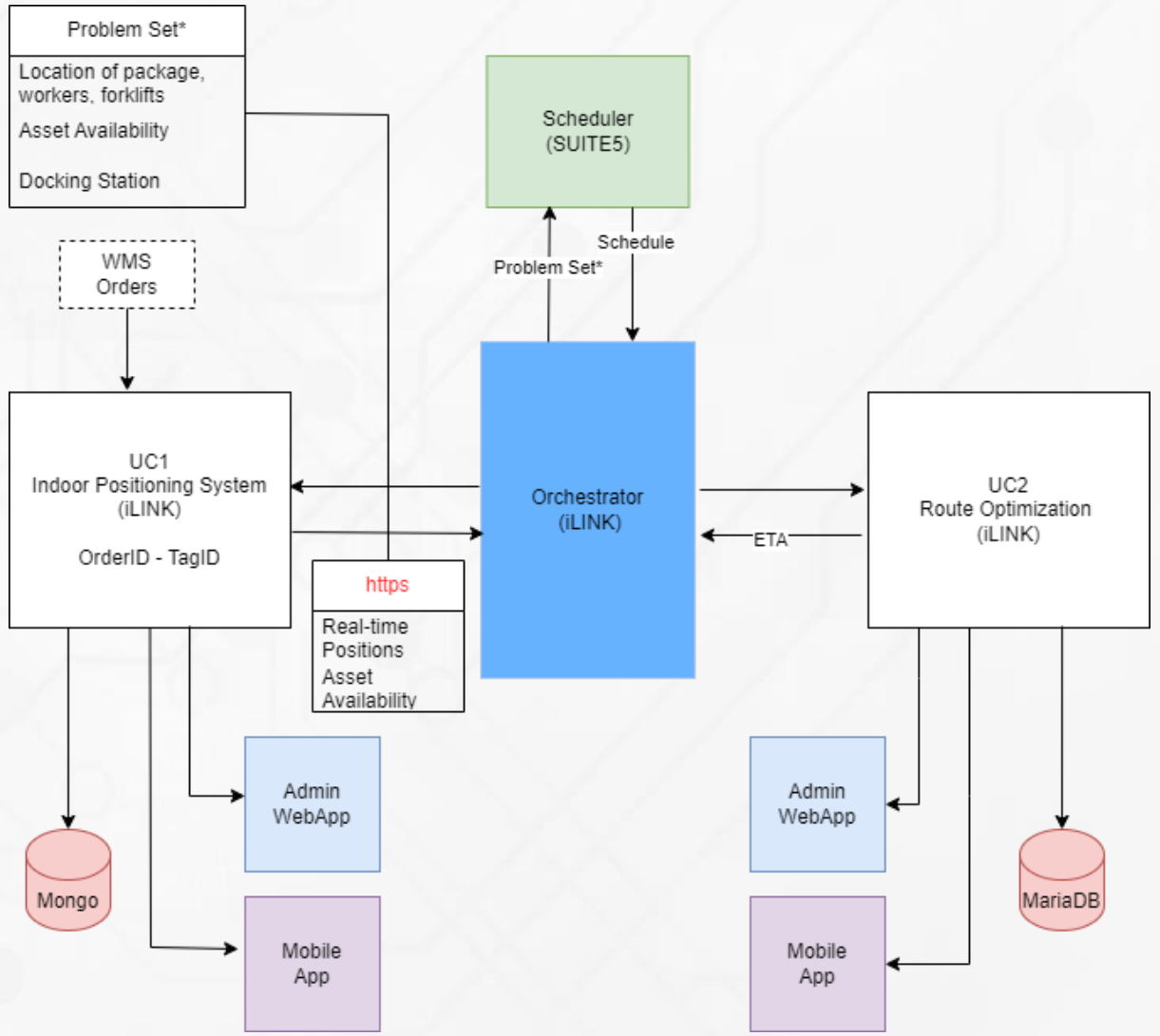
SMART LOGISTICS BEYOND SOTA

- Resources optimized utilization - advanced Route Optimization Algorithm (RaaS)
- Enhanced industrial infrastructures safety - sophisticated Collision Avoidance Algorithms
- Optimized Transport Quality and damage prevention of goods and products
- Edge computing exploited in terms of data exchange and decision-making



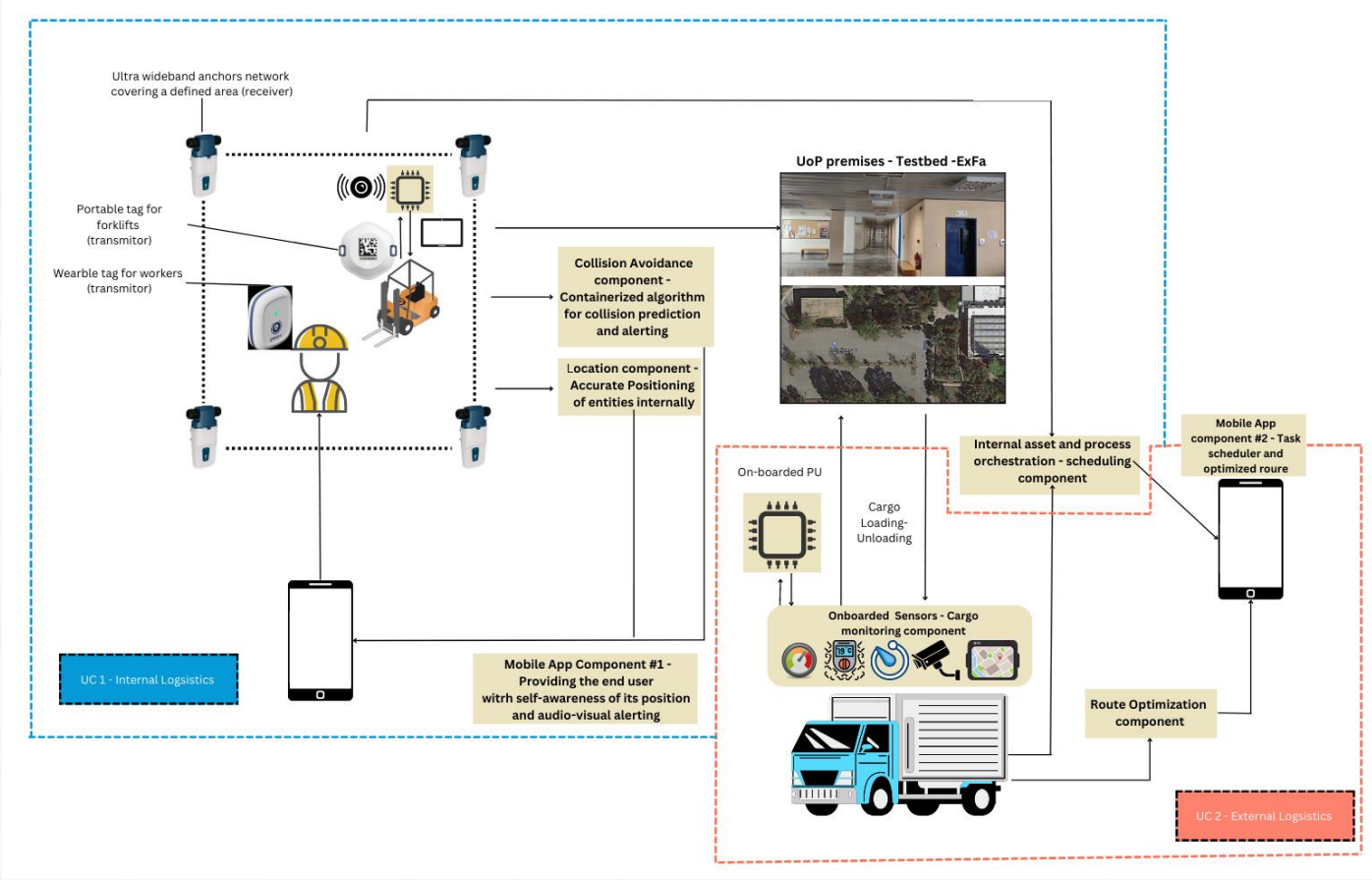
ENABLING TECHNOLOGIES

- 5G technology for reduced latency
- UWB for accurate location awareness
- IoT sensors for remote monitoring
- Far-edge computing for advanced decision-making
- Containerized software architecture
- INCODE's services and layers (Data management, Security, IDP, etc.)



BUSINESS VALUE OF AA1

- Location awareness of workers, forklifts, and packages lays the foundation for Digital Twin technology.
- Industrial smart safety proliferation enhances safety standards and Health, Safety, and Environment (HSE) compliance.
- Optimized operations scheduling improves resource utilization and cost-effectiveness.
- Route optimization and dynamic updates for load trucks based on transportation conditions and cargo sensitivity enhance efficiency.
- Real-time cargo monitoring and feedback increase added value across the supply chain.
- Supply chain innovation is driven by computer vision (CV) models and Far-Edge Computing.



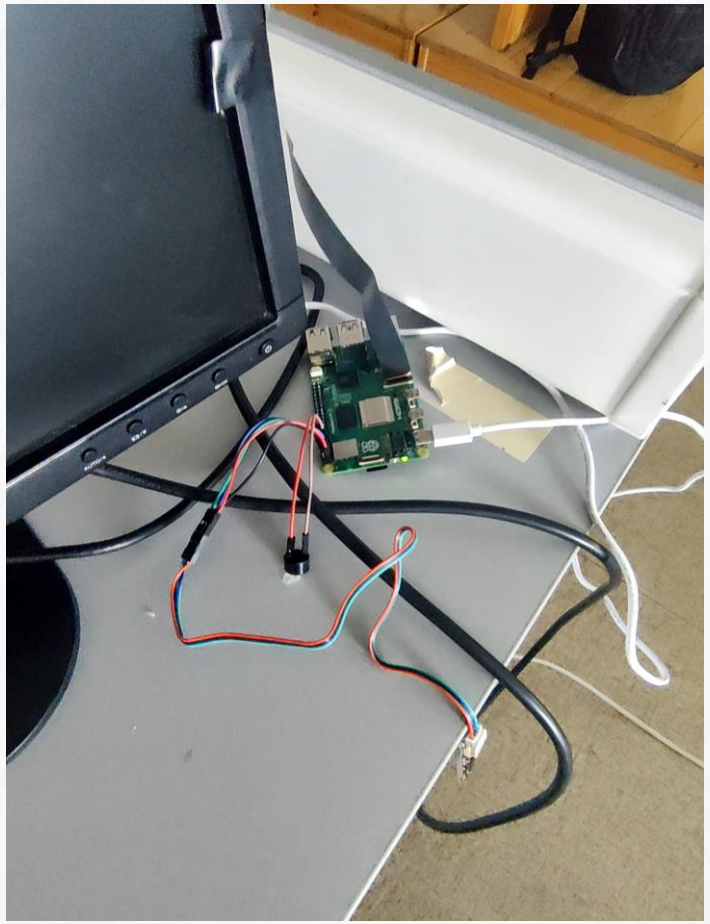
STAKEHOLDERS

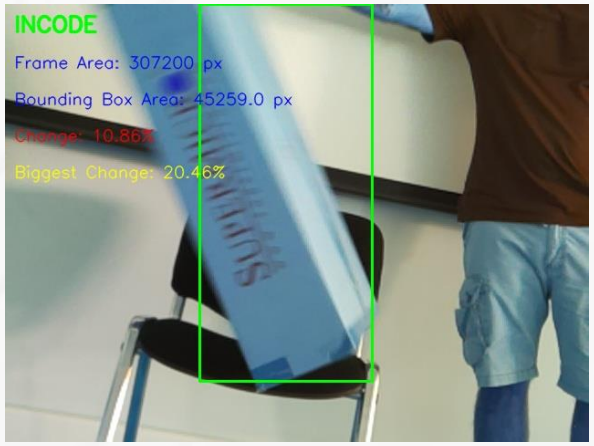
Industry Stakeholders:

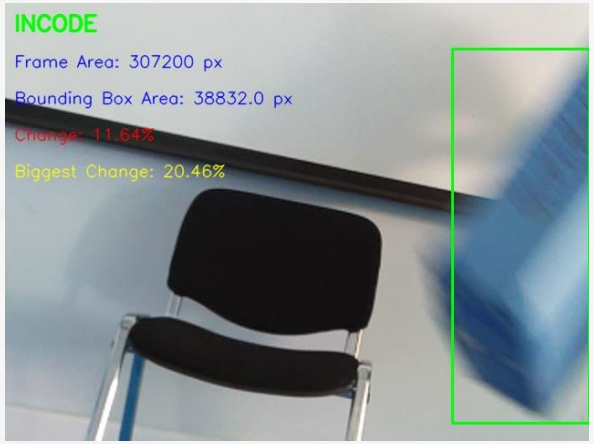
- Large Logistics operators with E2E supply management activities
- Warehouses with needs for advanced industrial safety
- standards
- Fleet operators
- Research Institutes
- Public and private sector entities

Internal Stakeholders:

- INCODE partners as technology providers across different layers
- Testbed provider (UoP)







INCODE

THANK YOU FOR YOUR ATTENTION

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Co-funded by the European Union

SmartEdge

Vehicle to Infrastructure Use Case

Kari Koskinen (Conveqs Oy), kari@conveqs.fi

SMARTEDGE Project

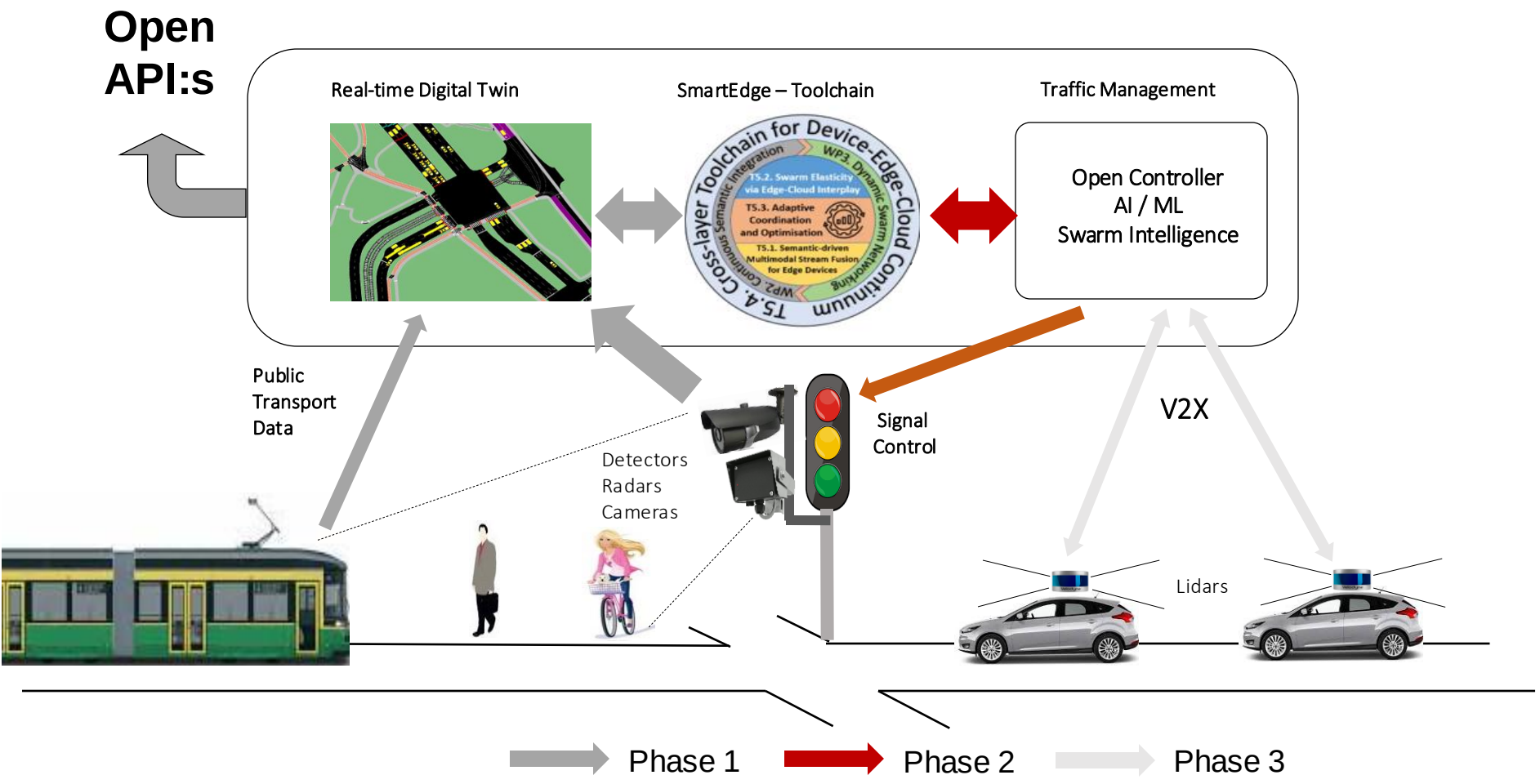
Grant No. 101092908

https://www.smart-edge.eu/

Why swarm intelligence in traffic management?

