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CLOUD-EDGE-IOT INNOVATIONS IN TRANSPORTATION: MARKET INSIGHTS AND USE CASES

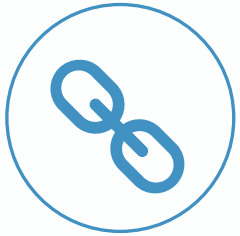
Maria Giuffrida, Trust-IT Services

5 July 2024

WELCOME AND HOUSEKEEPING

The event will be recorded and will be made available on the EUCloudEdgeIoT.eu channels in the next days (including the presentations of each speaker)

We do encourage you though to enter any question in the chat or Q&A box. The speakers will be pleased to answer back your questions real-time.



You can follow the chat to be informed and receive link on the main outputs and publications.

WEBINAR AGENDA

10:00 – **Welcome and opening remarks**, Maria Giuffrida, Trust-IT Services

10:05 – **UNLOCK-CEI's overview & CEI market trends in mobility**, Golboo Pourabdollahian, IDC

10:20 – **Value chain dynamics in mobility sector**, Carolin Zachäus, VDI/VDE Innovation

10:30 – **European data spaces for mobility**, Stefanie Federl, Acatech.de

10:40 – **Presentation of the Cloud-Edge-IoT mobility and logistics use cases**
- David Martinez, NebulOuS
- Izabela Zrazinska, ICOS
- Rudolf Sunsik, Nephele
- Sheraz Aslam, AerOS
- Salvatore Cipolla, Mobispaces

11:20 – **Panel discussion**
- Lorenzo Mantero, Mobispaces
- Raphael Stahlberg, Giesecke+Devrient
- Jurij Mirnik, Nephele
- Carles Miralpex, ICOS

11:45 – Q&A
12:00 – Wrap-up and closure

UNLOCK-CEI FINAL EVENT

Register Here!

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OVERVIEW OF UNLOCK-CEI AND CEI MARKET TRENDS IN MOBILITY

Golboo Pourabdollahian, IDC

5 July 2024

EU-CEI IN A NUTSHELL

A European Commission research and innovation initiative that aims to:

- Realise a pathway for the **understanding and development of the Cloud, Edge and IoT Continuum**
- By promoting **cooperation** between a wide range of research projects, developers and suppliers, business users and potential adopters of this new technological paradigm.
- Support the definition of **large scale pilots**

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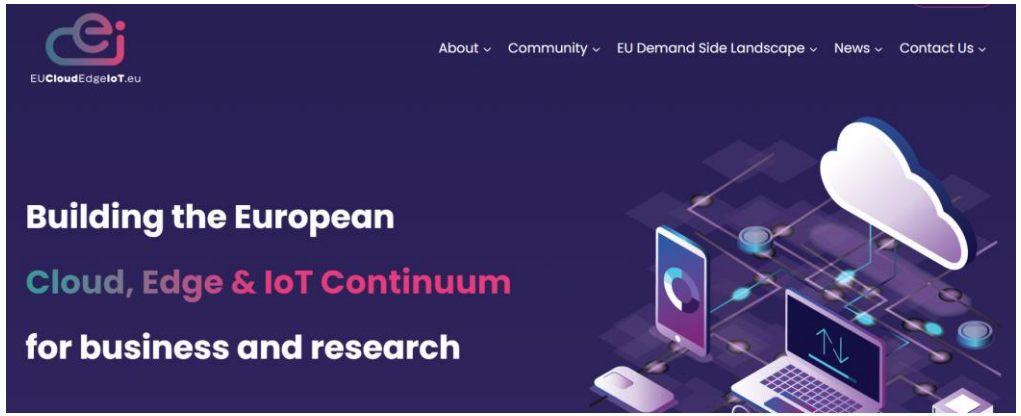
CLOUD

EDGE

IOT



UNLOCK-CEI & OPEN CONTINUUM

OPEN CONTINUUM

Objectives

- Promote the establishment of a **European industrial Open Ecosystem**
- **Map and analyse** the supply-side landscape
- Engage the EU industrial and research actors to **create a supply-side community**
- **Coordinate** the relevant EU project portfolio

UNLOCK-CEI

Objectives

- Assessment of **CEI demand landscape**
- Define **market scenarios** and guidance
- Build and activate **CEI industry constituency**
- **Coordination and interaction** with supply side
- Awareness and **impact generation**

ADOPTION OF CEI IN MOBILITY SECTOR

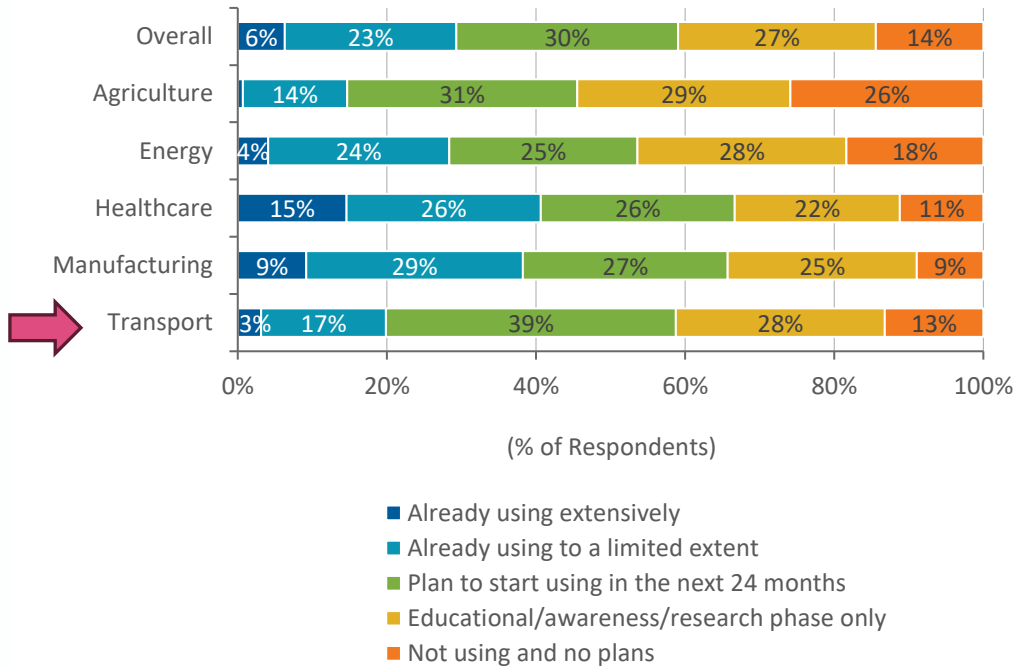
Despite of the current low adoption, the market is quite interested and need to deploy the technology in the future

European Cloud, Edge and IoT Markets

Cloud	Edge	IoT
Spending in 2022 EUR 109.6 bn	Spending in 2022 EUR 33.5 bn	Spending in 2022 EUR 172.3 bn
CAGR to 2026 20.8%	CAGR to 2026 14.1%	CAGR to 2026 10.8%

European Cloud, Edge and IoT Market Size (Source: IDC Spending Guides and Trackers, May 2023)

Edge usage and plans by industry:



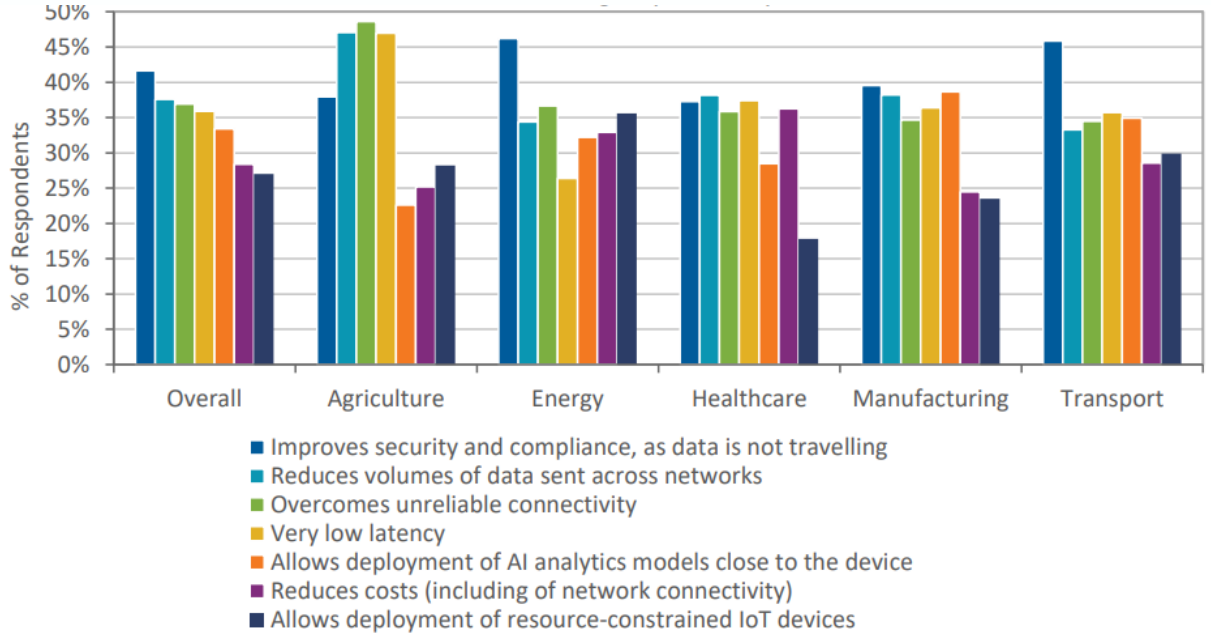
n=55

Note: % of respondents selecting the response; choose up to 3

Source: IDC, UNLOCK CEI Survey, 2023

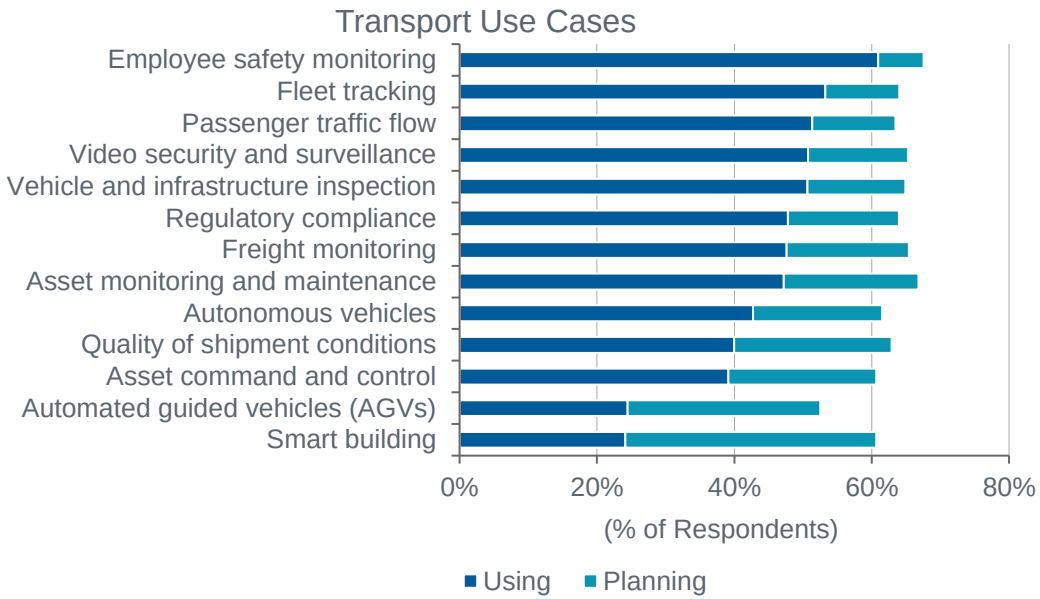
DRIVERS AND USE-CASES

Benefits of edge by Industry



Question: Which benefits of Edge computing are most important for your projects?
N=500 (Base: Edge users or planners)

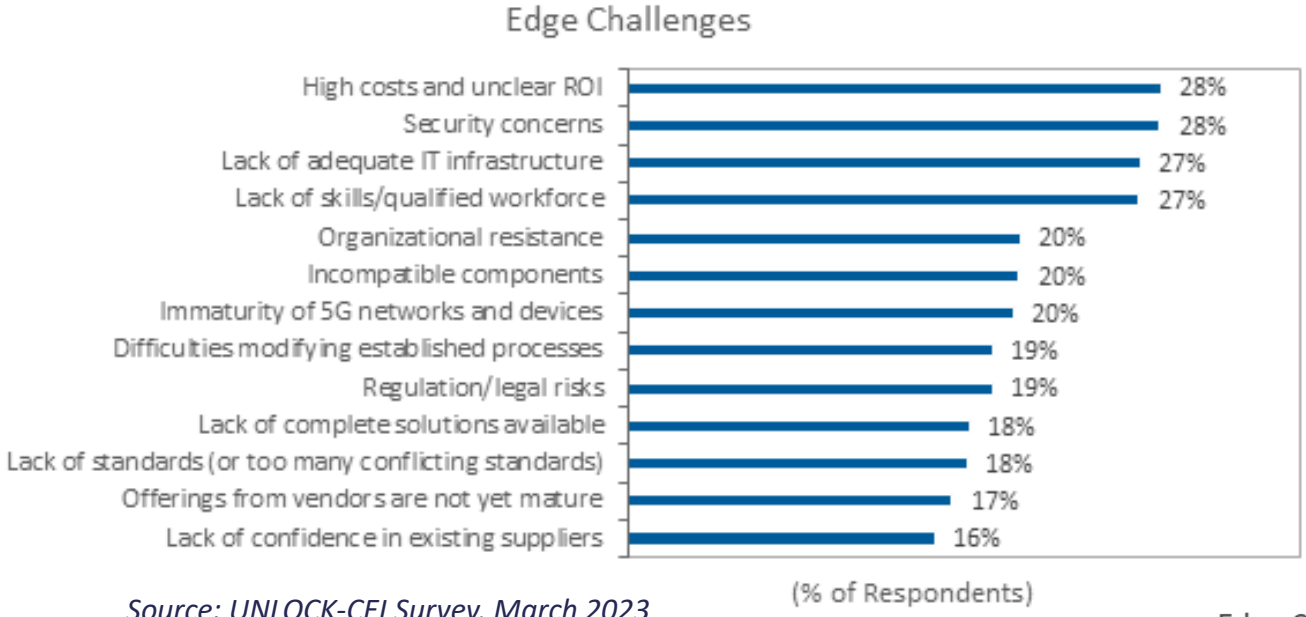
CEI Mobility use-cases



Question: In which of the following areas does your organization use or plan to use IoT in the next 24 months? Choose all that apply
n=104 (Base: Transport companies using or planning to use IoT)

Source: IDC, UNLOCK CEI Survey, 2023

MANY CHALLENGES HOLD BACK CEI

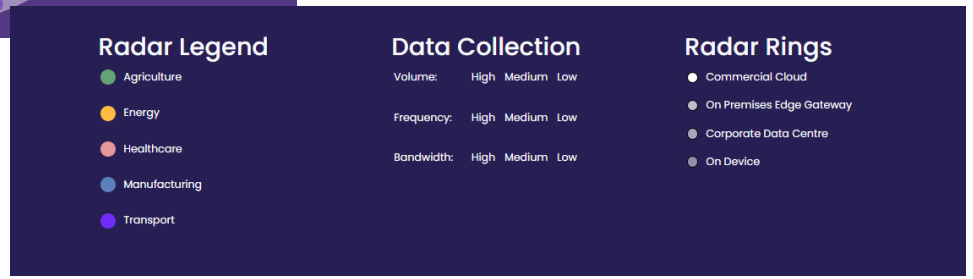


Source: UNLOCK-CEI Survey, March 2023

Edge Challenges – Top 5 by Industry

Agriculture	Energy	Healthcare	Manufacturing	Transport
1. High costs and unclear ROI (33%)	1. Lack of skills/qualified workforce (29%)	1. Security concerns (37%)	1. Lack of adequate IT infrastructure (28%)	1. Incompatible components (29%)
2. Lack of skills/qualified workforce (30%)	2. High costs and unclear ROI (29%)	2. High costs and unclear ROI (32%)	2. Security concerns (27%)	2. Lack of adequate IT infrastructure (28%)
3. Security concerns (29%)	3. Lack of standards (or too many conflicting standards) (27%)	3. Lack of adequate IT infrastructure (28%)	3. Lack of skills/qualified workforce (26%)	3. Lack of skills/qualified workforce (27%)
4. Lack of adequate IT infrastructure (25%)	4. Security concerns (25%)	4. Organizational resistance (24%)	4. High costs and unclear ROI (24%)	4. High costs and unclear ROI (26%)
5. Immaturity of 5G networks and devices (25%)	5. Regulation/legal risks (25%)	5. Lack of skills/qualified workforce (20%)	5. Organizational resistance (24%)	5. Security concerns (25%)

CEI DEMAND REPORTS & TOOLS



Demand use-case radar is a dynamic platform, developed by the UNLOCK-CEI CSA to visualise the diverse landscape of CEI computing continuum, through mapping more than 70 CEI use-cases across five sectors as a results of use-case level market analysis in the project.

https://eucloudedgeiot.eu/

UNLOCK-CEI FINAL EVENT

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THANK YOU!

Golboo Pourabollahian
gpourabdollahian@idc.com

EUCloudEdgeIot.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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MARKET DYNAMICS AND OPPORTUNITIES FOR EUROPEAN COMPANIES IN THE TRANSPORTATION SECTOR

Dr. Carolin Zachäus (carolin.zachaeus@vdivde-it.de)

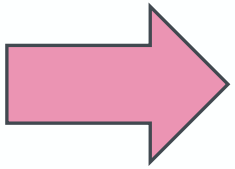
Jörg Dubbert (joerg.dubbert@vdivde-it.de)

July 2024

DIGITAL TRANSFORMATION IN THE MOBILITY SECTOR

Key IT Trends:

- Increasing computing and networking power
- Distributed software architecture
- Ubiquitous availability of mobile devices
- Computing continuum
- Real-time data, data hubs, access points
- AI, ML, Digital Twins



Trends in Mobility Sector:

- Software-defined vehicles
- Multimodal agent-based traffic management
- Shared mobility services
- Mobility as a service platforms
- Automated transport
- Electric mobility
- Disruptive new means of transport

High quality, efficiency, performance and safety of mobility.

SPECIFIC CHALLENGES FOR CEI IN MOBILITY

- Enhance traffic and transport efficiency, improve vehicle and infrastructure design, and optimize logistics, while being economically viable and offering clear added value over existing technologies at competitive prices.
- Manage the complexity of transport and real-time traffic operations, ensuring reliability, plausibility, and failure safety in dynamic and critical environments.
- Enhance transport and traffic safety through highly reliable, plausible, and failure-safe real-time data processing using AI, ML, simulations, and Digital Twins.
- Ensure robust data protection, cyber-security, and privacy for transport systems, safeguarding against cyber-attacks, data misuse, and ensuring system resilience, especially as networking and automation increase.
- Establish clear governance and regulatory frameworks for CEI systems, promoting public-private cooperation in urban, regional, and inter-urban transport. Ensure open interfaces, standards, and data exchange while protecting commercial interests and maintaining high data quality and security.
- Efficient functioning despite the lack of adequate IT infrastructure, ensuring reliable performance and scalability in diverse technological environments.

USE CASES

- Software-defined vehicle (SDV)

- Co-operative Intelligent Transport Systems (C-ITS)

TOPIC 1: SOFTWARE-DEFINED VEHICLE (SVD)

Example of **Continental Automotive Edge Platform**

Cooperation between AWS, Continental and Elektrobit.