- State of the art traffic management is operating with very limited knowledge about the traffic conditions
  - Limited sensing capabilities (e.g. inductive loops)
  - Traffic controllers are monolithic and isolated in their operations
  - No semantic understanding of traffic conditions
  - Hardly any sharing of data
- Current developments in the market are promising
  - Sensing and computing equipment becomes cheaper and cheaper
  - Modeling, simulation, AI and other programming techniques are developing rapidly
  - Sensing equipment in vehicles is becoming ubiquitous
- Sharing of data swarm offer huge potential
  - Lower cost of installation (by using existing sensors in cars and infrastructure)
  - Understanding instead of individual data points

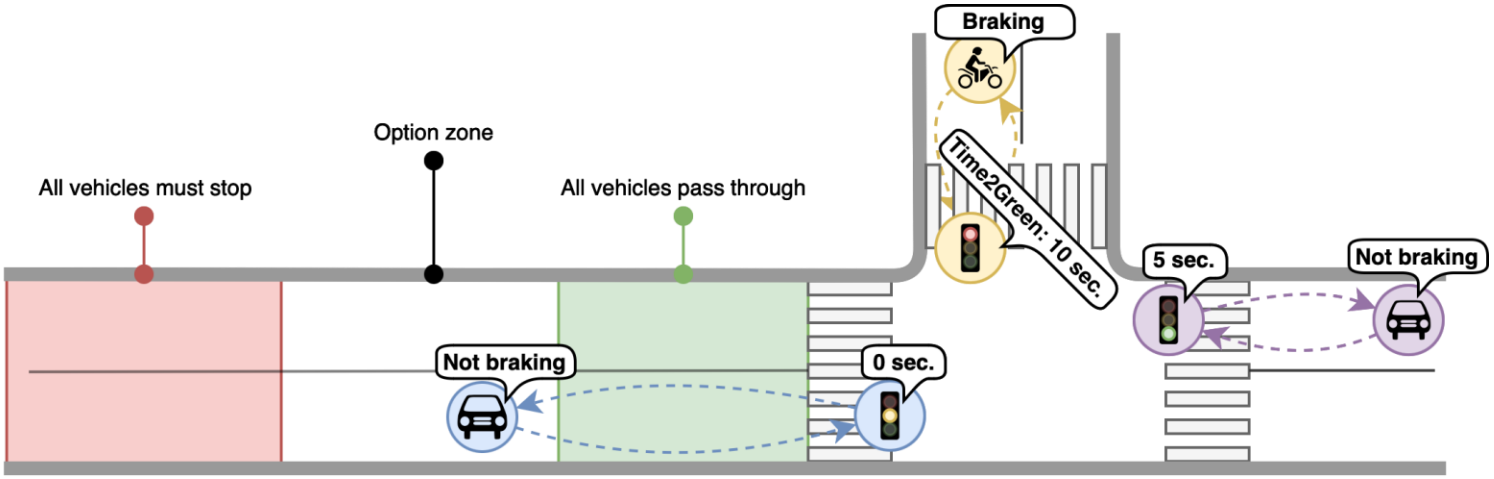
Background: SmartEdge as part of holistic traffic management



Picture: Iisakki Kosonen, Aalto University

Active option Zone management

- Goal is to implement safety functionality for traffic light operations
- This is only a simple example of functionality made possible by the connected vehicles and swarm intelligence



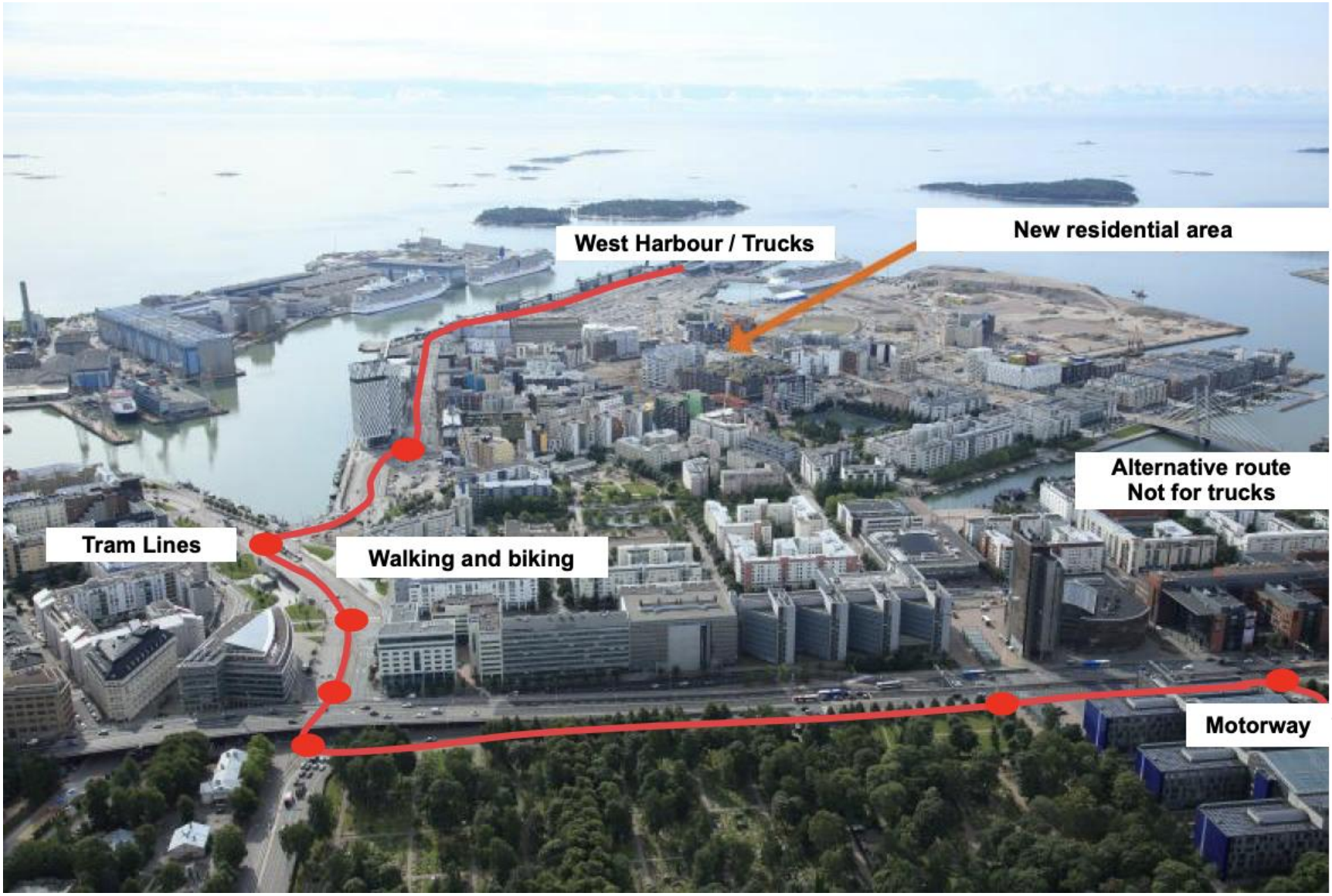
Technology innovation

- Semantic representation of traffic environment and conditions
  - Open Controller (an open source traffic controller developed by Conveqs and Aalto university)
  - V2X capabilities
  - Standards (WoT, SSN, SOSA, OpenXOntology, ETSI 5G, etc.)
- Sharing environment information between vehicles and infrastructure
  - Swarm formation
  - Data fusion
  - Trust networks
- Establishing two-way communication between infrastructure and road users
  - Currently only communication from infrastructure is traffic light (green or red), and single detection from vehicle to infrastructure
  - Wider array of data can be shared
- Hardware acceleration

Demonstration and field tests

- Lab tests
  - DELL infrastructure used for integration
  - Open source simulation environment (SUMO)
  - Data collected from the field infrastructure (Conveqs) and with instrumented cars (Aalto)
  - Winter 2024 - 2025
- Field tests
  - Will be carried out in Jätkäsaari test environment
  - Some 17 radars and cameras installed in the area (City of Helsinki, Conveqs)
  - Six intersections also connected to the system (Open Controller, field equipment)
  - In addition one or two instrumented vehicles will be used (Aalto)
  - Will be carried out in summer 2025

Jätkäsaari test area



Potential economic benefits

- Benefits of technologies developed in this project comes from:
  - Improved traffic flows (reduced time spent in traffic, reduced CO2 emissions)
  - Traffic safety (less accidents), and
  - Better informed decisions by the policy makers and road users
- Potential socio-economic benefits are very big, it is estimated *) that:
  - IoT solutions in centralized and adaptive traffic control can have 100 – 390 billion euros worth of socio-economic impact in 2030
  - Autonomous vehicles could capture 240 – 300 billion euros value in the same year
- Connected vehicles as well as swarm solutions are big part of any IoT solution
  - Isolation of current systems is the major problem in intelligent traffic operations
  - Most benefits can only be realized with co-operative systems capable of sharing data and resources
- However, it should be noted that most socio-economic benefits are consumer surplus

*) McKinsey: “The Internet of Things: Catching up to an accelerating opportunity”, November 2021

Lead parners

- Data collection, validation and field tests
  - DELL (integration), Aalto University (Instrumented vehicles)
- Semantic representation
  - Cerfiel, Aalto University, TUB
- Swarm formation and data exchange
  - CNIT, TUB
- Open data
  - TUB, W3C, Aalto
- Computing enhancements
  - Oxford, Universite de Fribourg, TUB

Acknowledgment

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https://www.smart-edge.eu/

SmartEdge

Use Case: Autonomous Mobile Robots for Smart Factories

Dai Bowden, Dell Technologies, david.bowden@dell.com

SMARTEDGE Project

Grant No. 101092908

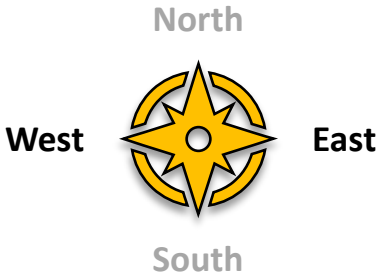
https://www.smart-edge.eu/

Why Use Swarms in Smart Factories

- Smart Factories
  - Smaller more flexible local factories
    - ✓ Closer to customers they supply
      - Reduced transportation CO^2 emissions
      - Shorter more robust supply chains
      - Easier to recycle component back into production
    - ✓ Larger range of products – smaller batch sizes
      - Dynamic production lines
      - Copes with indeterminant multi-agent environment
      - Similar costs
  - Enabling smart factory technologies
    - ✓ Robotic Flexible Assembly Cells (RFACs)
    - ✓ Autonomous Mobile Robots (AMRs)
    - ✓ Made up of swarms of intelligent edge devices called nodes
      - Peer-to-peer collaboration at the edge
      - Coming together to achieve a common goal
      - With minimal central supervision
      - Some degree of local problem-solving ability
      - Heterogeneous devices contributing different capabilities and skills
      - Communicating using common semantics interfaces

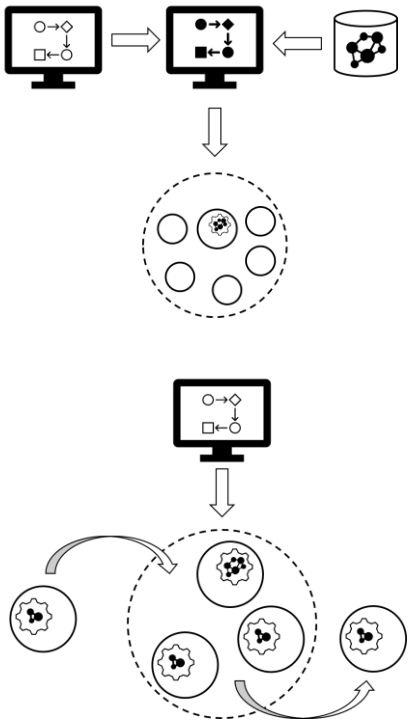
Humans are messy

Dell Technologies' use case



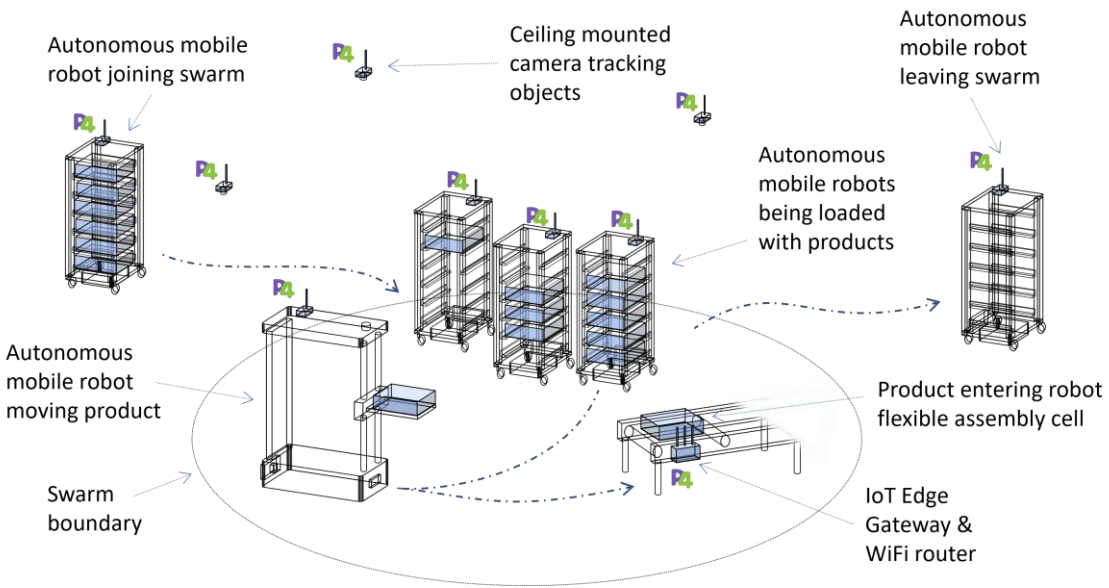
Static bound and dynamic swarm

- SmartEdge supports several types of swarm
  - Statically bound swarms
    - ✓ Swarm nodes defined at design time and allocated to swarm
    - ✓ Nodes remain with the swarm throughout its operational lifespan
    - ✓ Useful for supporting brownfield devices and backwards compatibility
  - Dynamic swarms (goal oriented) ← Manufacturing use case
    - ✓ Swarm starts with a seed node around which the swarm forms
    - ✓ Devices are actively enlisted into the swarm to provide skills the swarm needs to fulfil its goal
      - Make use of swarm contracts to enlist devices into swarm
    - ✓ Swarm nodes remain independent agents and can leave the swarm if required
      - e.g. battery level running low
    - ✓ When the goal is achieved the swarm brakes up
      - But with a little bit of stickiness
  - Dynamic swarm (device oriented) ← Traffic use case
    - ✓ Similar to goal oriented swarms but more for the benefit of the individual device
    - ✓ Requires a certain number of core swarm nodes
    - ✓ Devices request to join the swarm because it provides a benefit to them
      - e.g. faster transition through road traffic junctions



AMRs vs AGVs

- AGVs - Automated Guided Vehicles
  - Been in our factories for decades
  - Tend to follow predefined routes
  - When they encounter an obstacle
    - ✓ they stop
- AMRs – Autonomous Mobile Robots
  - Newer addition to our factories
  - Can navigate their environment
    - ✓ typically using SLAM
  - Limited intelligence to avoid obstacles



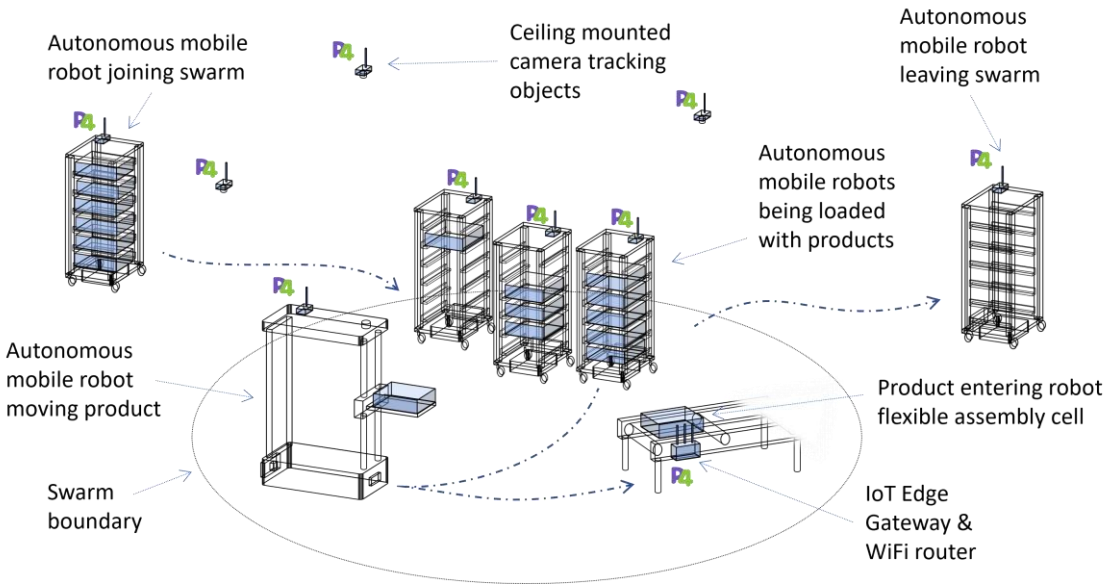
- SmartEdge AMRs
  - Form swarms of AMRs that collaborate in achieving a common goal
  - Use semantic integration to communicate within the swarm
  - Use semantic SLAM to better understand their environment
    - ✓ And modify their behaviour appropriately

SLAM: Simultaneous localization and mapping

Semantic SLAM: arXiv:2201.11625: SemRob: Towards Semantic Stream Reasoning for Robotic Operating Systems

Heterogeneous Swarm Devices

- SmartEdge supports different edge devices
  - With different skills and capabilities
  - e.g. ceiling mounted cameras or flexible assembly cells
- Swarm nodes can borrow sensor streams and even environmental 3D models from other nodes
  - And even share data processing task between swarm nodes
- Much of the swarm formation and management is handled in the network layer
  - Developed in the P4 network programming language

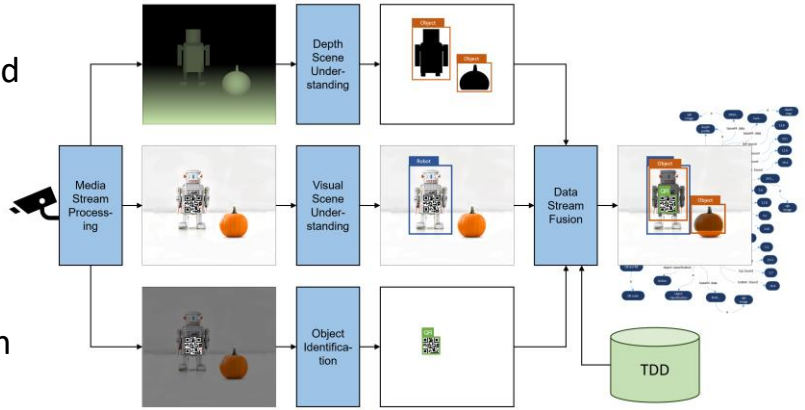


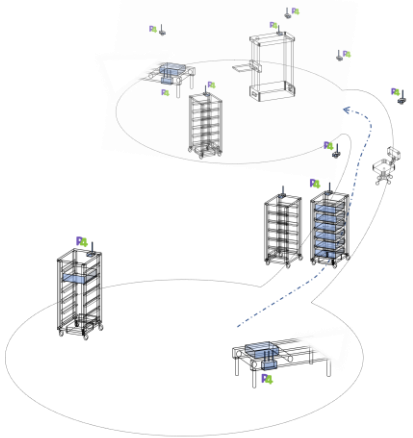
Web of Things

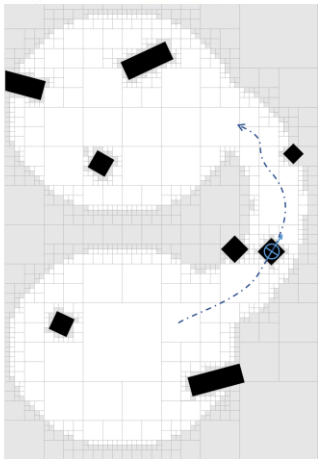
- Web of Things (WoT)
  - A set of guidelines and standards coordinated by the W3C
  - Used to model the nodes in the swarm in terms of their:
    - ✓ Properties
      - e.g. a thing's location or what skills it has
    - ✓ Action – operations that can be performed on a thing
    - ✓ Events – notifications that can be emitted by a thing
  - Can be used to construct a digital twin of the thing
- Can also be used to model other things in the environment that the swarm nodes interact with
  - Objects
  - Other independent agents
    - ✓ e.g. people
- The properties, actions, and events are grouped together into a Thing Description (TD)
  - And the TDs are stored in a Thing Description Directory (TDD)
  - SmartEdge makes extensive use of the TDD to build swarms
  - TDDs can be a central resource or implemented as distributed replicas

A Common Scene Understanding Between Swarm Nodes

- Swarm nodes comprehend their environment by building scene understanding graphs of what is around them
  - Each swarm node can have a different perspective
  - And augmented with thing descriptions from the TDD
    - ✓ Which provides additional context
- The scene graphs are shared between swarm nodes in real-time
  - And can be used to build 3D models of the environment
    - ✓ Which can also be shared with other nodes in the swarm
- This will enable a blind AMR (no sensors) to navigate around the factory by utilising semantic data feeds from other swarm nodes
  - A 3D semantic environmental model can be converted into a 2D occupancy grid used for navigation of the AMR
  - Or modify its behaviour depending on the type of obstacle
    - ✓ People can be asked to move – caster chairs could be pushed

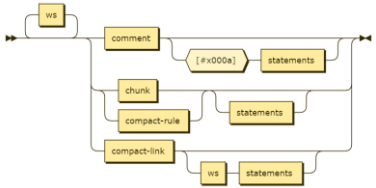






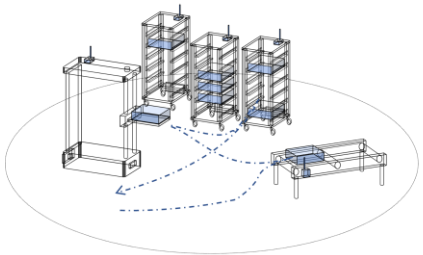
Swarm Node Collaboration

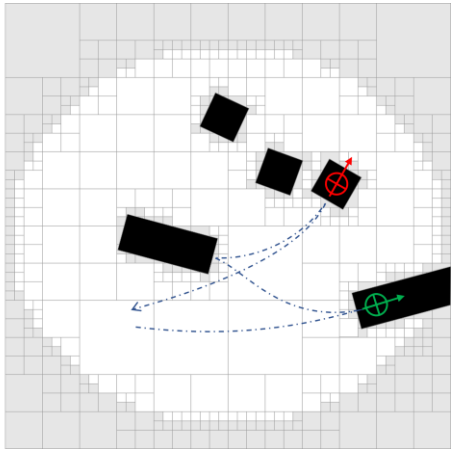
- Nodes in a swarm can communicate and collaborate to achieve a common goal
  - e.g. moving products from flexible assembly cells into autonomous mobile racks
- The actions performed by the swarm nodes are coordinated by an orchestrator
  - The orchestrator is just a node in the swarm with the right set of skills
  - Orchestrator can execute a plan implemented in W3C's Chunks & Rules
    - ✓ Or other rules engine

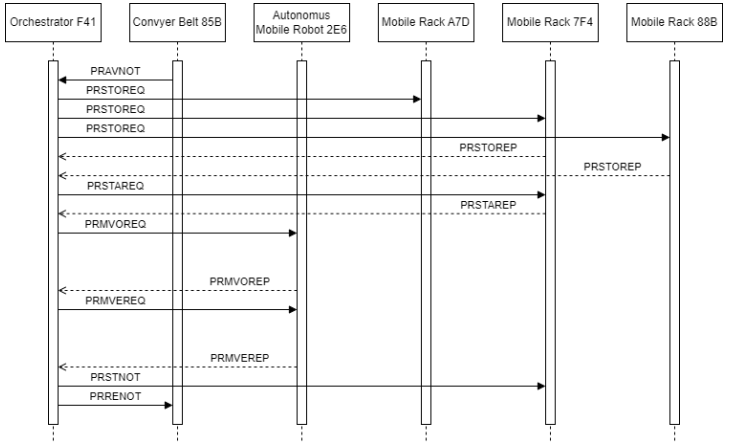


https://w3c.github.io/cogai/

- Swarm nodes exchange messages and negotiate actions between themselves

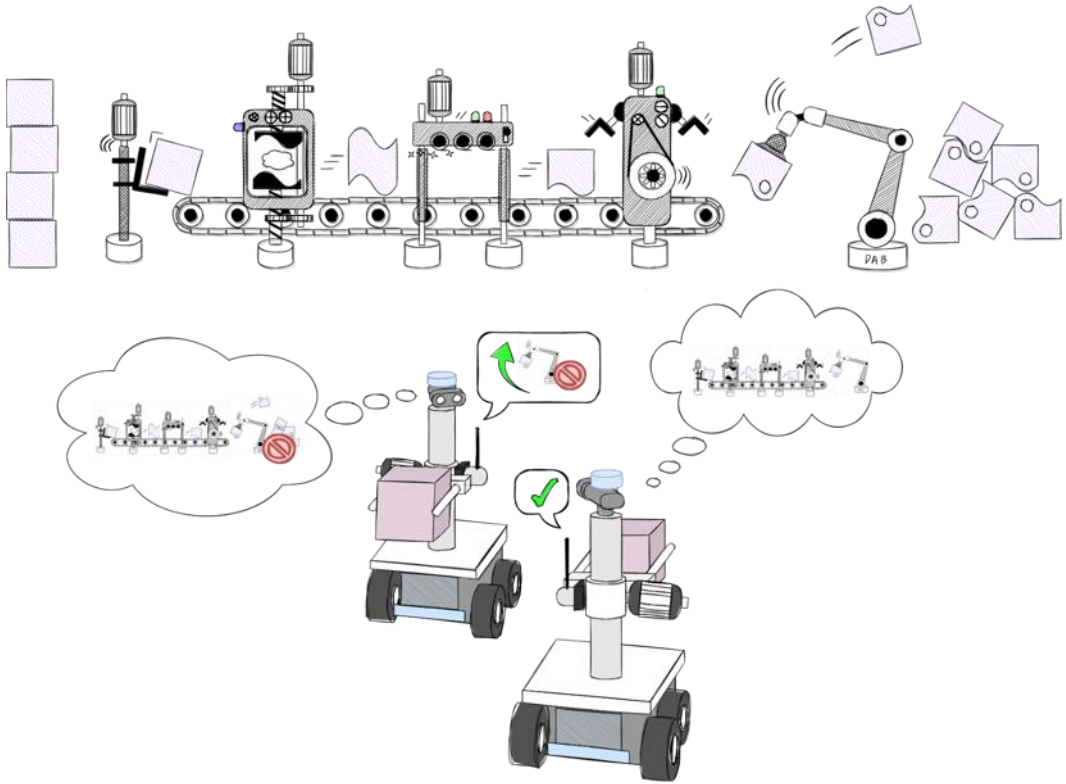






Summary

- We need more flexible, adaptable, and productive smart factories
- Swarms of autonomous mobile robots can help implement smart factories and cope with uncertain environments
- Different types of swarms can be used for different use cases
- Swarm nodes share semantic information to have a better understanding of their environment
- Swarms enable collaboration between nodes in a trusted and safe manner to achieve common goals



This project is supported by the European Union's Horizon RIA research and innovation programme under grant agreement No. 101092908 (SMARTEDGE)

https://www.smart-edge.eu/

AI-IoT Edge-cloud and platform solutions for energy

Svetoslav Mihaylov
Internet of Things
DG CNECT
European Commission

Swarms projects workshop , 5 Sep 2024

HORIZON-CL5-2023-D3-01-15

Supporting the green and digital transformation of the energy ecosystem and enhancing its resilience through the development and piloting of AI-IoT Edge-cloud and platform solutions

- Decentralised environment in the energy sector
- Large-scale validation (+ open call) in a real environment and market uptake
- Cloud-Edge continuum, edge and swarm computing, federated AI/ML, IoT
- Innovative data-driven energy services
- Open Source solutions
- Standards
- Distributed renewable energy, bi-directional EV charging, smart buildings
- Compliant to the common European data spaces (energy, mobility)
- Based on existing EU solutions (e.g. MetaOS and swarms projects)
- Target TRL 7-8 from initial TRL 5-6
- Two projects - Odeon and Hedge-IoT

ODEON

FEDERATED DATA AND INTELLIGENCE ORCHESTRATION & SHARING FOR THE DIGITAL ENERGY TRANSITION

at a glance

5 pilot sites

Distributed in 5 different EU member states

48 months

Starting in January 2024
Ending in December 2027

34 partners

From 13 different member states

Total budget: 22.56 M€
Total funding: 17.87 M€

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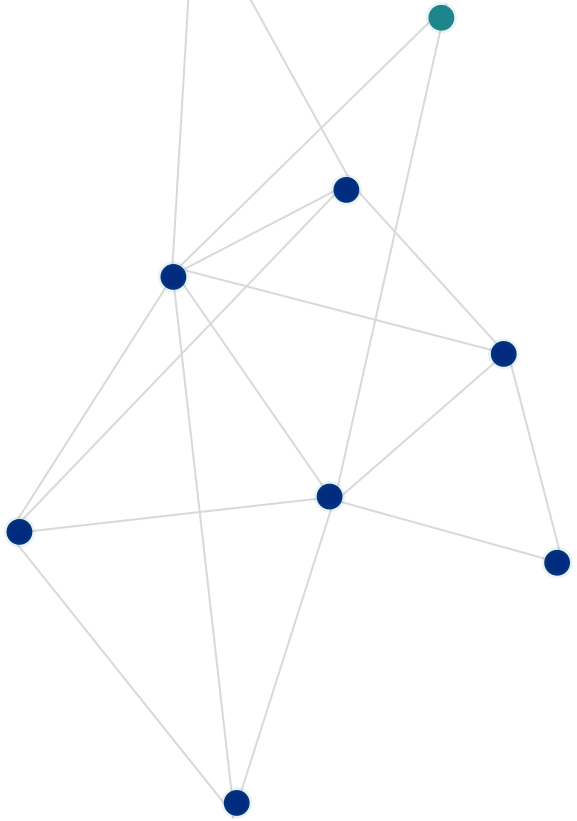


ODEON

partners

etra I+D

ΕΠΙΣΕΥ ICCS

EVIDEN

DTU

Fraunhofer FOKUS

Suite5 We Deliver Intelligence

UBITECH ubiquitous solutions

UBITECH digitizing energy

tecnalia MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

INTRACOM TELECOM

GRUPPO Maggioli

HEDNO

UPC UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

JOANNEUM RESEARCH LIFE

SPACE

Sagemcom Odit-e

circe Creating together

IES

InQbit Innovations

sicae

pi Prospex Institute

Cuerva*

vergy

Fuinneamh Oileáin Árann Aran Islands Energy

TREFOR El-net

barbara

HPΩN

INTERNATIONAL DATA SPACES ASSOCIATION

logikers

ARTHUR'S LEGAL

EWII

FundingBox

EPL TECHNOLOGY FRONTIERS

European Commission

ODEON goals

Technology innovation goals

ODEON aims to revolutionize the **Green and Digital Energy transition** through the creation of an inclusive ecosystem of stakeholders characterized by the **integration of a mesh of Data, Intelligence, Service, and Market flows in the energy system**. ODEON enables the resilient operation of the energy system considering the increased **RES integration**, and the effective orchestration of **the flexibility from assets residing at the edges of the system (edge-computing).**

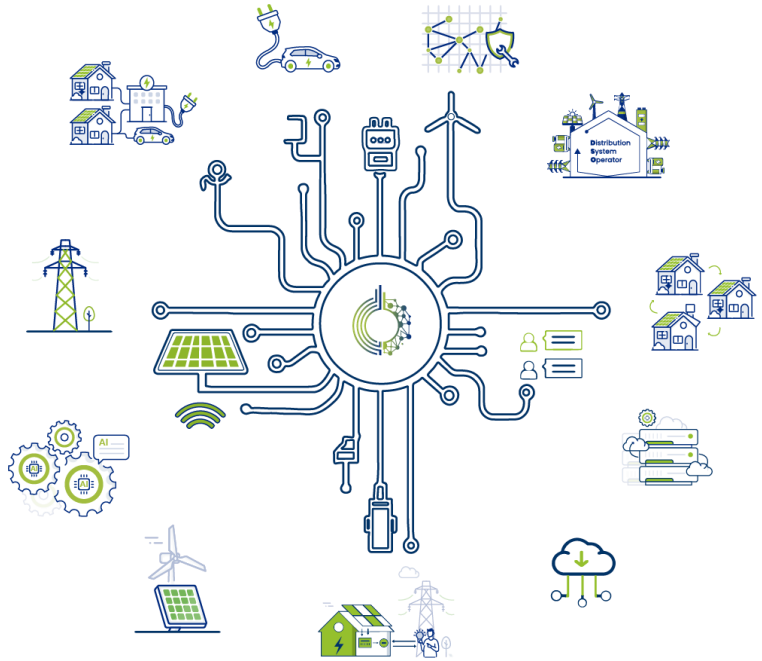
01 **To promote a highly distributed open framework for orchestrating federated data management, sharing and intelligence**

02 **To deliver innovative energy services enhancing grid resilience and decentralized flexibility**

03 **To encourage data exchanges by fostering technical and semantic interoperability**

04 **To promote a decentralized environment in the energy field**

05 **To provide intelligence-enabled solution and services driven by data to achieve energy transition goals**



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ODEON goals

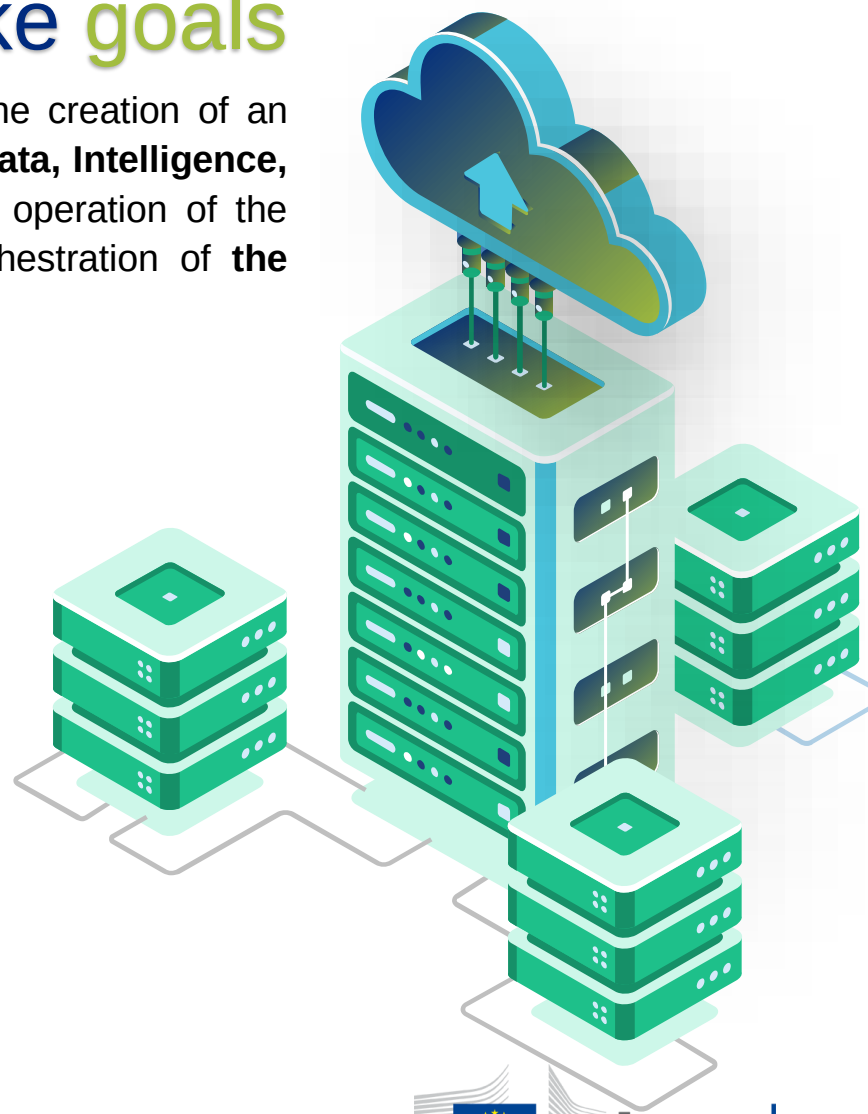
Business innovation and Market Uptake goals

ODEON aims to revolutionize the **Green and Digital Energy transition** through the creation of an inclusive ecosystem of stakeholders characterized by the **integration of a mesh of Data, Intelligence, Service, and Market flows in the energy system**. ODEON enables the resilient operation of the energy system considering the increased **RES integration**, and the effective orchestration of **the flexibility from assets residing at the edges of the system (edge-computing).**

01 **To demonstrate and validate the concept in 5 large-scale demonstrators across real-life and critical conditions**

02 **To prepare the grounds for the successful replication and market uptake**

03 **To promote ODEON as a reference Cloud-Edge Data and Intelligence enabler for the Green and Digital Transition through intense dissemination and knowledge transfer**



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ODEON innovations

ODEON Cloud-Edge Data and Intelligence Service Platform

Reference Energy Data Spaces implementation around energy data

ODEON Catalogue of AI Artefacts

Machine-Learning mechanisms for orchestration of devices

ODEON Energy services for DSO

- Flexibility-based Network Management
- Dynamic Power Flow Management and Quality restoration
- Network Planning and Reinforcement Assessment
- Asset management and Predictive maintenance

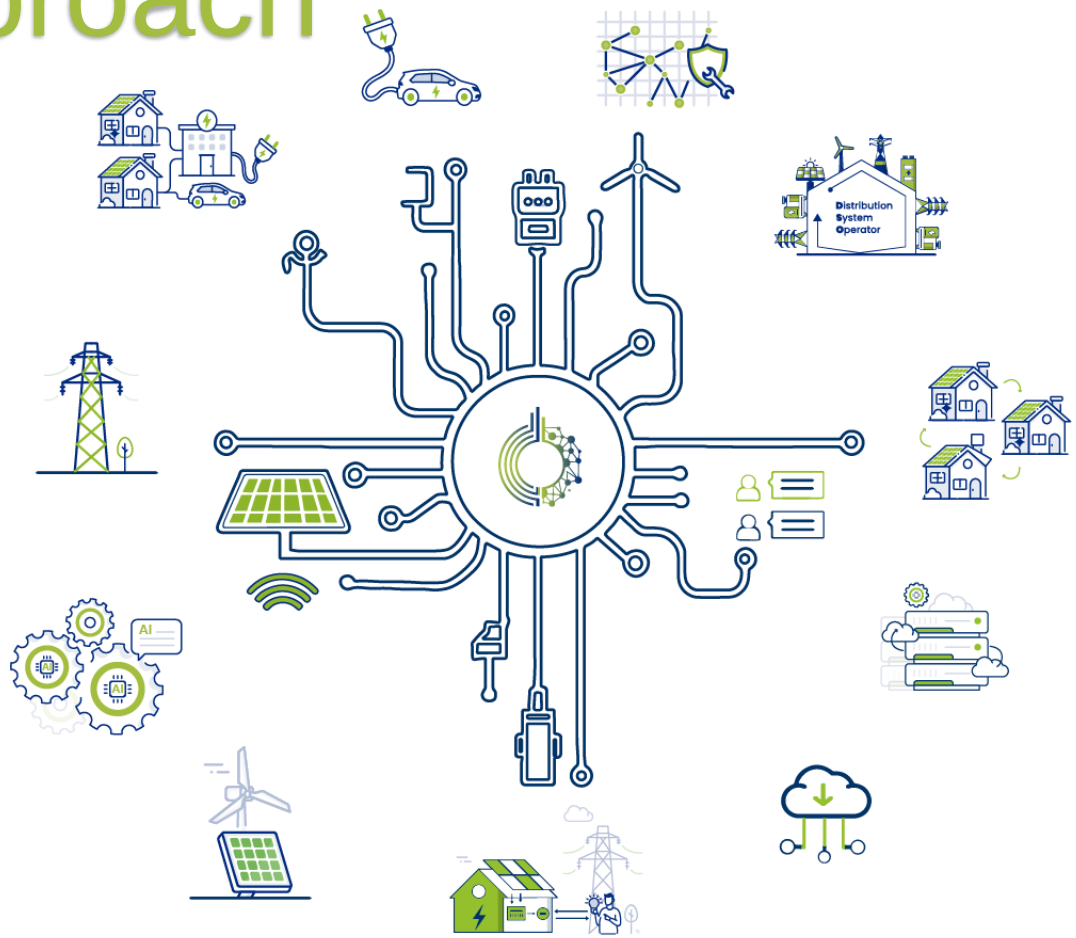
ODEON Energy Services for LECs/Aggregator