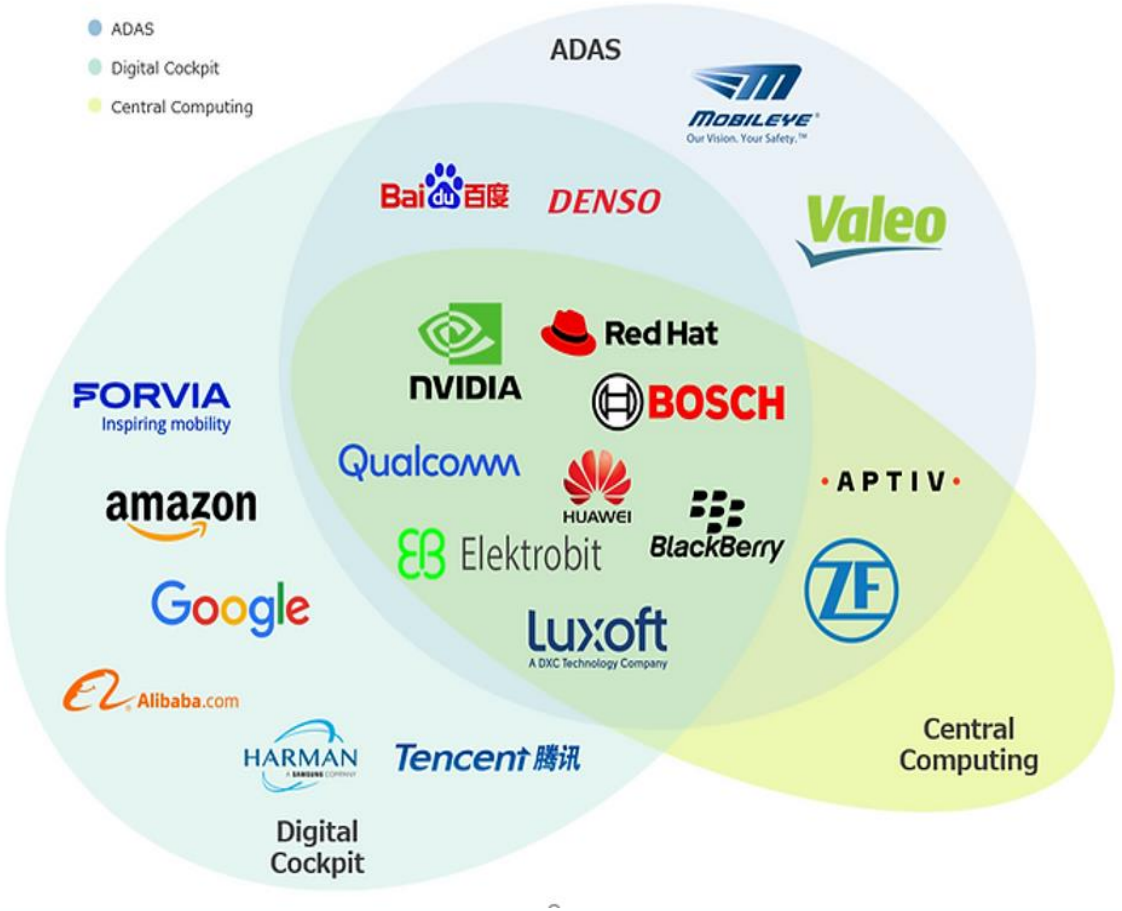
AWS provides the cloud-based services & Continental/Elektobit deliver vehicle-related hard- & software.

Source: Continental

Bilder tauschen?!

IDENTIFIED OPPORTUNITIES IN SDV

- Efficient, parallel development of hardware and software to accelerate innovation cycles.
- High computing performance of cloud services to process and analyze the massive volumes of vehicle data that cannot be handled on premise.
- AI in the cloud to validate detected objects against test data, enabling the approval of new software updates quickly and reliably.
- Cloud storage and data pipelines to support simulations, such as testing ADAS functions, to ensure robust vehicle performance.
- Conducive development environment through edge platforms, benefiting both OEMs and suppliers in the SDV ecosystem.
- Digital Twins as crucial components to simulate, test, and certify vehicle electronics within a cloud computing environment, enhancing reliability and efficiency.
- Opportunity for SMEs to collaborate with OMEs in vehicle software development by leveraging open modular platforms.
- Industry task forces like ECLIPSE and SOAFEE support the development of standards and open source solutions.



Source: SBD Automotive

IDENTIFIED CHALLENGES IN SDV

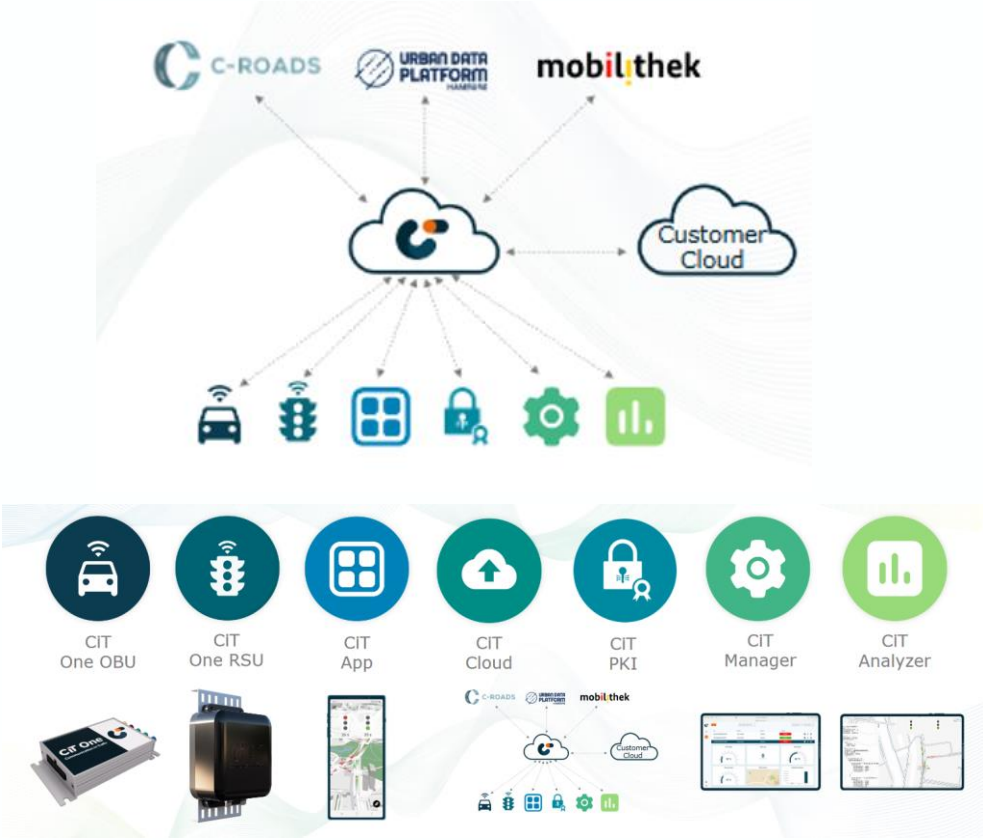
- The business value of vehicle data has largely been over-estimated. It is depending on the specific business case to generate added value.
- Start-ups which collect and sell vehicle data have not yet been commercially successful. Today, user experience generates the highest value preposition.
- Data sharing efforts in the framework of CATENA-X are already a first success, but open solutions for the collection of vehicle data is still an issue.
- Open interfaces are not largely implemented, not all interfaces will be open. Data sharing of vehicle data will be most likely not possible. Field data from vehicles will remain in the vehicle also in the future.

TOPIC 2: TRAFFIC MANAGEMENT/ C-ITS

Example of C-ITS traffic management formed by **Consider IT and Hetzner in Hamburg (Germany)**.

Consider IT provides an edge-based platform for the management and maintenance of C-ITS-Services as well as V2I roadside units and vehicle-onboard units.

Cloud services come from European providers, e.g. Hetzner.



C-ITS Approach City of Hamburg

Source: Consider IT

IDENTIFIED OPPORTUNITIES AND CHALLENGES IN C-ITS

- Innovative solutions for more **efficiency and safety** in a smart mobility system.
- The application is an example for a CEI solution which is completely based on a co-operation of **European stakeholders**.
- **Open access** to traffic data is possible e.g. via the Urban Data Platform Hamburg and the Mobilithek as National Access Point for traffic data in Germany.
- **Open access** to traffic data is possible in the public domain, especially if required by accompanying regulation.
- **Data security** (Public Key Infrastructure) is integrated in the system.

CONCLUSIONS FROM THE WORK

- Mobility expertise can often be found among European IT providers specialising in mobility. This is a potential area for European Edge Computing.
- The mobility sector is largely dominated by the same hyperscalers as other industries.
- The services of hyperscalers should be employed in as a simple service when required, but the European expertise must remain in the application-based edge solution without European suppliers losing knowhow.
- European know-how needs to be incorporated into European CEI solutions (e.g. PKI functions, specific knowledge of automated driving regulations).
- For European solutions, especially in the public sector, open data platforms and data sovereignty are important.
- Ideas for European R&I projects:
    - Cooperation between OEMs and supply chain: Build and demonstrate open interfaces between cloud-based development environments and tool chains for different OEMs and suppliers.
    - Standardisation of data sharing formats for seamless integration of tool chains.

deployEMDS

Towards a common European mobility data space

UNLOCK-CEI Webinar on Cloud-Edge-IoT in Transportation

05.07.2024

Dr. Stefanie Federl

Co-funded by the European Union

This project has received co-funding from the Digital Europe Programme under grant agreement no. 101123520.

Context

Common European data spaces

- Health
- Industrial & Manufacturing
- Agriculture
- Finance
- **Mobility**
- Green Deal
- Energy
- Public Administration
- Skills

Initiatives supporting the creation of a common EMDS

PrepDSpace4Mobility

CEF technical support study:
technical & governance dimensions
(Ricardo, Wavestone, VTT)

deploy EMDS

Co-funded by the European Union

From theory to implementation

PrepDSpace4Mobility

Oct 2022 – Sep 2023

17 European partners

Map existing data ecosystems

analyse and recommend
common building blocks for a future EMDS.

deploy EMDS

Nov 2023 – Oct 2026

45 European partners

build a decentralised technical infrastructure
and common governance mechanisms

for urban mobility use cases in 9 cities and
regions across Europe.

01

Vision

A common data space can help address key challenges in mobility

CHALLENGES	Fragmentation of data sources	Reluctance to share data due to security and competition concerns	Lack of interoperability between different data types and standards	Underutilised innovation potential of mobility data
OPPORTUNITIES	 Better data discoverability & accessibility	 Data sovereignty and trust through identification & usage policies	 Convergence towards common standards	 New data-driven solutions and business models

EMDS empowers trustworthy, accessible and interoperable data sharing

Data sovereignty and trust

Retaining authority and control over data.