Reduction of energy costs and increase their autonomy by management in RES and flexible assets

ODEON Energy Services for Prosumers

Informed and transparent participation in flexibility and energy transactions

A Bird-eye view of the ODEON approach



SERVICE ENABLERS

- Network and Asset Management
- VPP and Demand Response
- Investment Guidance
- Self-consumption
- EV Smart Charging

INTELLIGENCE ENABLERS

- Federated AI Containers
- Pipeline design,training and execution
- Federated intelligence
- AI pre-trained artefacts

MARKET ENABLERS

- P2P Energy Trading
- Local Flexibility Trading
- Market Codes and Processes

DATA ENABLERS

- Federated Data Spaces and DataOps Orchestration
- Interoperability and Data Sharing
- Data privacy and Cyber security

DER, GRID Assets, Distributed Data Assets

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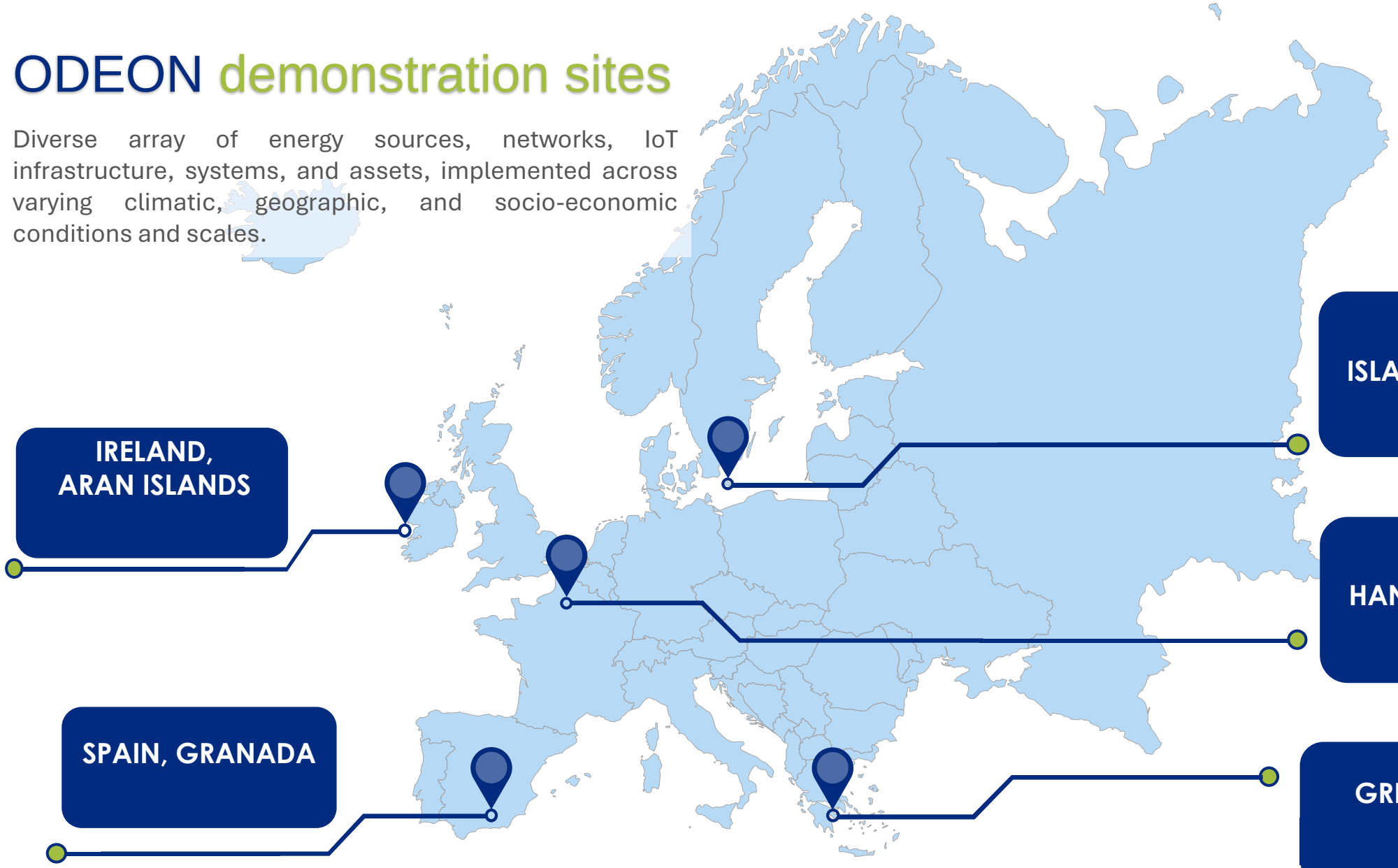
ODEON demonstration sites

Diverse array of energy sources, networks, IoT infrastructure, systems, and assets, implemented across varying climatic, geographic, and socio-economic conditions and scales.



DENMARK, ISLAND OF BORNHOLM

IRELAND, ARAN ISLANDS

FRANCE, HANGEST-EN-SANTERRE

SPAIN, GRANADA

GREECE, MESOGIA

HEDGE-IoT

- **Project Grant Agreement:** No. 101136216
- **Project Coordinator**: European Dynamics Luxembourg SA
- **Budget**: 21.9 M Euro
- **Grant**: 17.9 M Euro
- **Duration**: 42 months
- **Start Date**: 1st January 2024

Consortium members

European Dynamics

Industrial Data Space Association

University of Zagreb

REN

elergone energia

CyberEthicsLab.
Responsible Research and Innovation

Acea energia

CEVE

Jožef Stefan Institute

areti

ΔEH

ELES

OPERATO
member of ELES Group

ARNHEMS BUITEN

KONČAR
Inspired by challenge

CONTINENTE

ΔΕΔΔΗΕ
HEDNO

SOCIAL OPEN & INCLUSIVE INNOVATION
INCLUSINN

iCity
SMART CONNECTIONS, QUALITY LIVING

JÄRVI-SUOMEN ENERGIA

ipto
INDEPENDENT POWER TRANSMISSION OPERATOR

hse

enex

ABB

ENERVA

Tampere University

SOCIAL OPEN & INCLUSIVE INNOVATION
INCLUSINN

CluBE
Bioeconomy & Environment Cluster Western Macedonia

ABB

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R&D
NESTER
CREATING A SMART ENERGY FUTURE

VTT

UNIVERSITATEA TEHNICĂ
DIN CLUJ-NAPOCA

Trialog

TNO innovation for life

elektro gorenjska

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Elia Group

INESCTEC

RWTH AACHEN UNIVERSITY

ENGINEERING
THE DIGITAL TRANSFORMATION COMPANY

HEDGE-IoT

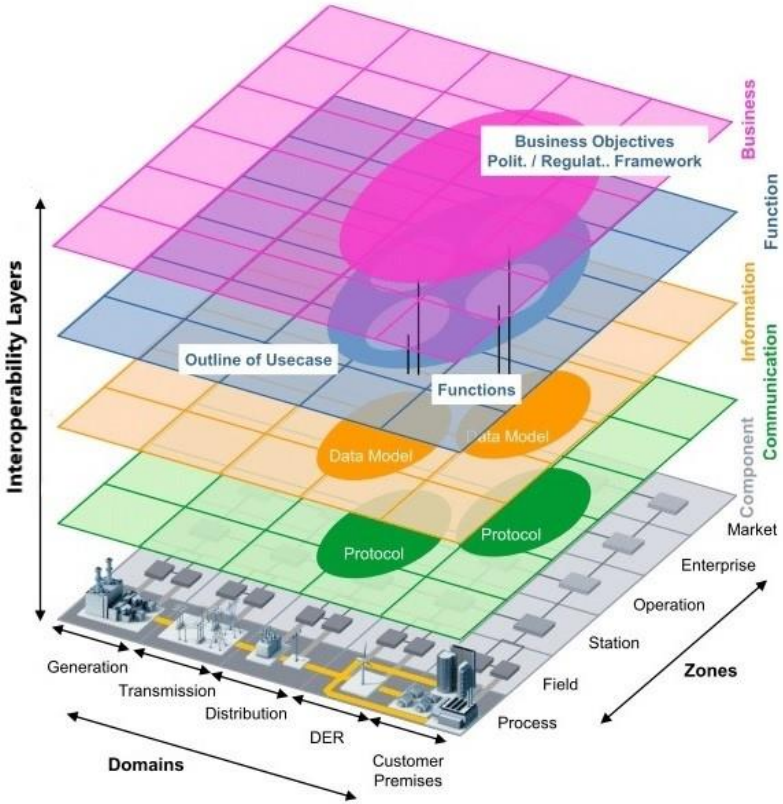
Holistic Approach towards Empowerment of the Digitalization of the Energy Ecosystem through adoption of IoT solutions

European Commission

Vision

HEDGE-IoT – *Holistic Approach towards Empowerment of the DiGitalization of the Energy Ecosystem through adoption of IoT solutions* will:

- **deploy IoT assets** at different levels of the energy system (**from behind-the-meter, up to the TSO level**)
- **add intelligence to the edge and cloud layers**
- **bridge the cloud/edge continuum** introducing **federated applications** governed by **advanced computational orchestration** solutions.



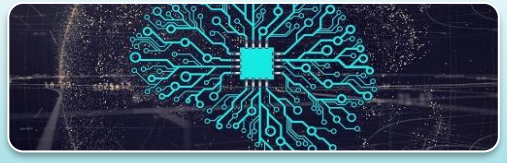
Source: https://digital-strategy.ec.europa.eu/en/policies/eu-policy-digitalisation-energy

HEDGE-IoT
Holistic Approach towards Empowerment of the Digitalization of the Energy Ecosystem through adoption of IoT solutions

European Commission

Objectives

To add local/distributed intelligence leveraging IoT solutions at the edge/fog/cloud layers establishing the edge/cloud continuum through computational orchestration



To design AI/ML tools for edge/fog/cloud services for increased flexibility, resilience and observability

INTERNATIONAL DATA SPACES ASSOCIATION

To enable extended service and semantical/ontological interoperability and interconnectivity among distributed open platforms, systems and edge devices through a decentralized IDS-compliant Interoperability Framework

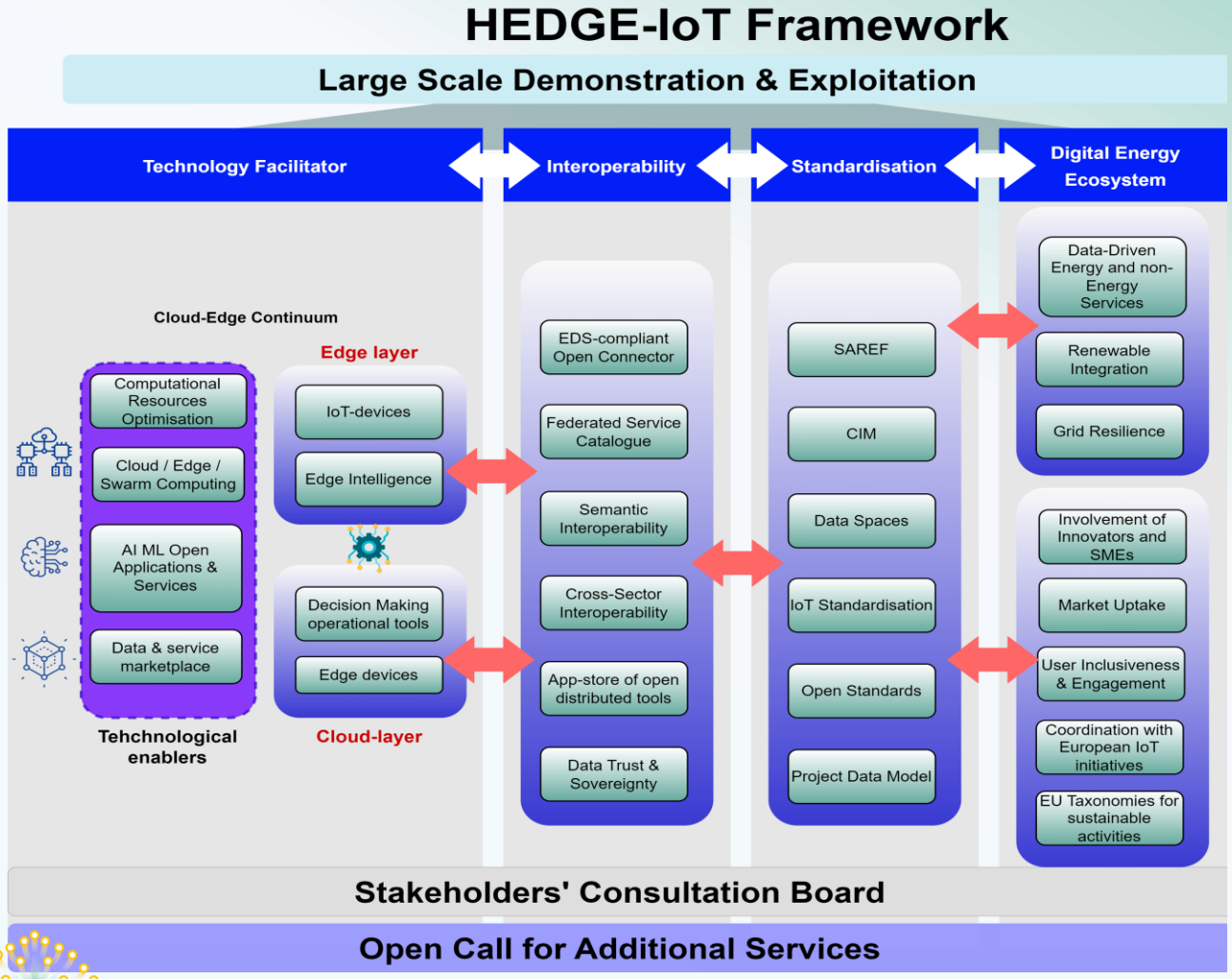
To demonstrate, validate the HEDGE-IoT solutions and frameworks in 6 Demonstrators in 6 European countries featuring different climatic, regulatory and societal conditions towards maximizing mutual learning and knowledge exchange

To apply and extend open standards for IoT, interoperability, grid and market related data exchanges and to create a set of commonly accepted standards

To facilitate the market uptake of the proposed solutions, strengthening their commercialization potential and contributing to the Digitalization of Energy Action Plan. To complement the HEDGE-IoT Framework with additional data-driven services, by 3rd parties and especially SMEs, through an Open Call campaign.

HEDGE-IoT Multi-dimensional Framework

1. Technology facilitator pillar
2. Interoperability pillar
3. Standardisation pillar
4. Digital Energy Ecosystem

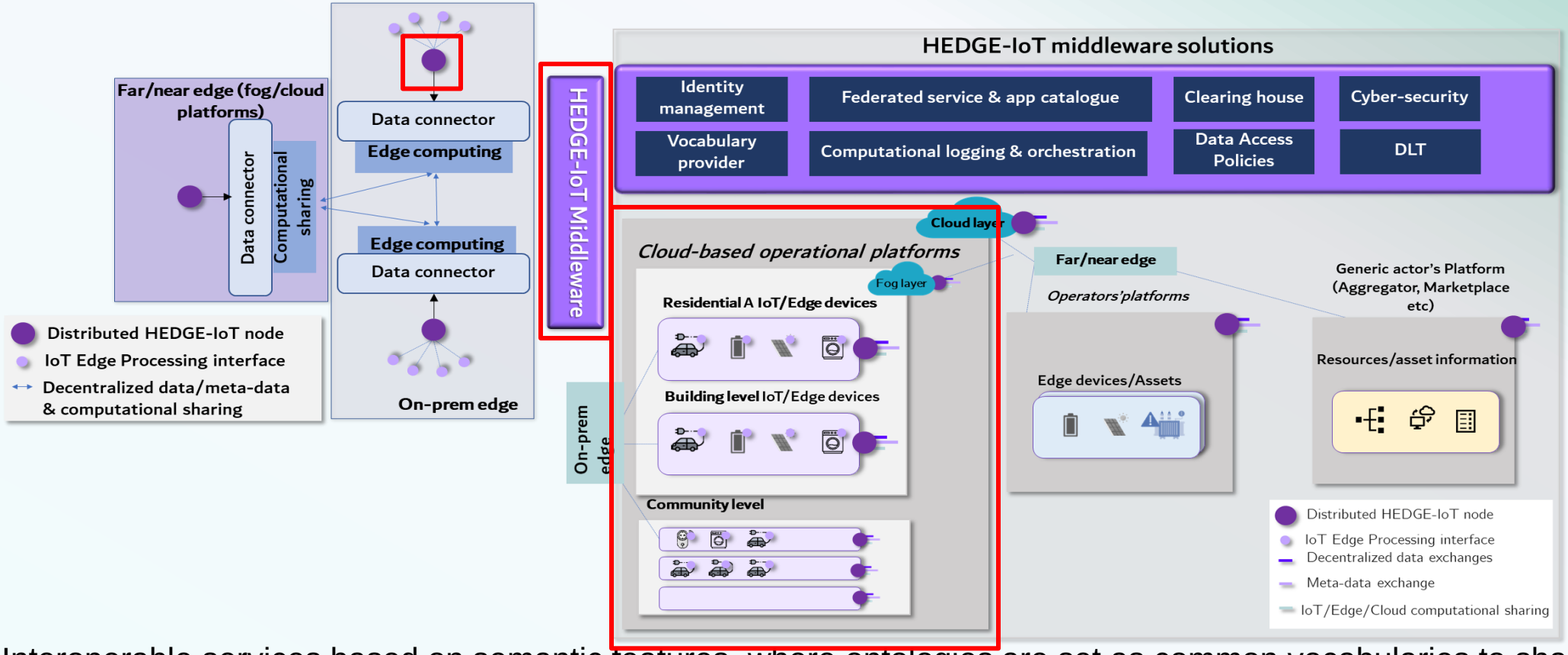


HEDGE-IoT

Holistic Approach towards Empowerment of the Digitalization of the Energy Ecosystem through adoption of IoT solutions

European Commission

Reference Architecture



- ✓ Interoperable services based on semantic features, where ontologies are set as common vocabularies to share and integrate data that can be encoded in different specific protocols and syntactical standards.
- ✓ Seamless interconnection of IoT/edge with HEMS gateway or with upper fog/cloud platforms leveraging the basic functionality of an IDSA-based connector.

HEDGE-IoT

Holistic Approach towards Empowerment of the Digitalization of the Energy Ecosystem through adoption of IoT solutions

European Commission

Pilots

Next-generation grid automation with IoT and edge/cloud data to improve distribution grid resiliency

Leverage IoT and Edge Computing to foster Local Flexibility Markets

Digitalize ECs and EV stations to Enhance Grid Resilience, RES Hosting and Socialize Local Productions

Enhance local grid flexibility to diverse end users by digitizing energy assets and incorporating SAREFized interoperable grid monitoring and control

Living Lab for Interoperable AI-based Energy Services

Enhanced Local Flexibility Services for Improved Asset Lifetime Extension Planning

HEDGE-IoT

Holistic Approach towards Empowerment of the Digitalization of the Energy Ecosystem through adoption of IoT solutions

European Commission

Conclusions

- ✓ Challenging and ambitious project
- ✓ Main focus is the digitalization of the energy sector through wide deployment and orchestration of IoT devices
- ✓ Synergies with ODEON sister project are in place
- ✓ Interesting to examine further synergies with relevant projects covering other sectors → replication

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Thank you

European Commission

INCODE

AA1 PROGRESS AND NEXT STEPS

Panagiotis Zikos(iLink)

Mid-term Review Meeting, 4/09/2024, Brussels

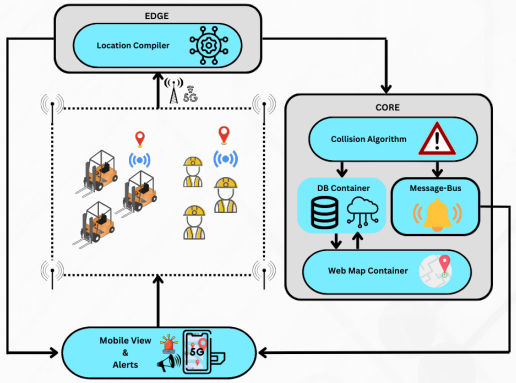
AA1 IN PRINCIPLE: LOGISTICS AND TRANSPORT QUALITY VALUE CHAIN

Resources optimized utilization - advanced Route Optimization Algorithm (RaaS)

Enhanced industrial infrastructures safety - sophisticated Collision Avoidance Algorithms

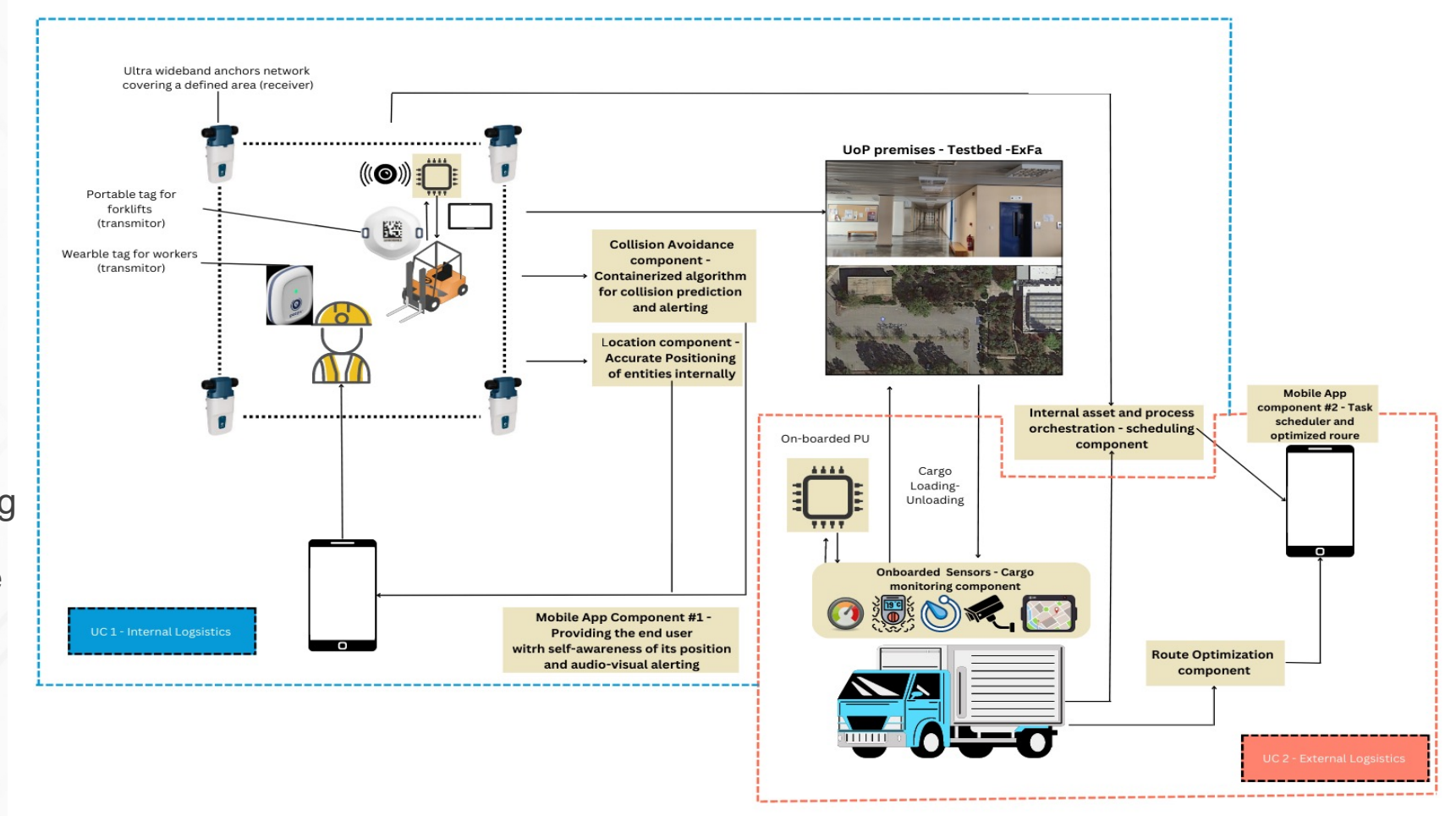
Optimized Transport Quality and damage prevention of goods and products

Edge computing exploited in terms of data exchange and decision-making

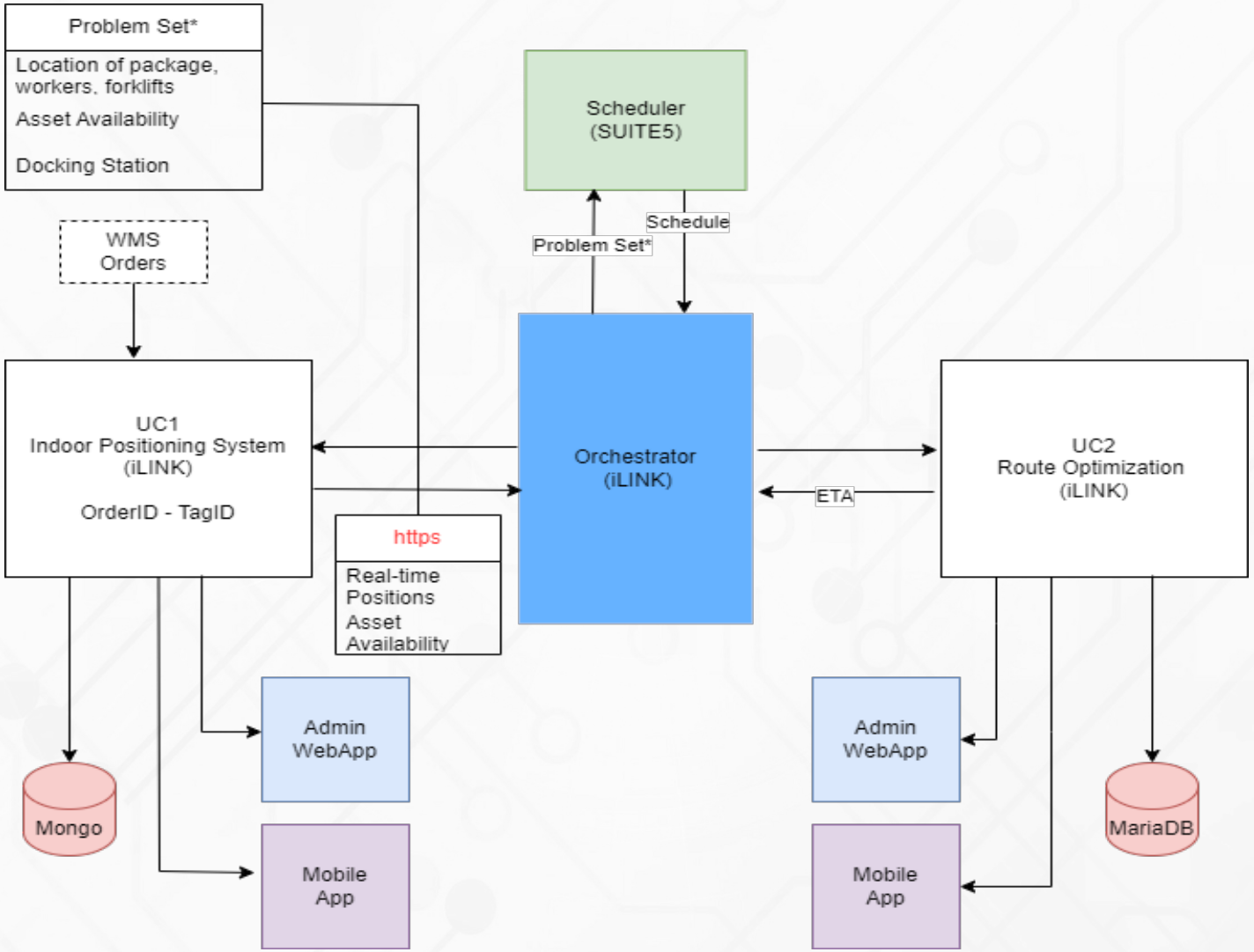


OVERVIEW OF AA1: HIGH-LEVEL ARCHITECTURE

- Main components (UC1):
  - Location Awareness of workers, forklifts, packages
  - Industrial Smart Safety
  - Operations Scheduling
  - Facility Monitoring
- Main components (UC2):
  - Route Optimization: RO algorithm capable of providing the best possible route to the driver by considering multiple factors
  - Cargo Monitoring: Real-time monitoring of the loaded cargo with diverse data feedback



AA1 LOW LEVEL ARCHITECTURE



USE CASE 1

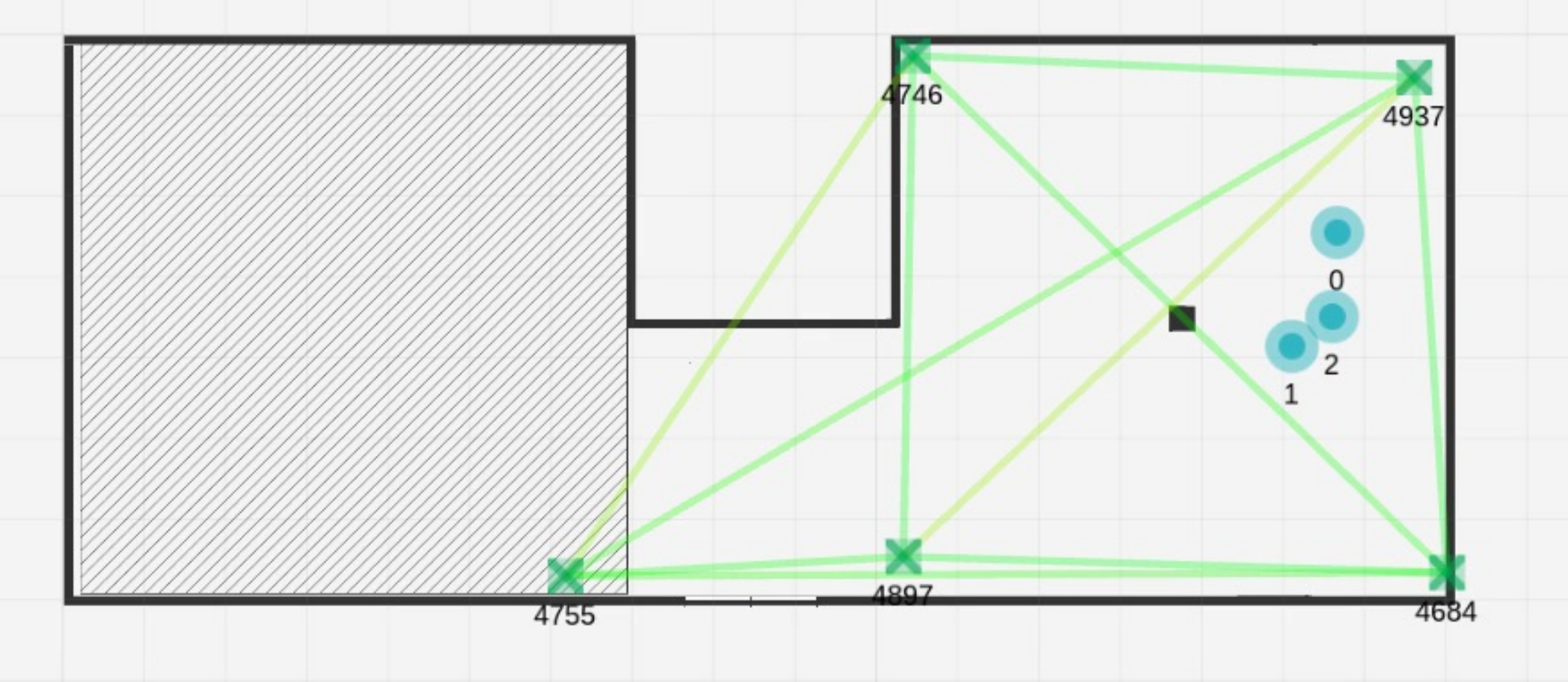
INTEGRATION INTO TESTBEDS – UC1 (NOV 23)

UWB Tags

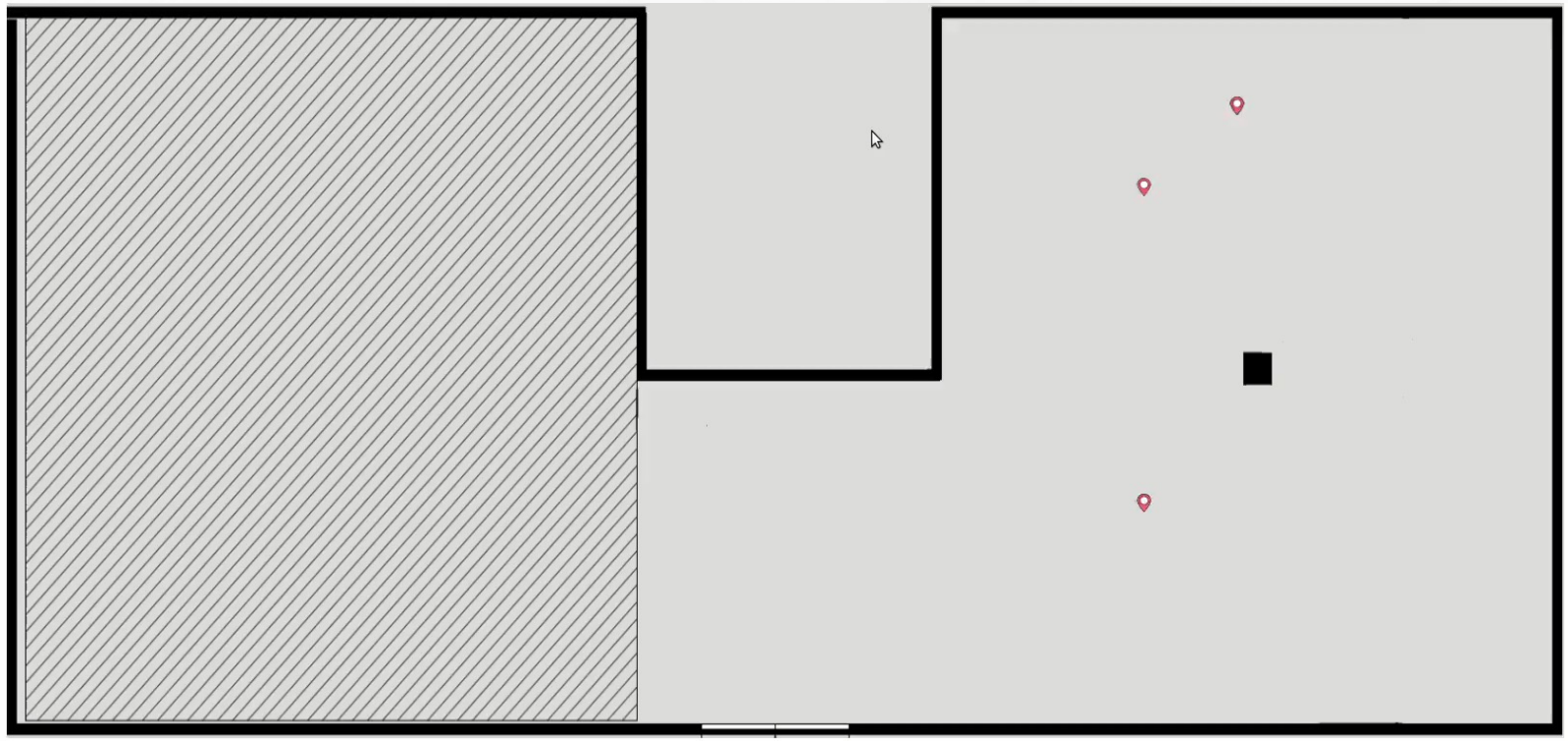
UWB Anchors

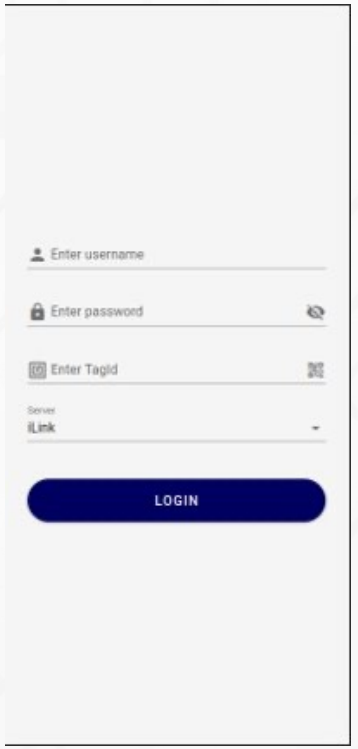
INTEGRATION INTO TESTBEDS - UC1 (NOV 23)