Accessibility

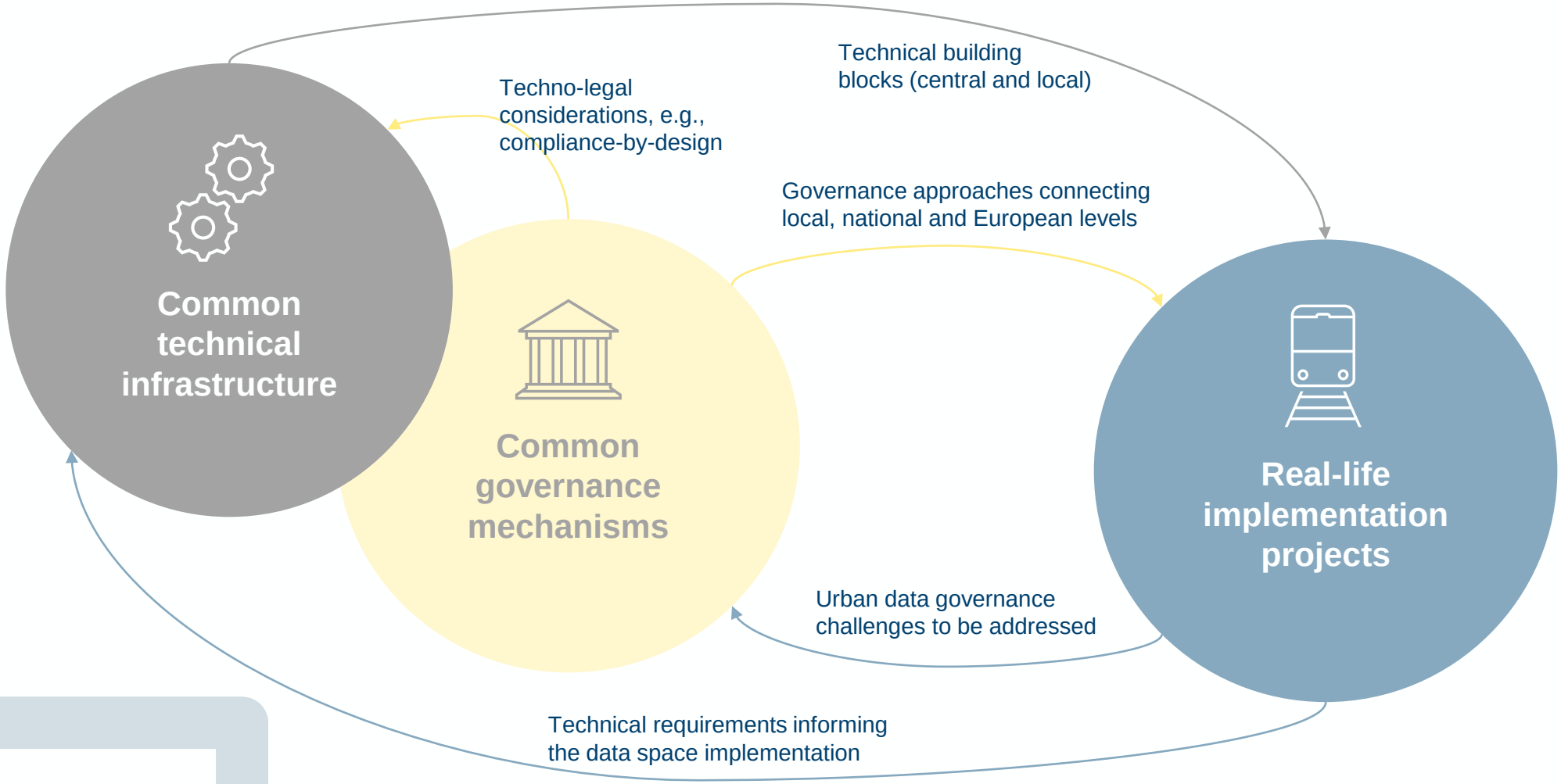
Discoverability and availability of mobility data.

Data interoperability

Sharing and exchanging data in a standardised way.

EMDS will offer a framework for interlinking and federating mobility and logistics data sharing ecosystems