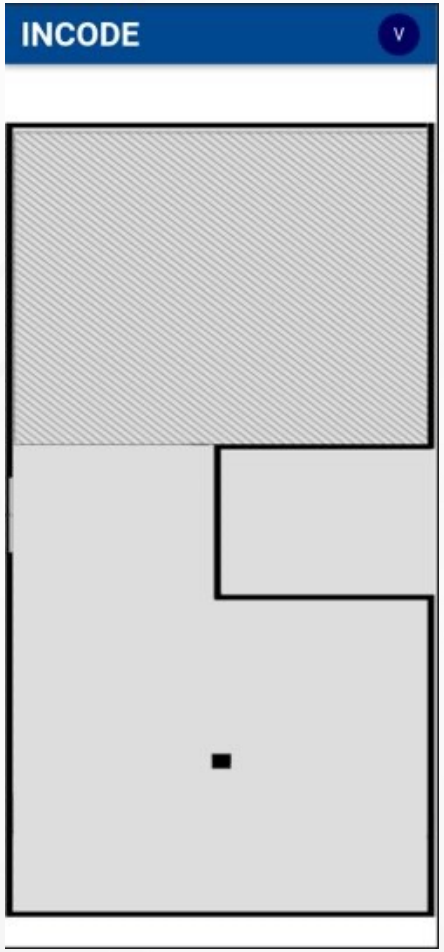
POSITIONING SERVER VIEW



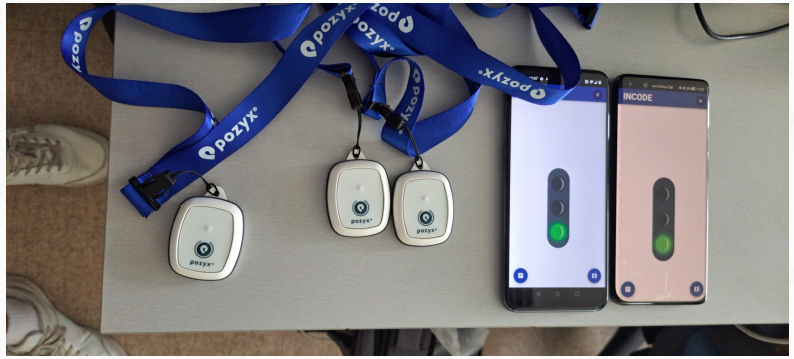
INITIAL SETUP AND TEST AREA – ADMIN & MOBILE VIEW





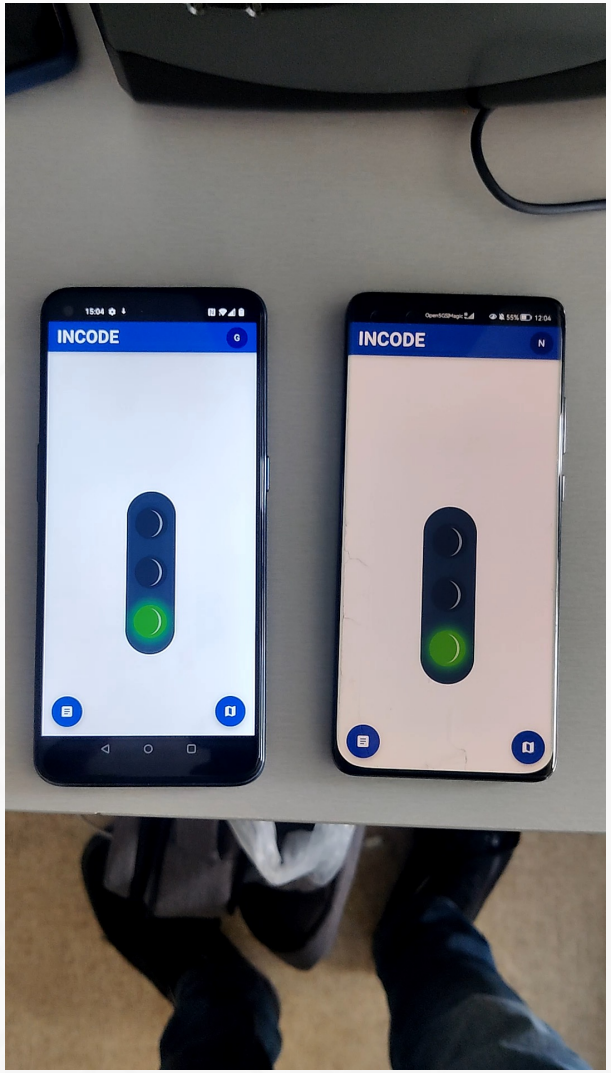


INTEGRATION INTO TESTBEDS - UC1 (JULY 24)

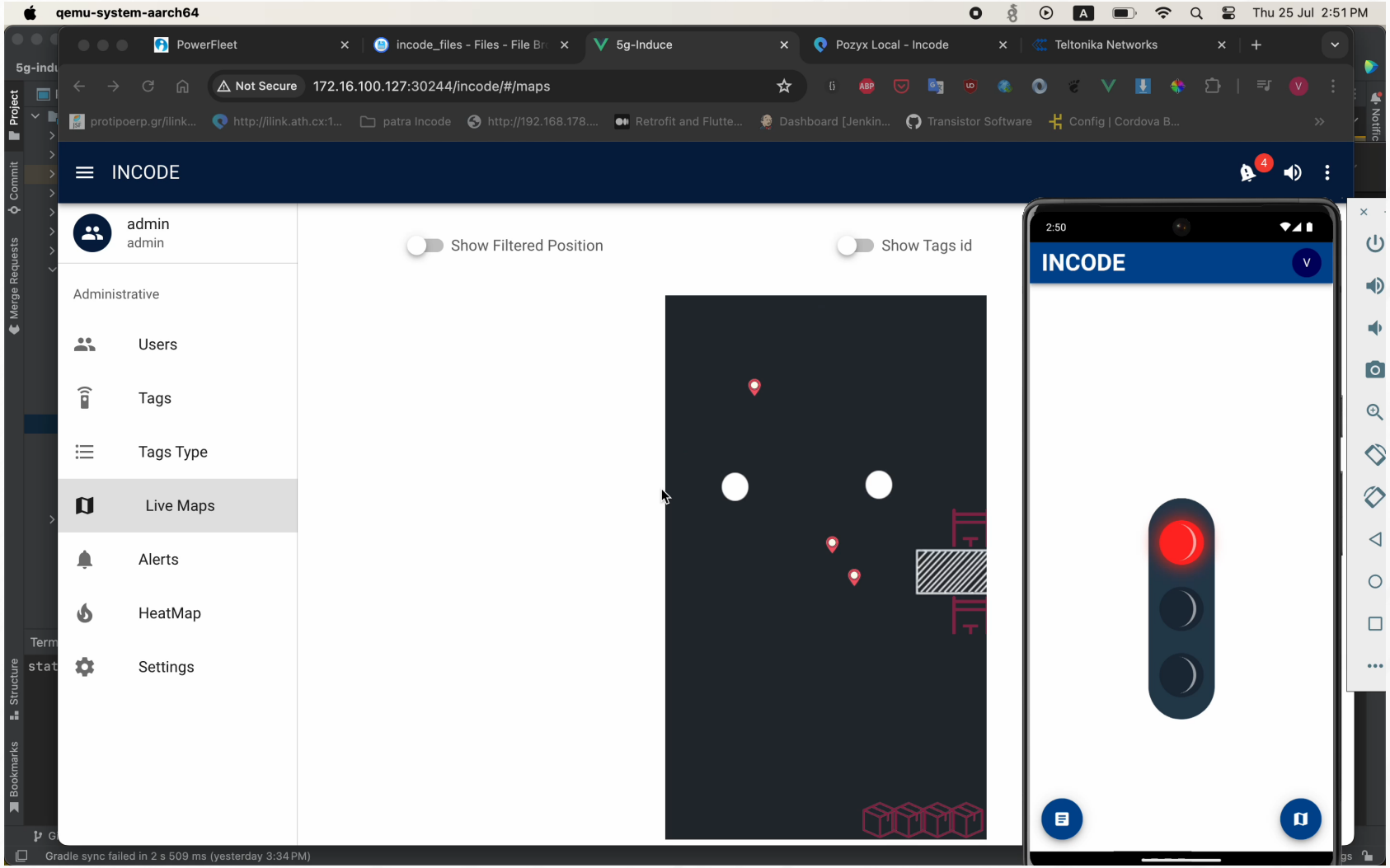


Location and Collision

- The indoor positioning component provides accurate positions for the involved entities
- The collision algorithm predicts imminent crashes and send alerts to the mobile and web applications



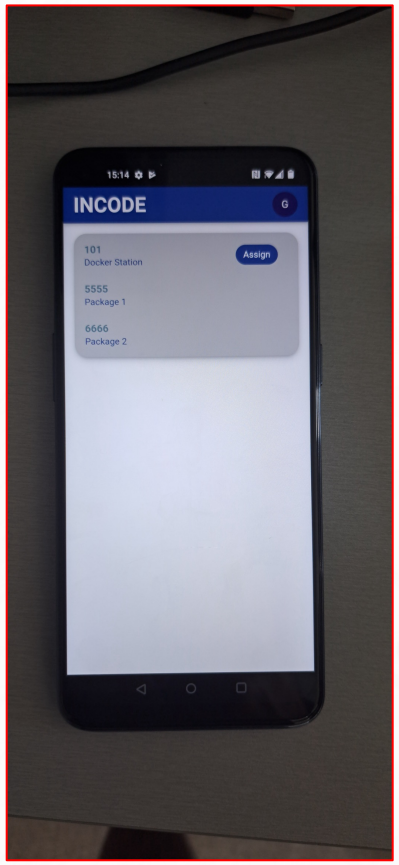
INTEGRATION INTO TESTBEDS - UC1 (JULY 24)

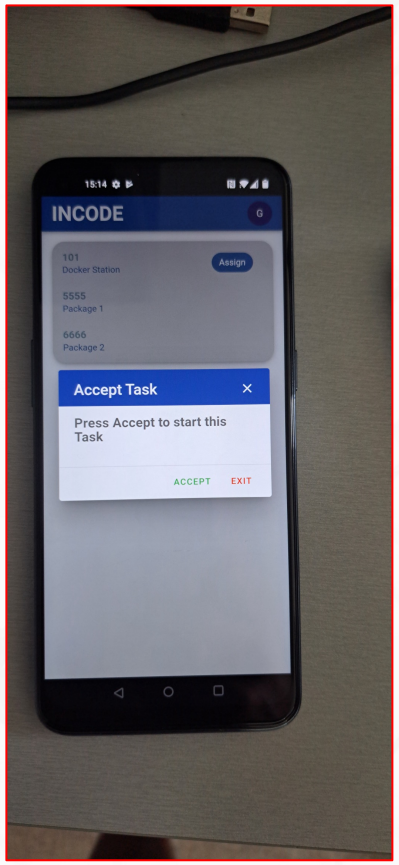


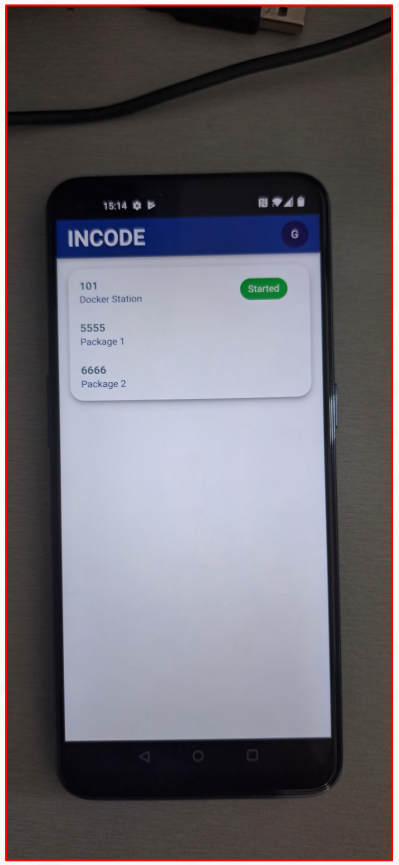
The web application map view with a simulated mobile device linked to a worker wearable tag. The 2 additional moving entities are linked to forklifts.

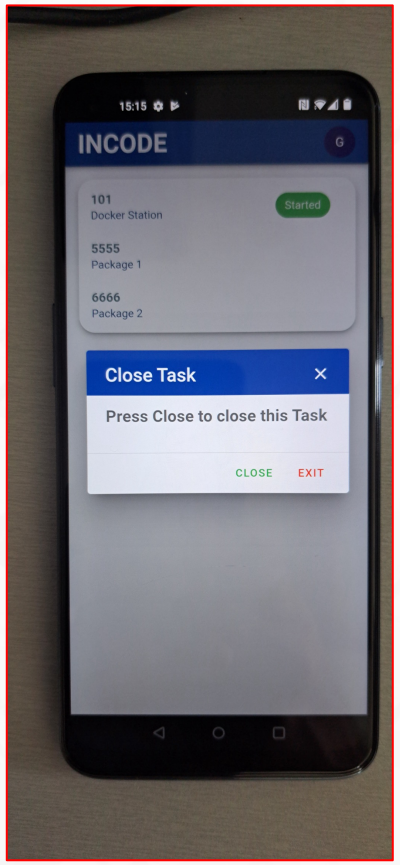
INTEGRATION INTO TESTBEDS - UC1 (JULY 24)

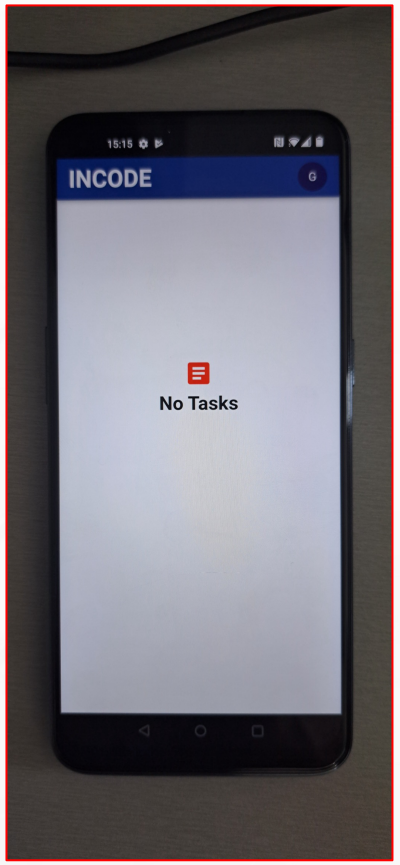
Task scheduler (Suite 5)





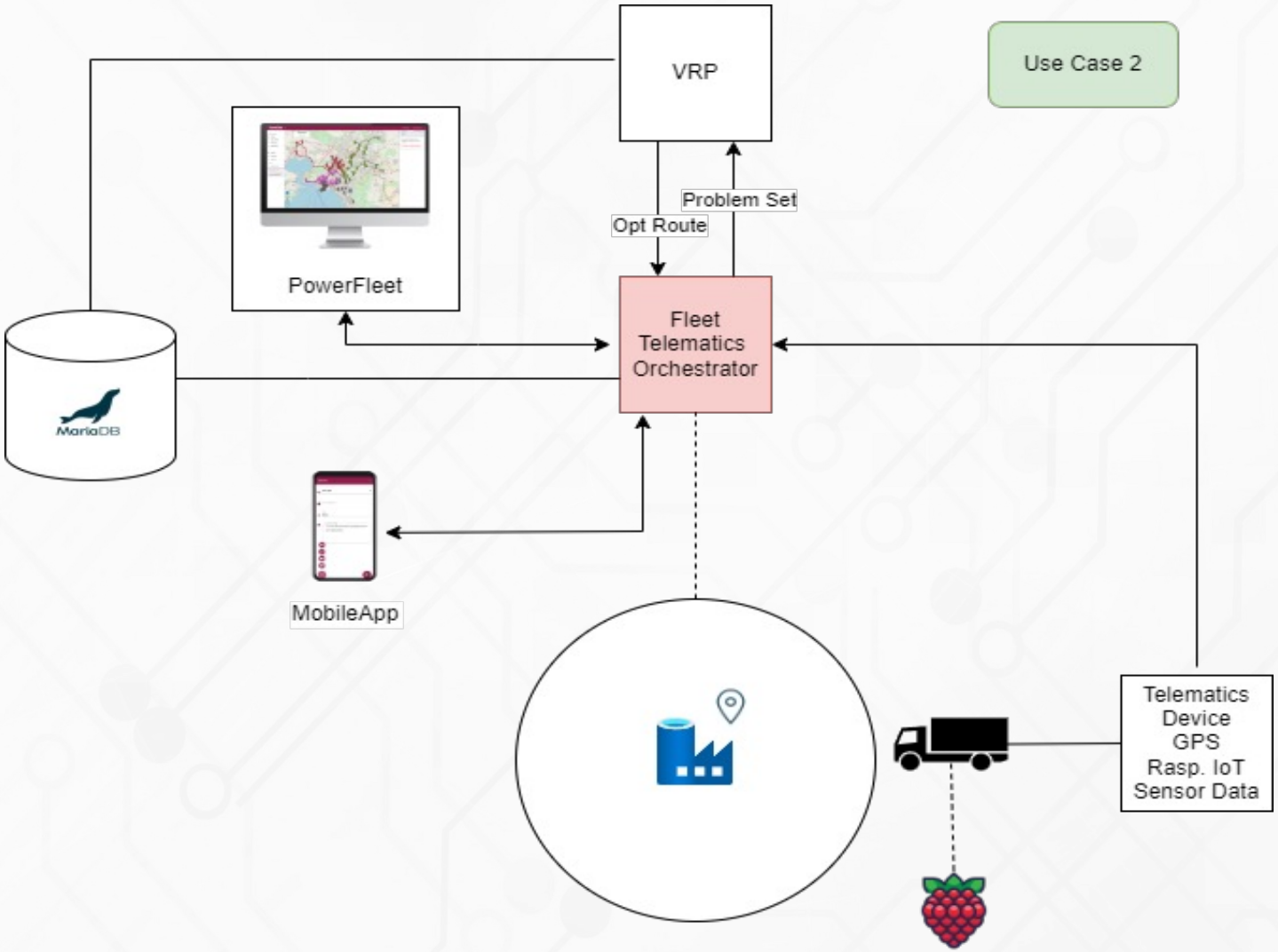




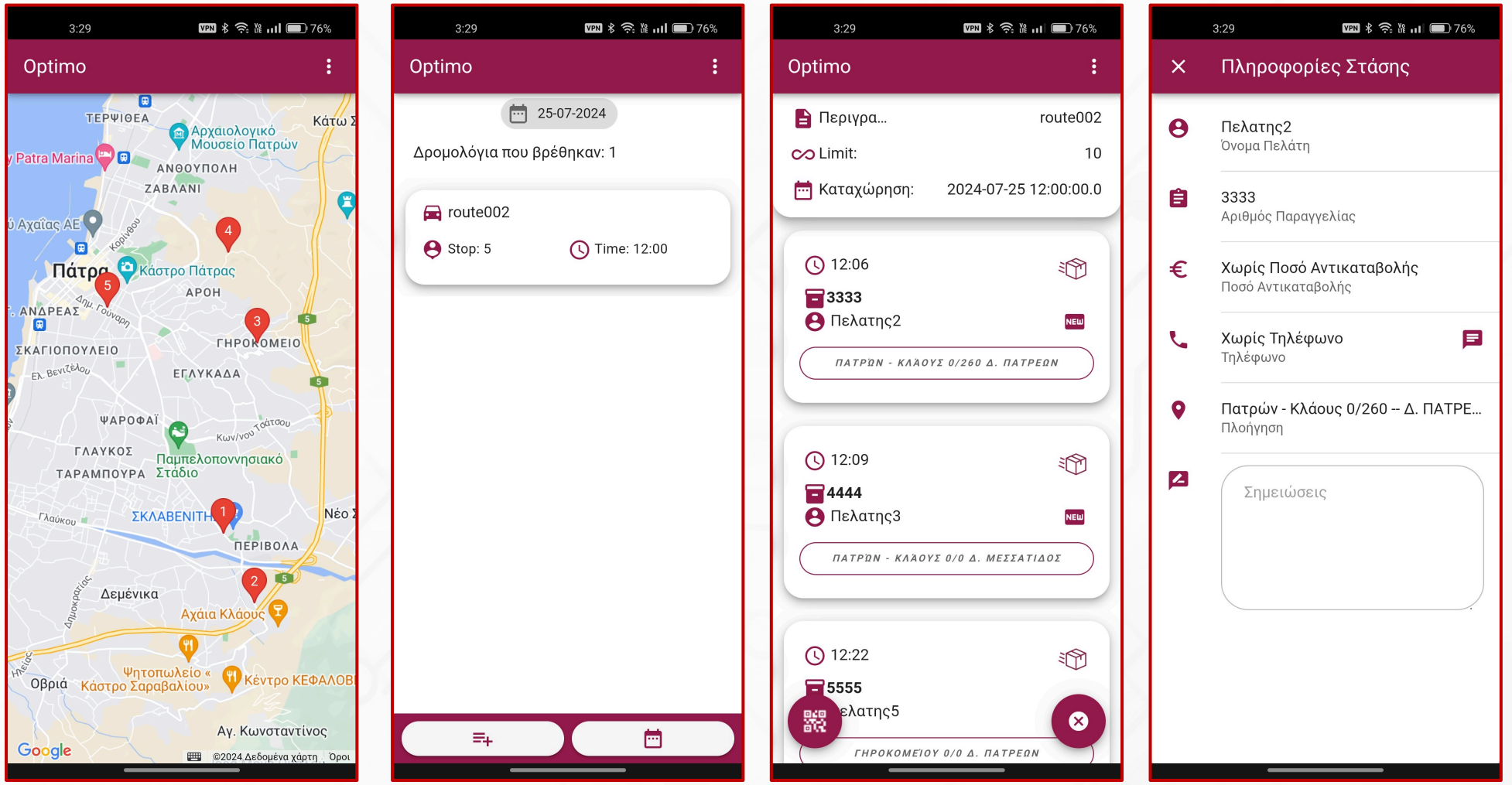


USE CASE 2

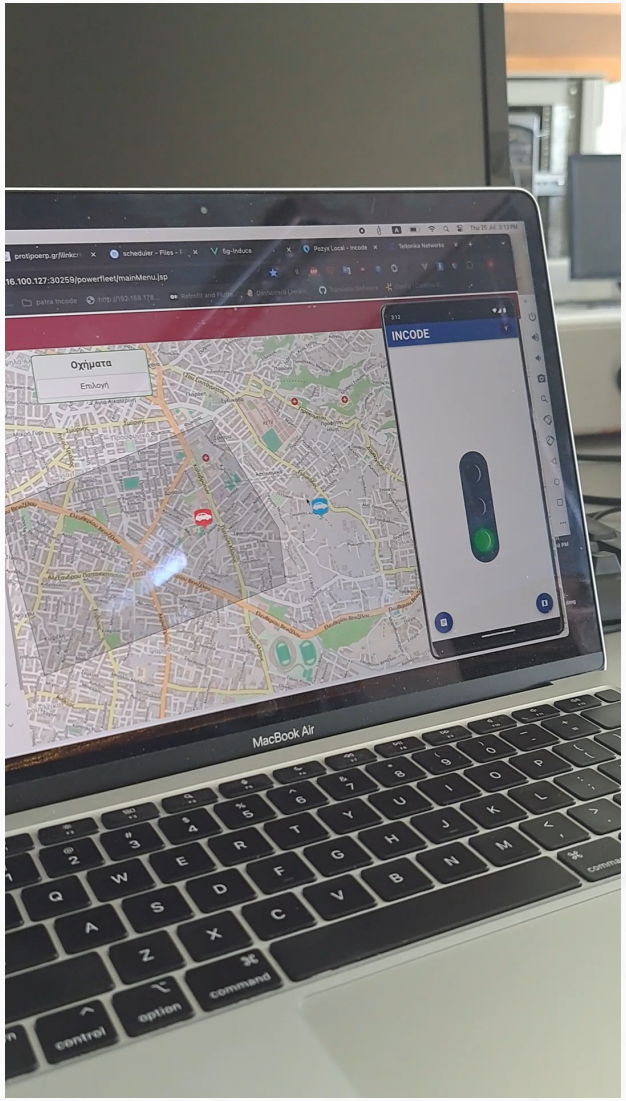
UC2 - ROUTE OPTIMIZATION AND CARGO MONITORING



ROUTE OPTIMIZATION ADMIN PLATFORM



INDOOR LOGISTICS OPERATION SCHEDULER

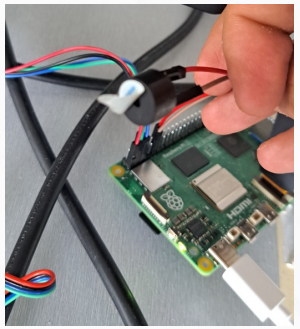


Route Optimization and Task Scheduler

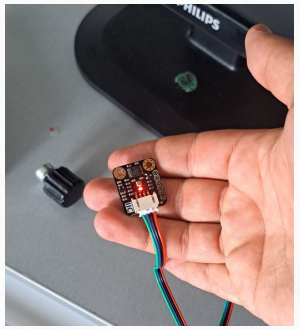
- The truck initiates its optimized route with the delivery points and intermediate stops
- When it enters the geofence, the AA1 orchestrator asks for the real-time positions of the available entities within the factory
- According to the OrderIDs of the requested packages, the Task Scheduler (SUITE5) calculates and sends the “TO DO” tasks to the workers and forklifts considering the operational efficiency

RASPBERRY PI5 & SESNORS

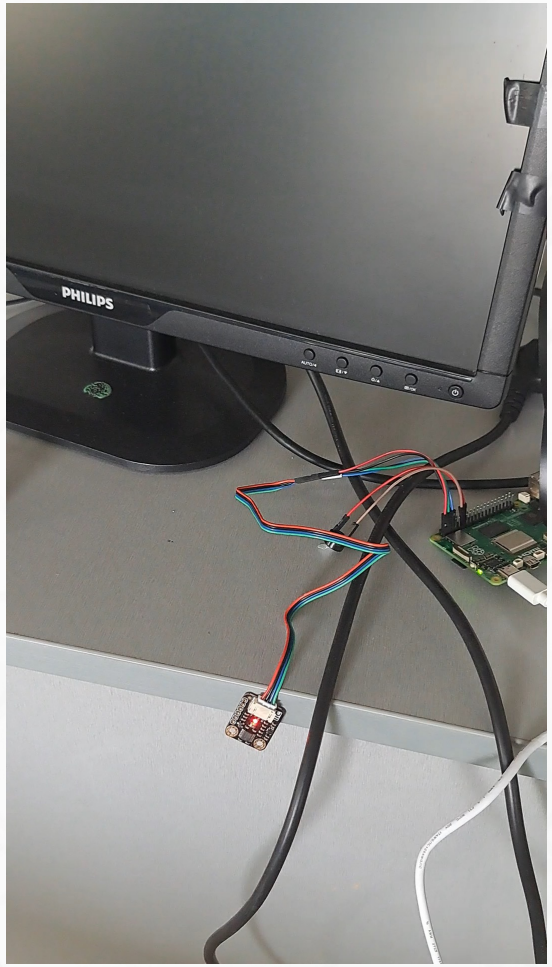
Full RPi5 set up



Sound buzzer

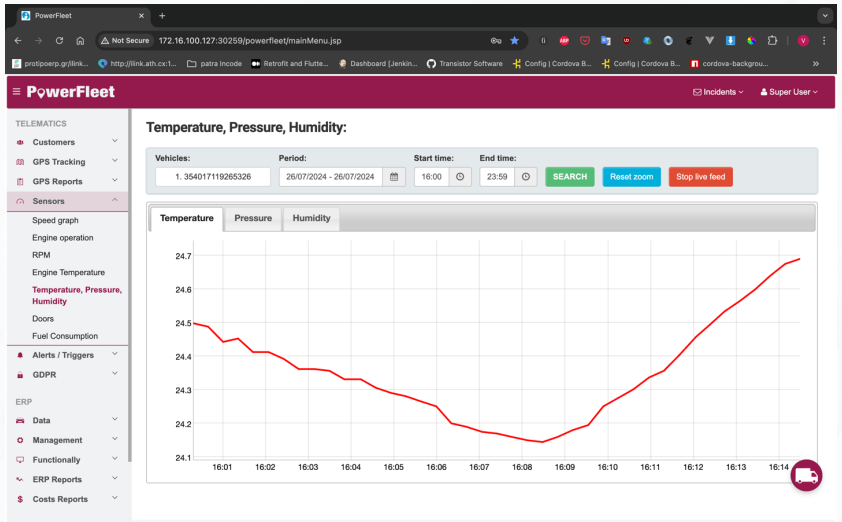


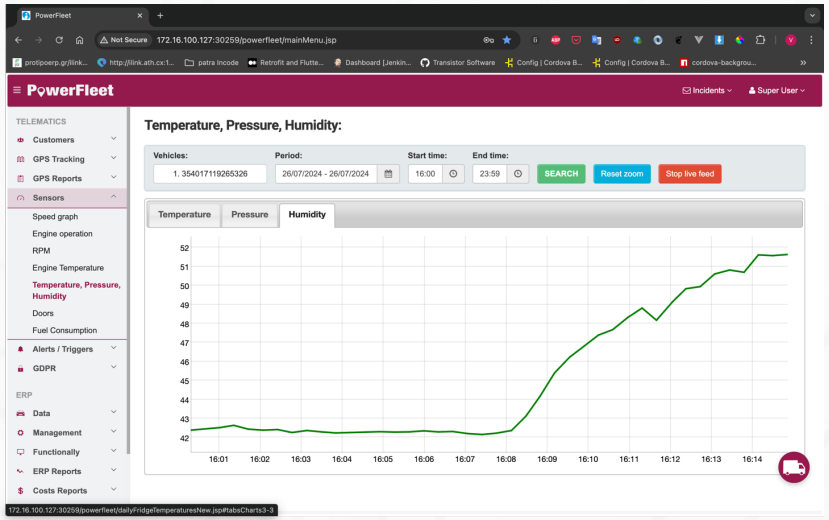
Environmental sensor



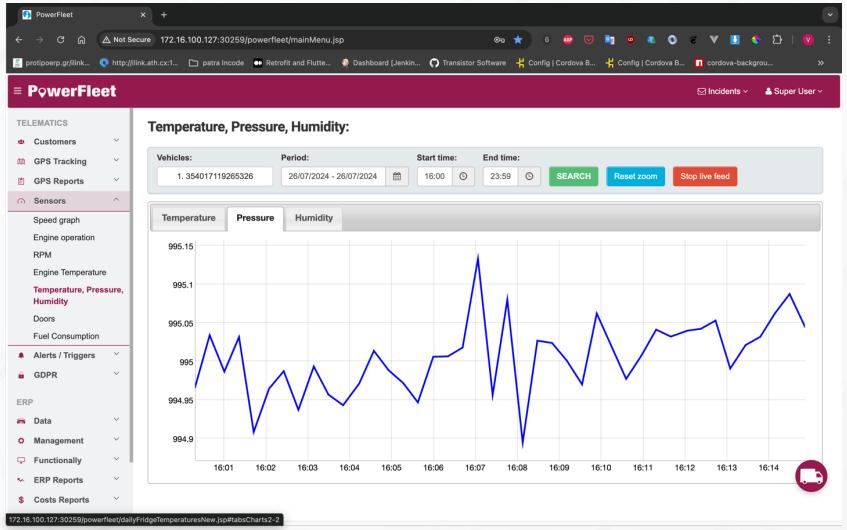
Demo video with the camera and buzzer

SENSOR DATA



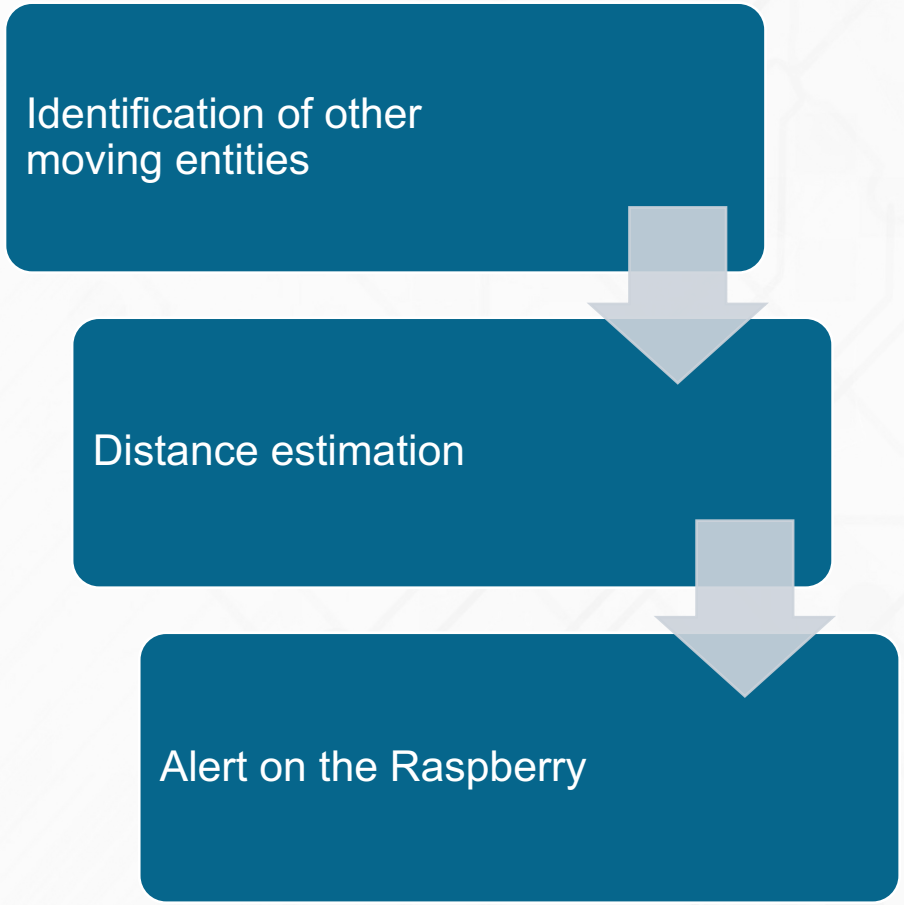


The platform of UC2 provides an extra admin feature with real-time monitoring of the temperature, humidity, and pressure of the cargo vessel.

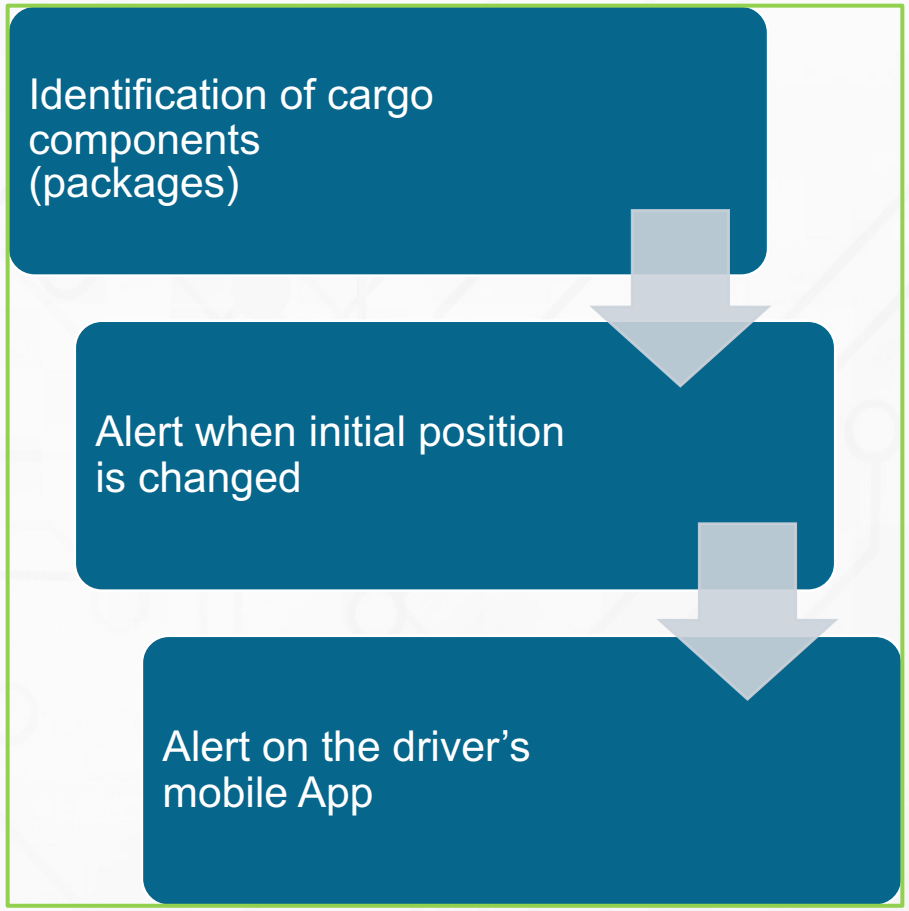


COMPUTER VISION MODEL

- UC1



- UC2



BUSINESS IMPACT

IMPACT AND INNOVATION

UC1 - Smart Industrial Safety and asset orchestration

- UC1 has been initially developed for large industrial facilities in the context of a prior EU HORIZON Project.
  - INCODE provided the opportunity to significantly enhance this use case with several added features
- UC1 significantly improves in-factory operations
  - Time and cost improvement: Location awareness sets the basis for the optimization of operations and accurate decision-making systems
  - The proliferation of safety standards through the collision avoidance algorithm and CV module, provides essential psychological safety to the employees in dangerous industrial facilities
- The infrastructure of UC1 is the core of future development in terms of software and hardware
  - Digital Twins
  - Warehouse Asset Management – Inventorying

IMPACT AND INNOVATION

UC2 - Route Optimization and Cargo Monitoring

- UC2 covers the external logistics scenario with a major impact on the time and resource consumption of vehicle fleets.
  - Optimized routes based on multiple variables significantly improve delivery time
  - Reduced fuel consumption leads to the reduction of emissions
  - The algorithmic route scheduling process reduces empty miles and maximizes positive economic impact for the end user
  - Cargo monitoring enables immediate response and mitigation of transportation-related risks
- UC2 is based on iLINK's main product *PowerFleet Optimo* – Business Experience & Logic
  - Proven Environmental and Economic Impact especially on medium and large fleets of vehicles
  - INCODE has also great impact on iLINK's competitiveness by enabling focused research
  - INCODE enhances the quality of digital solutions in the transportation and logistics sector for the EU SMEs

AA1 - Logistics and transport quality value chain

- AA1 covers the needs and challenges of the logistics and supply chain sector in a holistic manner
  - End-to-end logistics scenarios showcase the importance of the INCODE orchestration platform
  - Individual INCODE components combined with the 5G technology are critical to the AA1
- The combination and enhancement of these UCs aims to deliver great impact on the Logistics and Supply Chain sectors

PROJECT CONSORTIUM

INCODE

THANK YOU FOR YOUR ATTENTION

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Co-funded by the European Union

OpenSwarm

Swarm Cluster Meeting
Brussels, 5-September-2024

Siemens AG, Jochen Nickles, T CED

Presented by Inria, Thomas Watteyne

www.openswarm.eu

Outline

- Environment, Health, Safety (EHS)
  - State of the art and challenges
- OpenSwarm perspectives on EHS
  - Continuous optimization of EHS measures
  - Establishment of self-organizing EHS systems
- Research topics
  - User individual subscriptions to EHS related information
  - Swarm based data aggregation to provide a noise map
  - Spatial auto-configuration by swarm participants for context dependent data
- Summary

EHS in industrial production sites

Environment, Health, and Safety (EHS) measures are vital for **safeguarding workers and the environment** in **industrial sites**, requiring novel mechanisms to **ensure safe collaboration between humans and automated systems**!