deployEMDS supports the EMDS initiative through testing and implementation



02

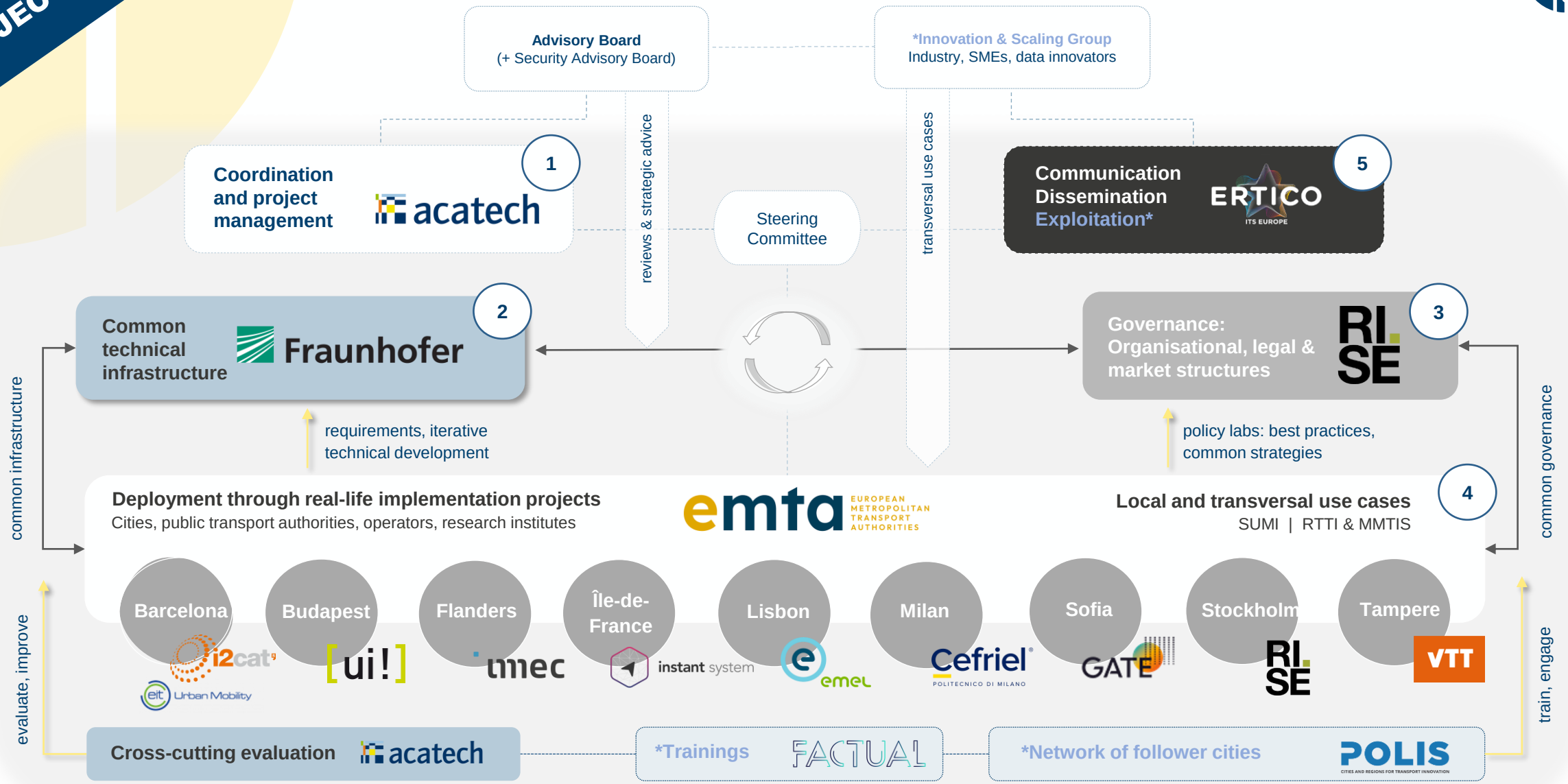
Project overview

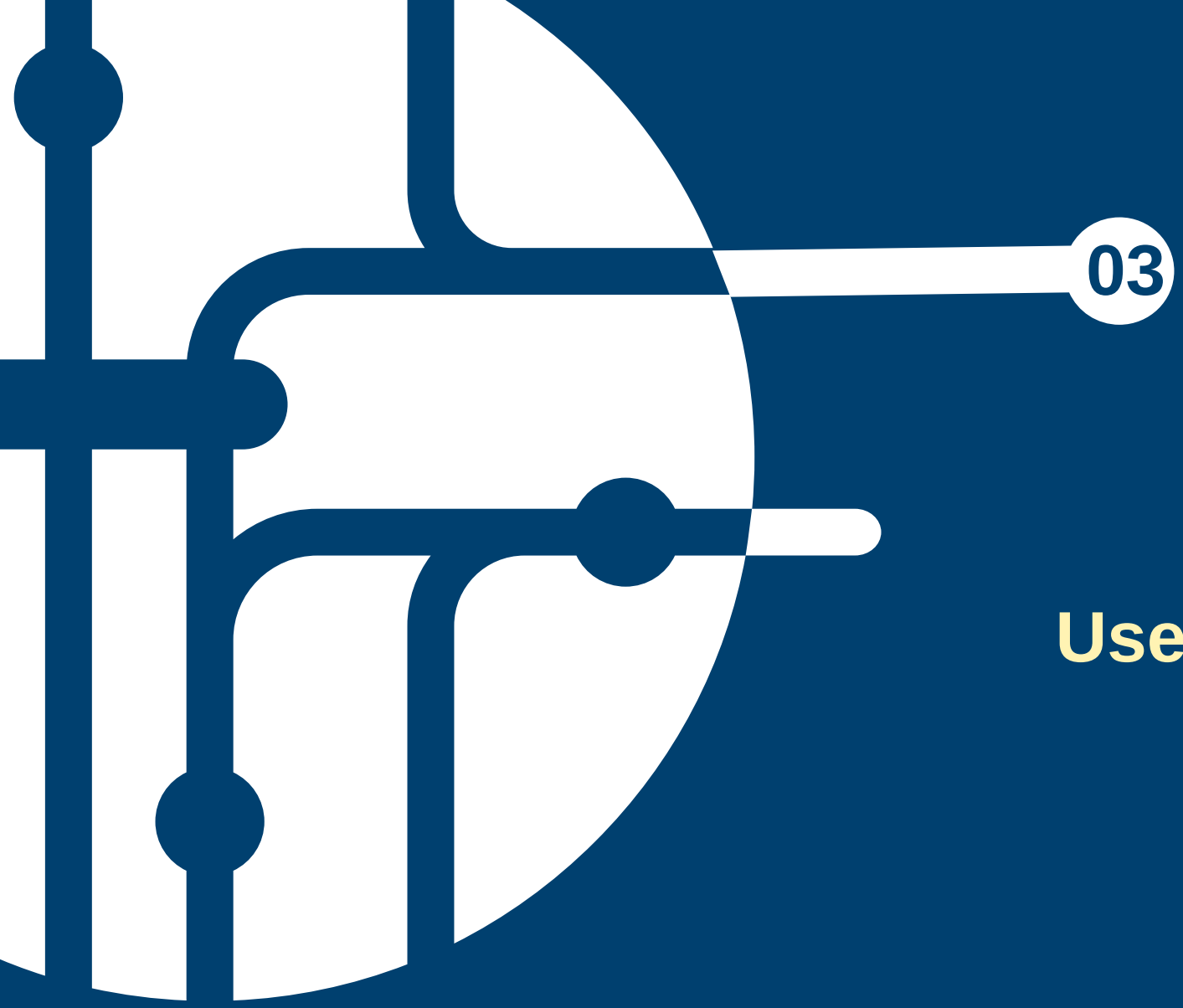
deployEMDS at a glance

36 months (Nov 2023 – Oct 2026) | Budget: ~EUR 16 million

38 beneficiaries (cities, regions, technical & domain expertise) | 7 associated partners

PROJECT SETUP





Use cases

16 use cases in 9 cities & regions

Mobilising Europe through interlinked data sharing ecosystems

Flanders

Sofia

Barcelona

Tampere

Île-de-France region

Focus:

- multi-modal travel information
- real-time traffic information
- Sustainable Urban Mobility Indicators

Budapest

Milan

Lisbon

Stockholm

deployEMDS.eu/deployment/

Local Use Cases in 4 Clusters, 2+ Transversial Use Cases

TRANSVERSAL 1: Multimodality (Open PT Ticketing, Integration of Shared Mobility in PT Apps, Multimodal Mobility Management and Data Reporting to Authorities)

TRANSVERSAL 2: Data Reporting for Sustainable Urban Mobility Indicators (SUMI)

Public Transport Operations

BAR 01: Multi-Operator Fleet Data System

LIS 03: Increase reliability and commercial speed of buses

Data for Mobility Planning

BAR 02: Forecasting system to optimize traffic

FLA 01: Optimizing the re-use of traffic measurement data

MIL 01: Decision support system for local public transport planning

MIL 02: MaaS based mobility scenarios

STO 01: Gradual introduction of zero emission zones and introduction of measures to reduce car traffic

TAM 01: Collection of data mandated by ITS Directive

Multimodality

BUD 01: Multimodal Route Planning in BudapestGO

IDF 01: MaaS for Companies

LIS 02: Increasing the attractiveness of alternative mobility solutions

SOF 01: Connected, Green and Shared Journeys

SOF 02: Park and Walk

IDF 02: Optimization environment for journey planner providers

Speciality Travel Information

BUD 02: Mobility as a Right for people with reduced mobility

LIS 01: Enhancing seamless route-planning for people with reduced mobility

Local use cases in the spotlight

FLA 01: Optimizing the re-use of traffic measurement data

Current situation: Traffic measurements are used for applications in and beyond the mobility domain, like traffic control, digital twins as well as modelling of emissions and noise maps. The sensor-to-analysis value chain is often linear and closed, limiting accessibility.
Objective: Further developing the VSDS traffic measurements data space in Flanders, interlinking the VSDS traffic measurements data space with other regions through the EMDS and improving usability for data consumers.

STO 01: Gradual introduction of zero emission zones and introduction of measures to reduce car traffic

Current situation: Data related to mobility, public transport and environment, e.g., air quality, is shared through its public data portal and open innovation platform. The adoption of governance models and standardisation of data formats varies greatly between these datasets.
Objective: Provide access to high-quality data to evaluate the zero-emission-zone by combining and improving existing data, collecting new data, and integrating them into the Stockholm Mobility Data Space (SMDS), with subsequent sharing to the EMDS.

Contact

Project coordination
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/deployEMDS

www.deployEMDS.eu

Co-funded by
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Fresh food supply and last mile optimization with NebulOuS

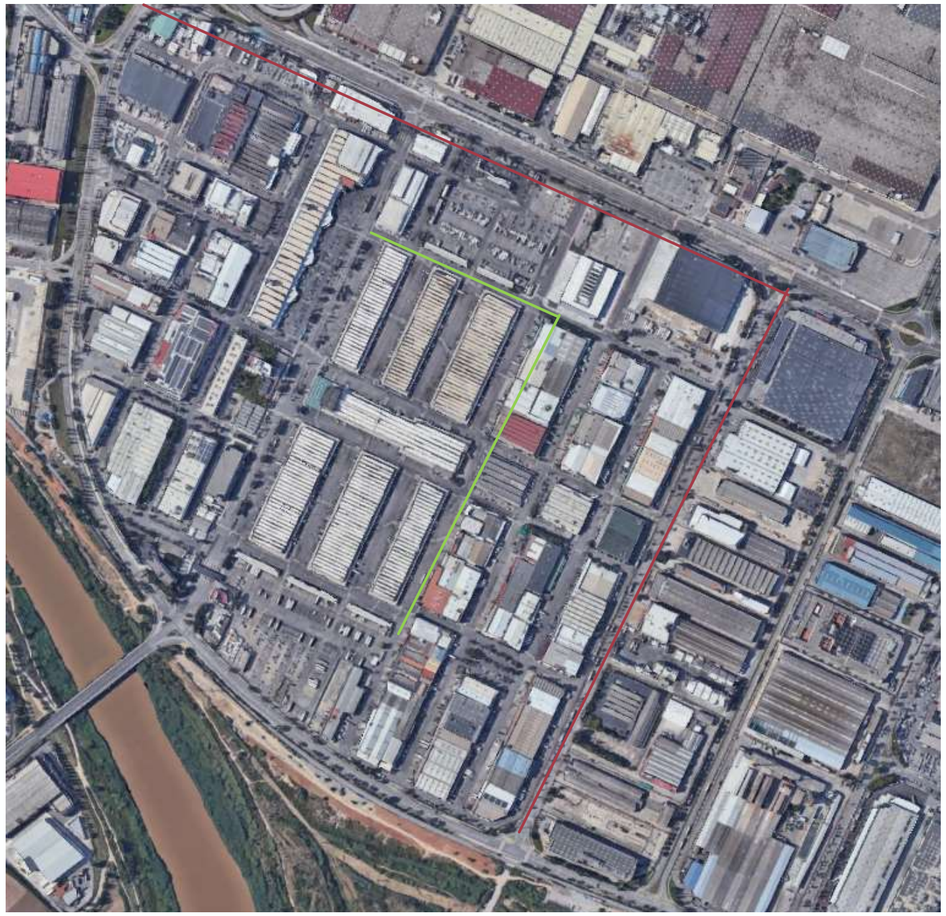
5th July 2024

Mercabarna

- Mercabarna is the largest wholesale market in Southern Europe and one of the biggest in Europe.

- Mercabarna is a fresh food hub with more than 600 companies specialized in fruits, vegetables, fish, meat and also flowers.

- From big trucks to vans, cars or forklifts work together to carry on customers' operations everyday.



Mercabarna

- Approximately 13,000 vehicles access the food unit every day
- Of which 7000 (54%) are commercial vehicles
- Of these, 1000 (8%) are large tonnage vehicles

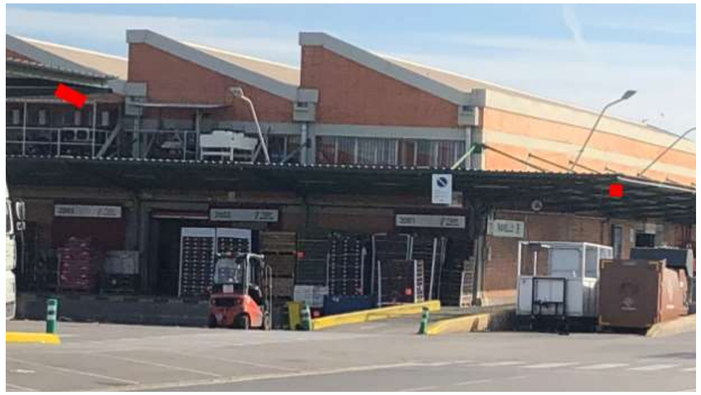
Mercabarna problem

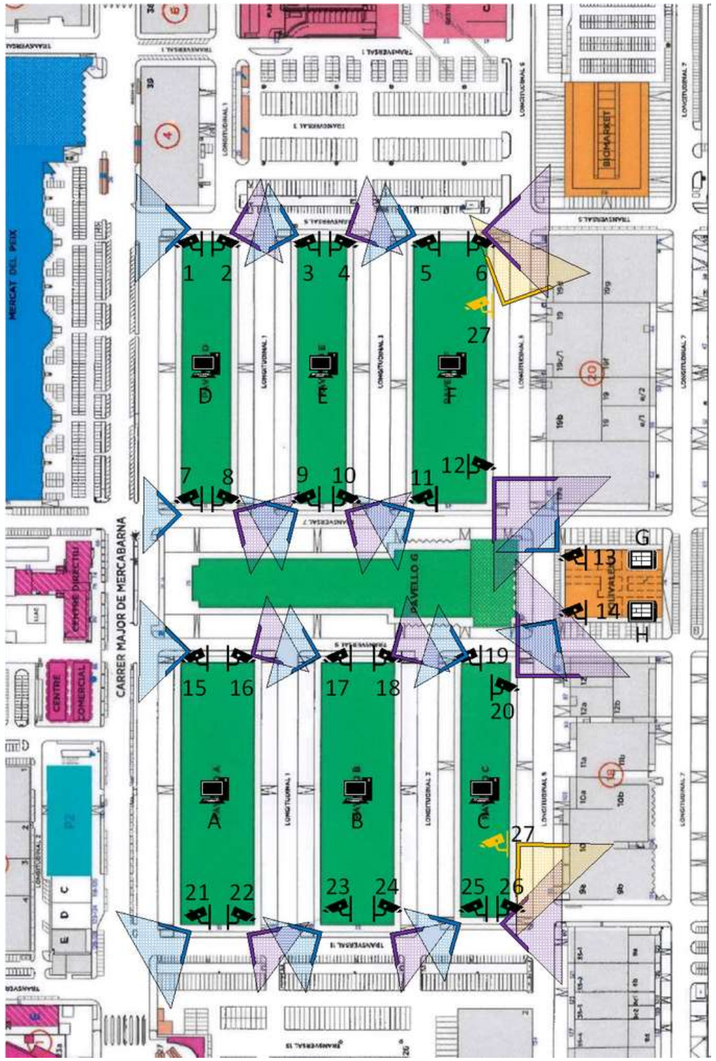
- Matching entry/exit windows

- The appropriate management of internal traffic is crucial for traffic jams and bottlenecks prevention