Today's Situation for EHS

- EHS solutions in industrial sites are limited, relying heavily on **manual processes without a holistic approach**.
- Current technologies focus on **protective gear and static monitoring**, lacking **automation and real-time data integration**.
- EHS software mainly handles workflows and documentation, with **little interconnection of equipment or live data processing**.
- To foster the wide adoption of EHS mechanisms **more efficient solutions** are required for the deployment in industrial sites.

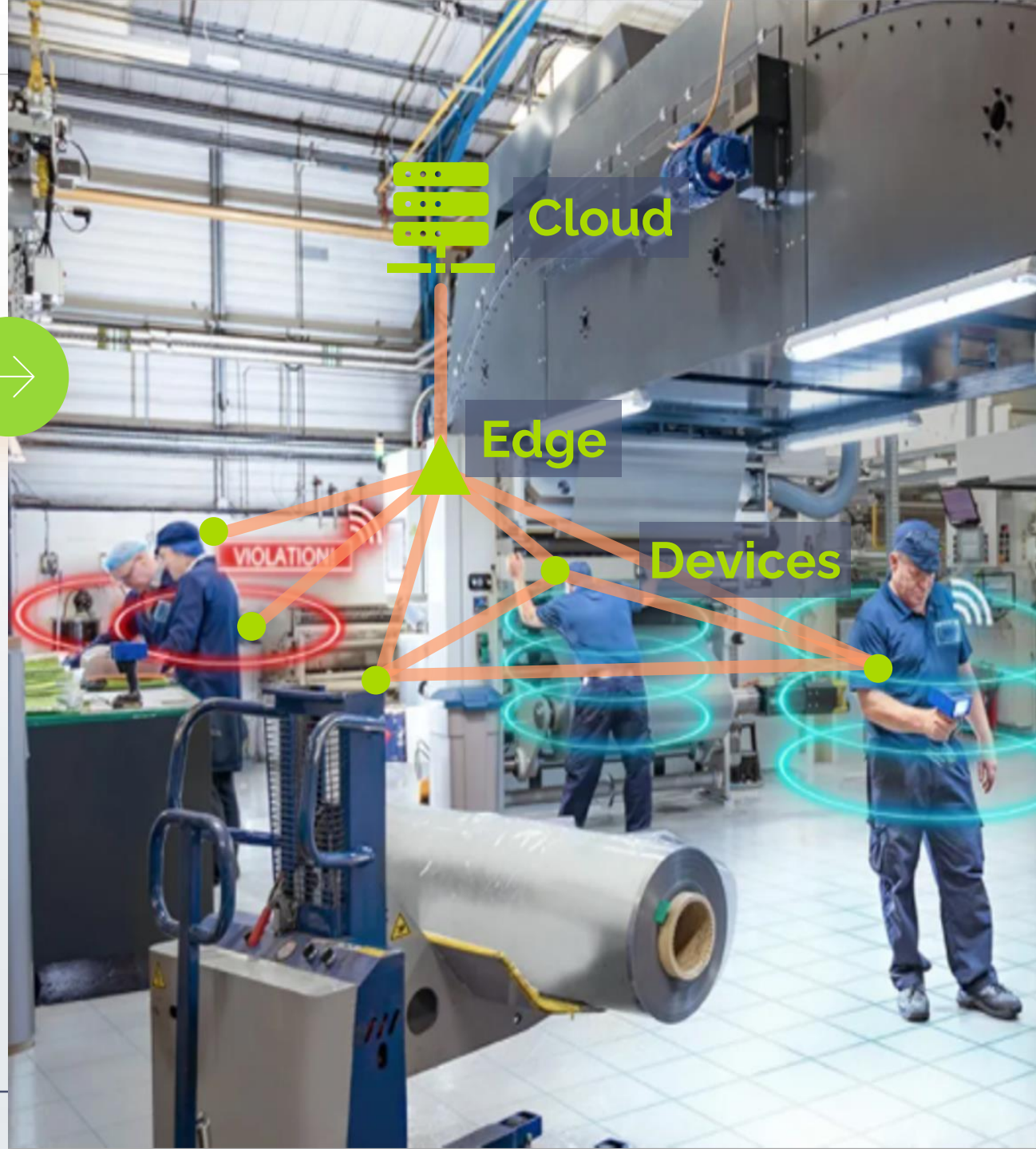
EHS in OpenSwarm

Concept

OpenSwarm technology is applied to equip **heterogeneous mobile and static entities** in an industrial environment with smart sensors in order to achieve a collective, distributed **situational awareness of the EHS state** of the target industrial site.

Benefits

EHS measures are **legally required in Europe**. Their continuous monitoring is expected to result in a **significant reduction in accidents** (and associated costs) and improved well-being for workers, as well as reduce the duration machines are not operating.



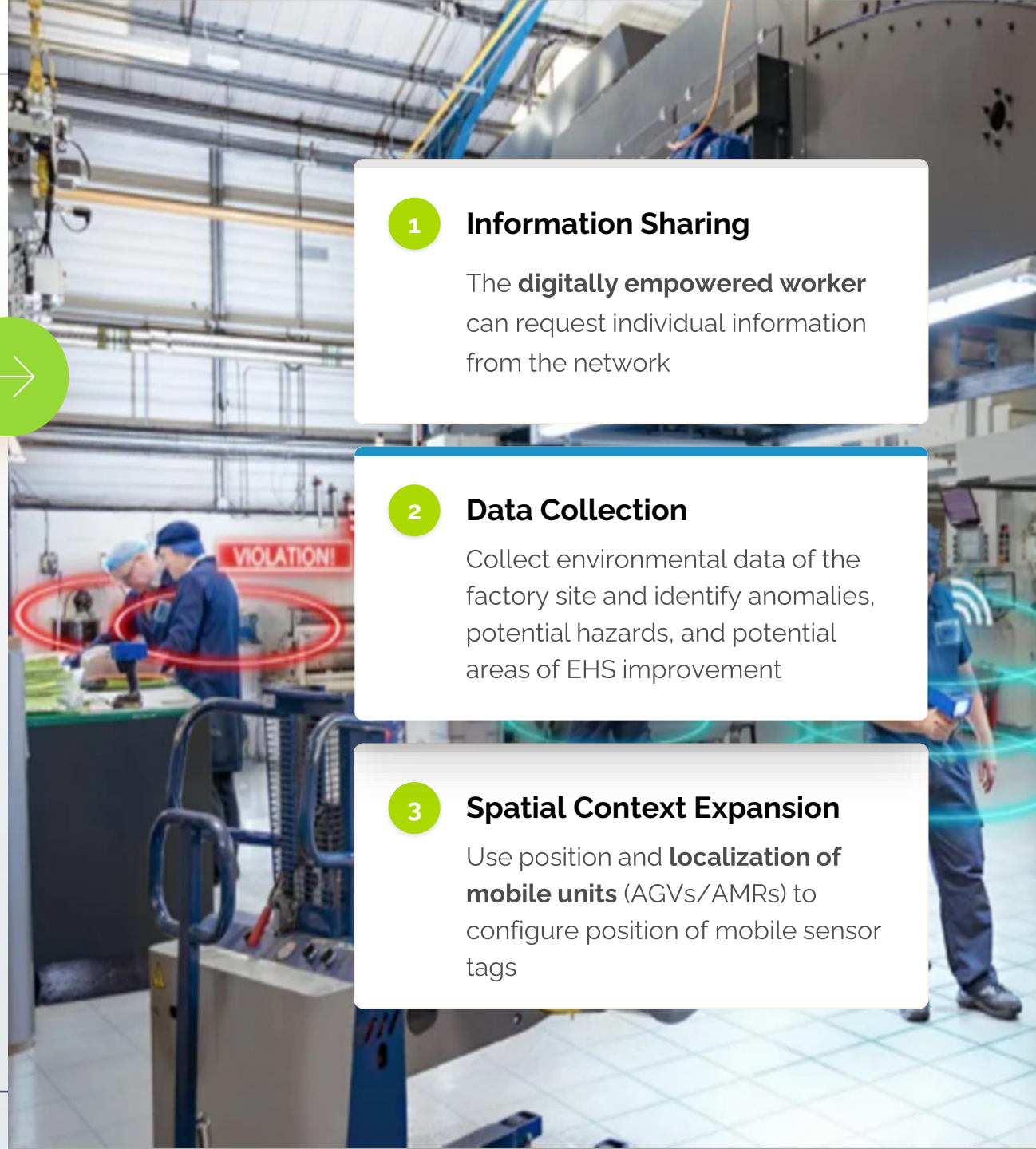
Objectives for EHS

Continuous Optimization of EHS Measures

Construct systems that use collected data, distributed intelligence, and situational awareness from a **heterogeneous sensor network** to continuously monitor and optimize EHS measures.

Establishment of self-organizing EHS Systems

Set up systems that allow EHS policies and measures to be defined and managed by human workers, companies, and local authorities in accordance with local and global guidelines.



1 Information Sharing

The **digitally empowered worker** can request individual information from the network

2 Data Collection

Collect environmental data of the factory site and identify anomalies, potential hazards, and potential areas of EHS improvement

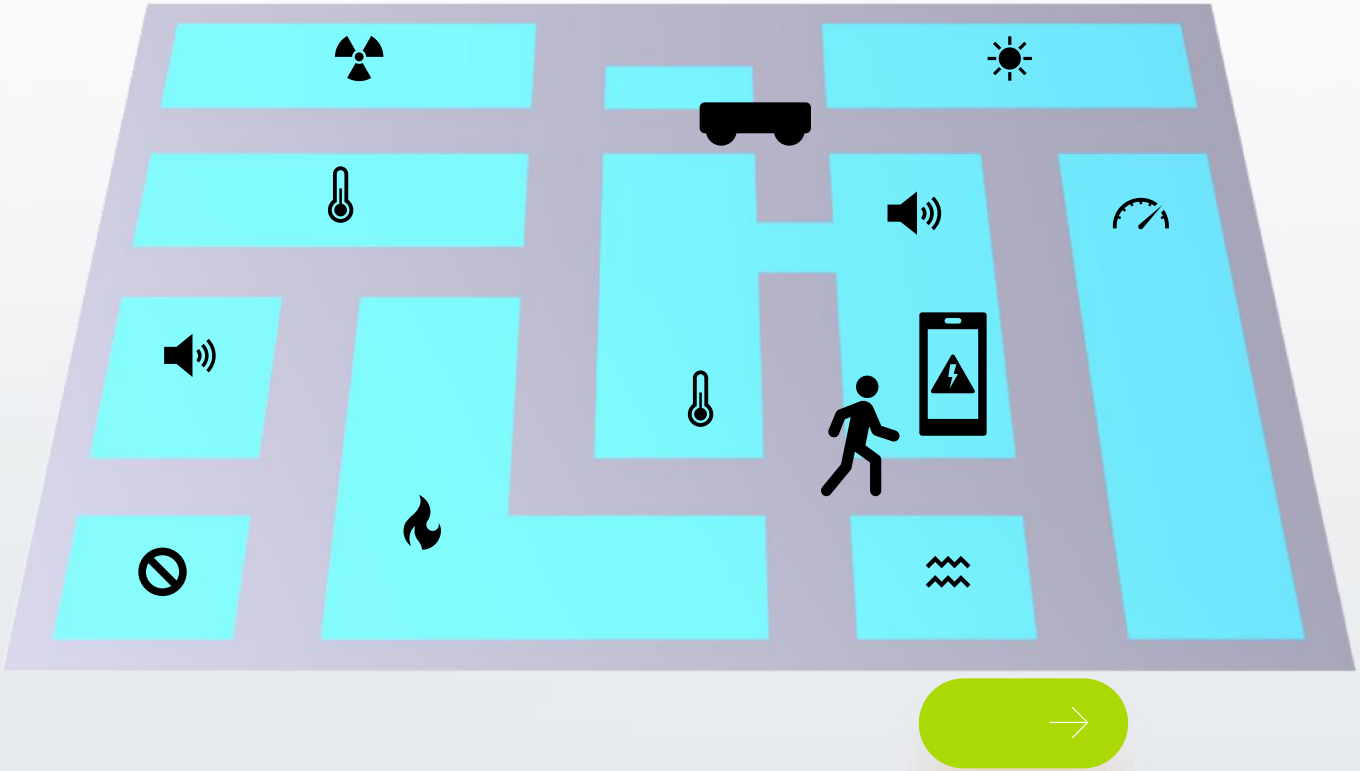
3 Spatial Context Expansion

Use position and **localization of mobile units** (AGVs/AMRs) to configure position of mobile sensor tags

Information Sharing

EHS Warning App

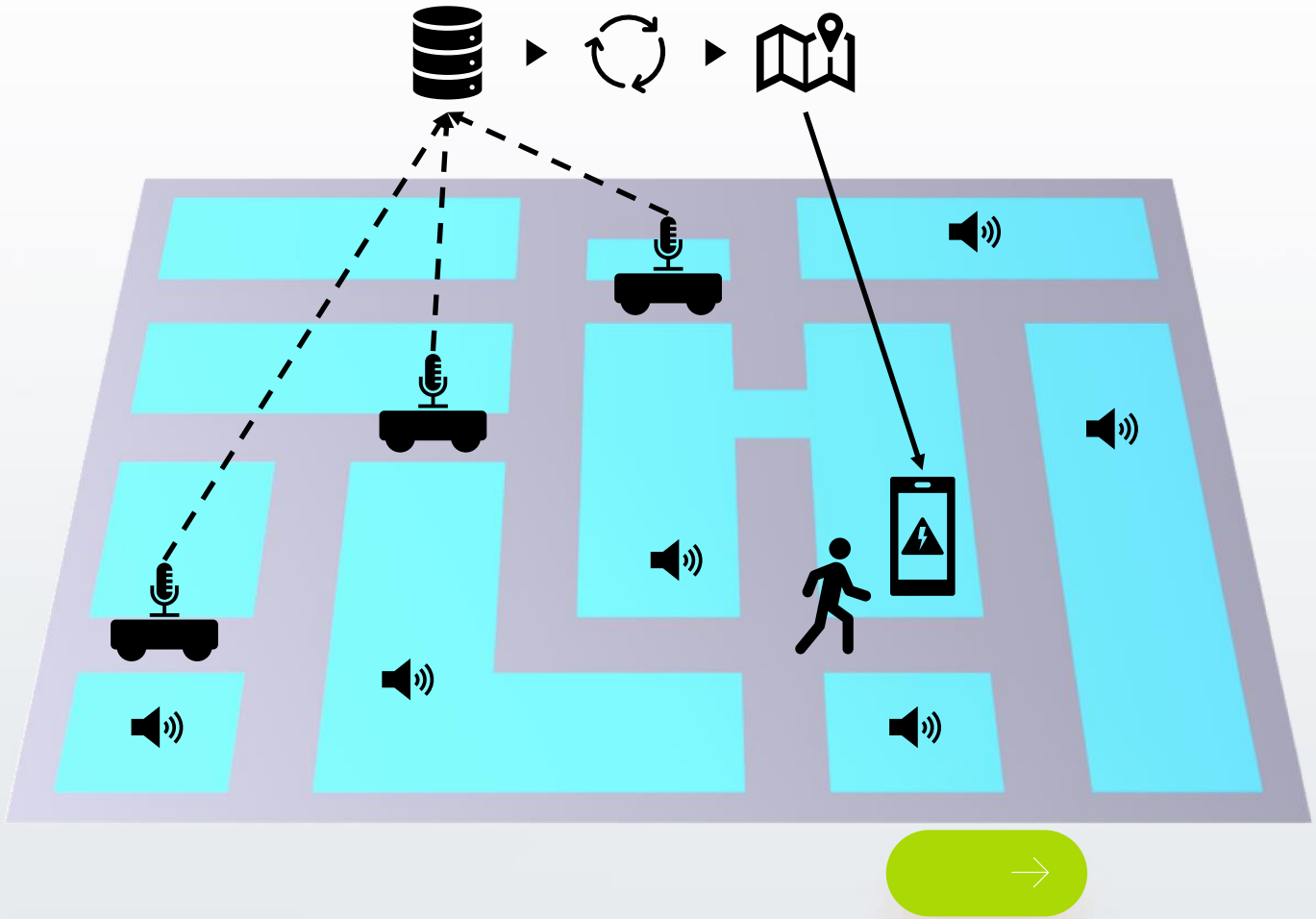
- Consumer devices (e.g., **smartphone**, tablet) interact with the OpenSwarm network.
- Configure policies based which **spatial context parameters** trigger which behavior in proximity of humans.
- Configure personalized levels for receiving **tailored warnings**.



Data collection

Generation of a Noise Map

- An **AGV fleet** (a swarm of systems), gets a task to collect the data necessary to **generate a noise map** of a shop floor which is needed to provide EHS related warning.
- Enable the operator to express complex relations between systems of the swarm by representing what the systems can do and what the swarm should do.



Spatial Context Expansion

Enriching data with spatial context

- There are independently attachable sensor tags with individual **sensors** that generate data for EHS-related information.
- The **spatial position of the sensor tags can be auto-configured** based on the known position information from mobile devices.
- This spatial information can then be used for peer-to-peer context aware notifications (e.g., to alert a person entering a hazardous area).

Summary

- The OpenSwarm EHS use case leverage the technologies developed in project (e.g., **collaborative communications, swarm programming**) to realize exemplary EHS information collection, processing and utilization processes.
- The proof-of-concept set the bases for further EHS application development and **showcase how swarm technologies ease the adoption of EHS mechanisms**.
- Overall, the proposed work **paves the way for increasingly safer industrial environments**.

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Funded by the European Union