Mercabarna solution

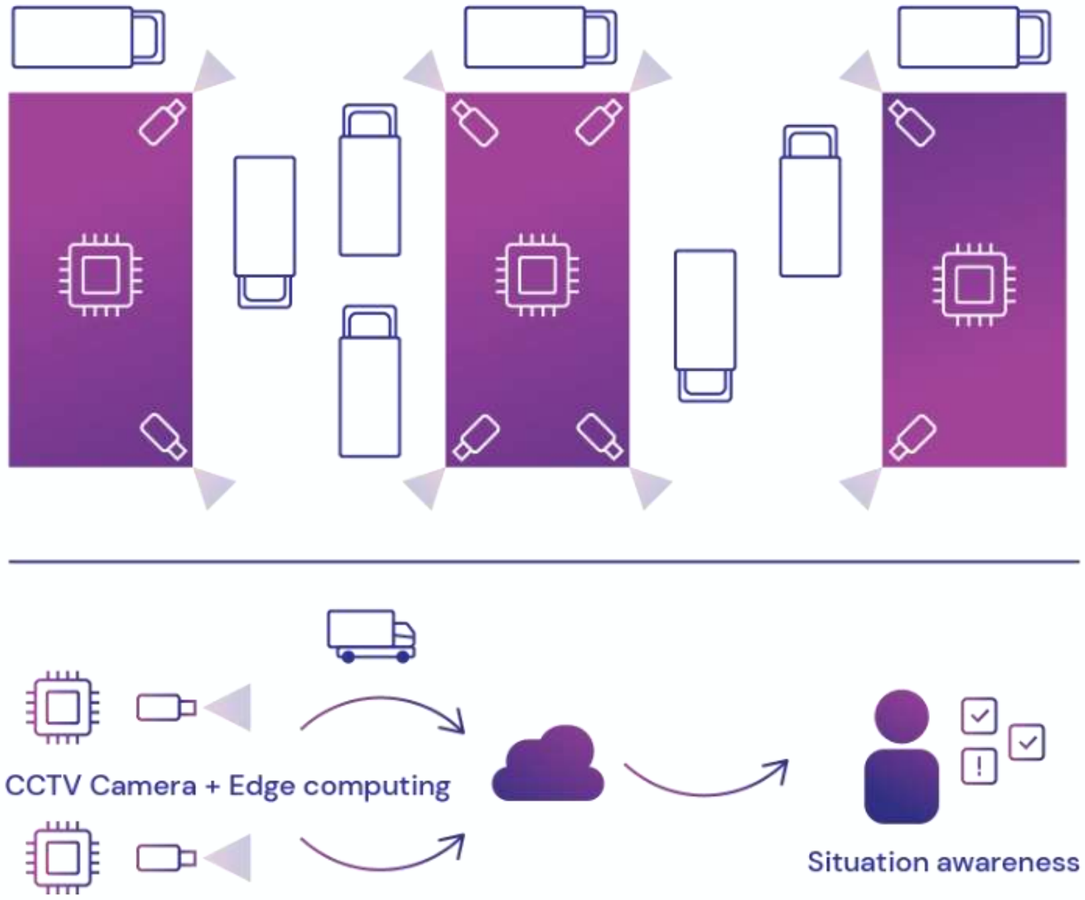
- Efficient management of internal traffic is a must.
- A real-time traffic monitoring system is currently in development.
- A network of CCTV cameras placed in the road intersections record the traffic in both directions.



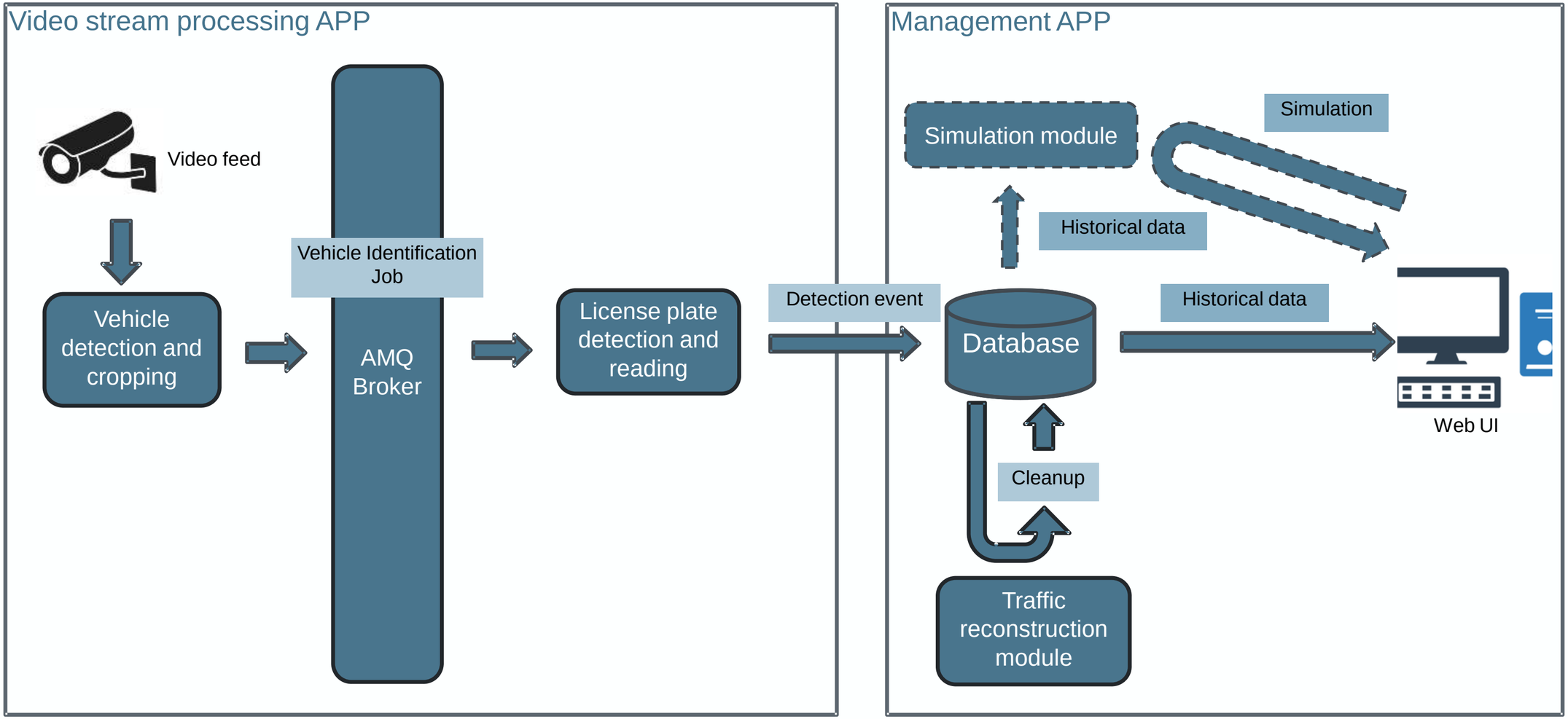


Mercabarna solution

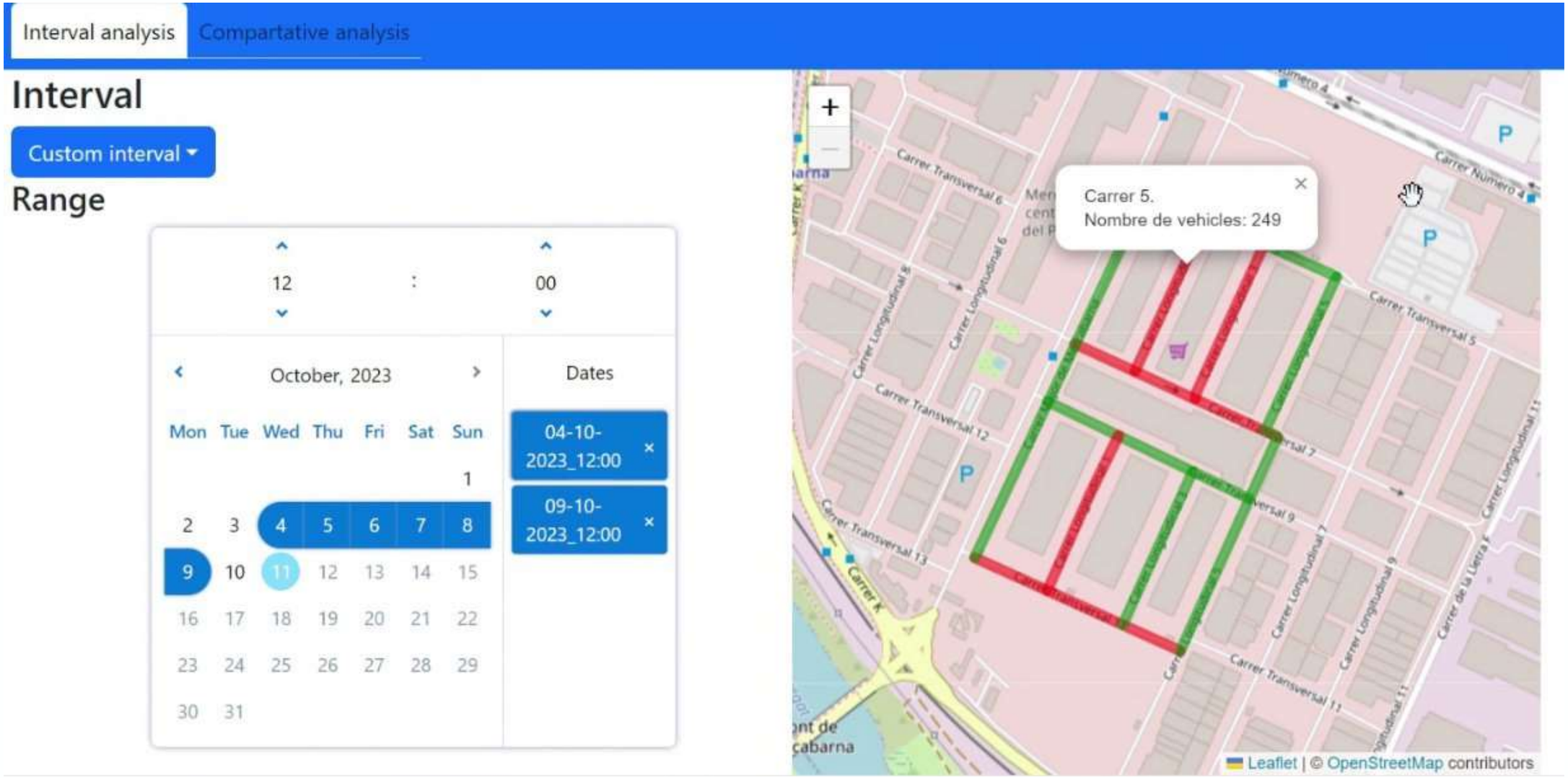
- The CCTV cameras stream the videos within the internal network, providing valuable information.
- With this information, we will be able to ensure smooth operations and prevent traffic jams or bottlenecks.
- Maintaining a cleaner and tidier environment will make life easier for our workers, sellers, buyers and visitors.



Architecture of the solution



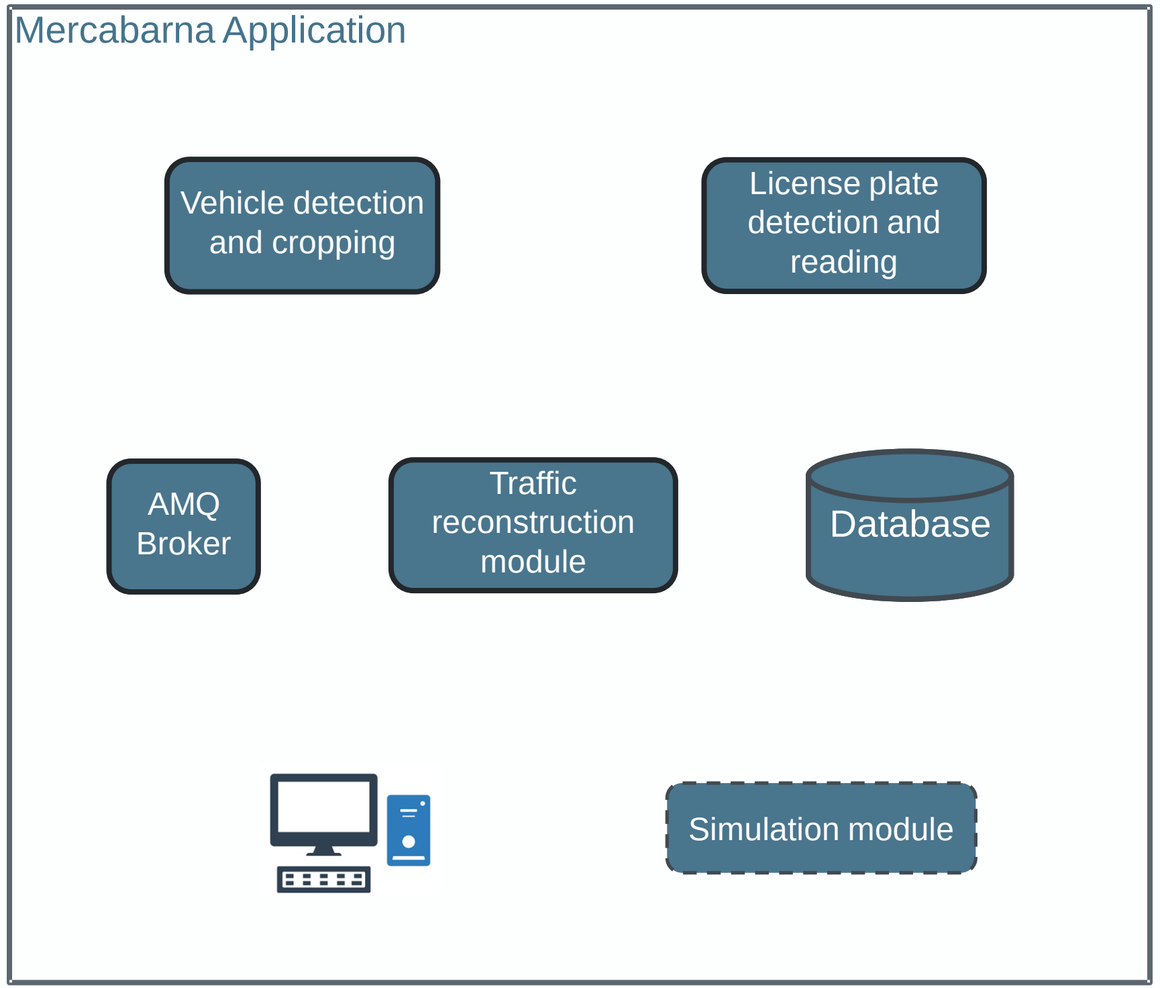
Web application



NEBULOUS

A META OPERATING SYSTEM FOR BROKERING HYPER-DISTRIBUTED APPLICATIONS ON CLOUD COMPUTING CONTINUUMS

- Manage the application deployment in cloud-fog-edge continuum.
- How NebulOuS helps the Mercabarna U.C?



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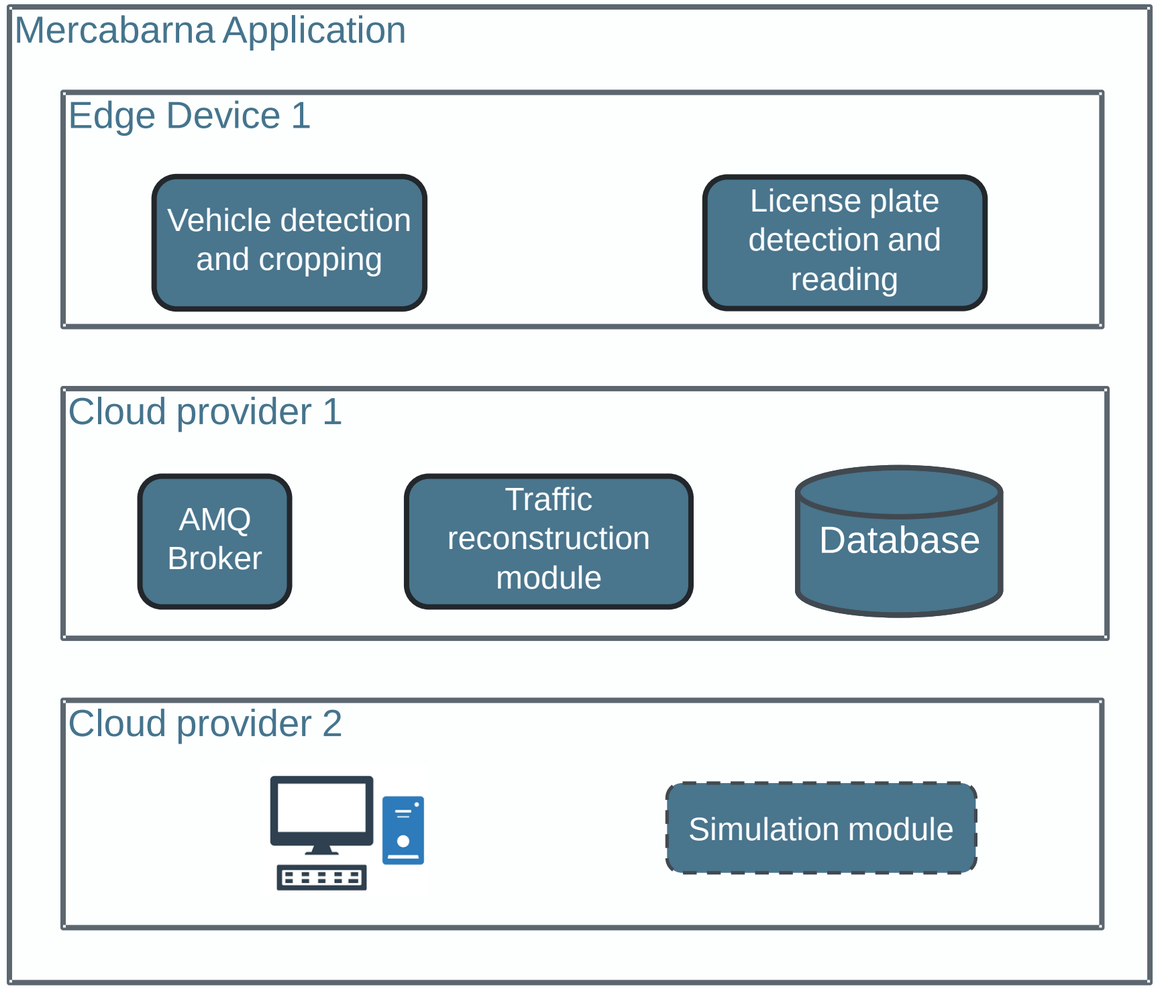

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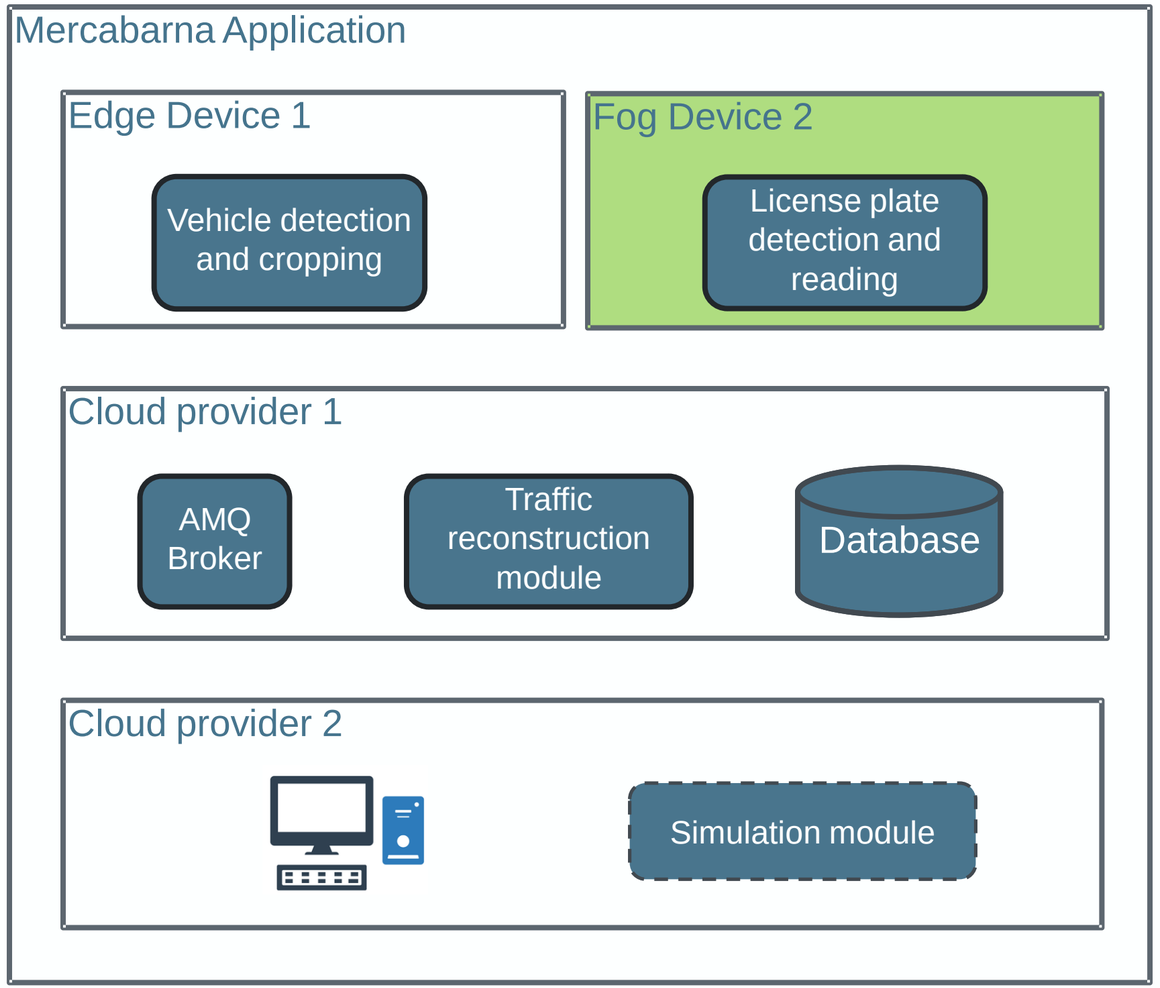

NEBULOUS

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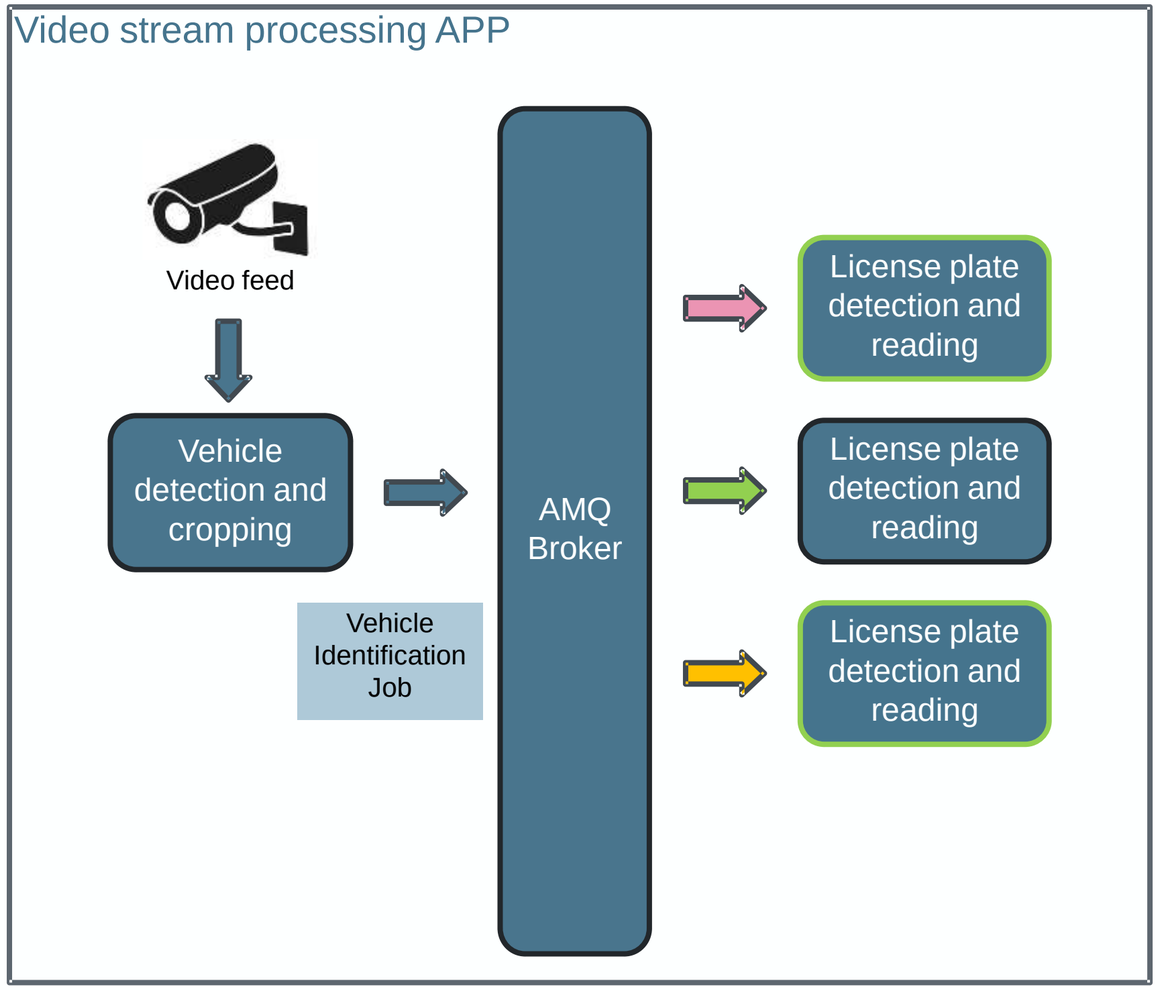
  - Decide at any time the application deployment topology
  - **Scaling the module instances**



Conclusion

- **Optimizing Traffic Management:** Improving to Smoother traffic, avoiding congestion and bottlenecks.
- **Enhancing Stakeholder Satisfaction:** Cleaner, Tidier Environment will improve Mercabarna's sellers, buyers, and visitors experience.
- **Agile deployment with NebulOuS**: Empowering Mercabarna with an easy and adaptively deployment capable of adapt according to the evolution of the environment.

NebulOuS

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info@nebulouscloud.eu

EUCloudEdgeIoT.eu

info@eucloudedgeiot.eu

EUCloudEdgeIoT

EU_CloudEdgeIoT

eucloudedgeiot_eu

Atos

BluSpecs

COMMpla
Communication Platforms and Online Solutions

ECLIPSE FOUNDATION

egi

IDC

Inside
Industry Association

MARTEL innovate

Trialog

Trust-IT Services
communicating to markets

VDI|VDE|IT

ICOS

Railway Structural Alert Monitoring system

Izabela Zrazinska

WORLD SENSING
CONNECTED OPERATIONAL INTELLIGENCE

Carles Miralpeix i Llorach

FGC
Ferrocarrils de la Generalitat de Catalunya

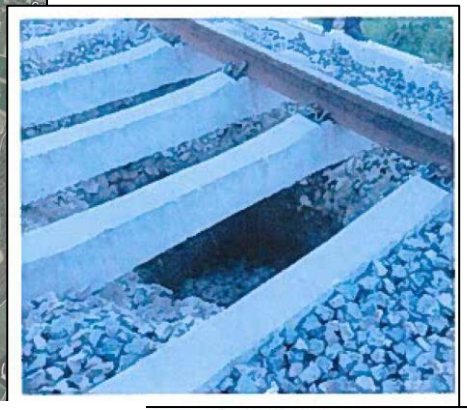
Funded by the European Union

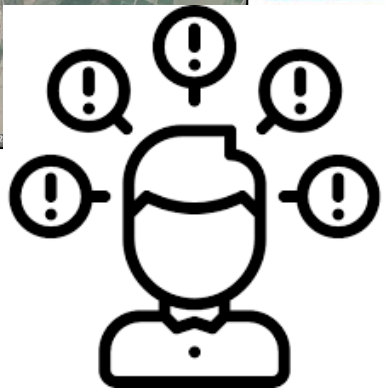
The problem

- Appearance of holes due to ground instability.
- Safety problem, due to unpredictable rail track movements.

Main impacts:

- Time: Visual inspections weekly/ bi-weekly.
- Repairs: Several times per year, works to correct track geometry.
- Quality: To reduce safety consequences, train circulation is limited to 30 km/h during 4km.

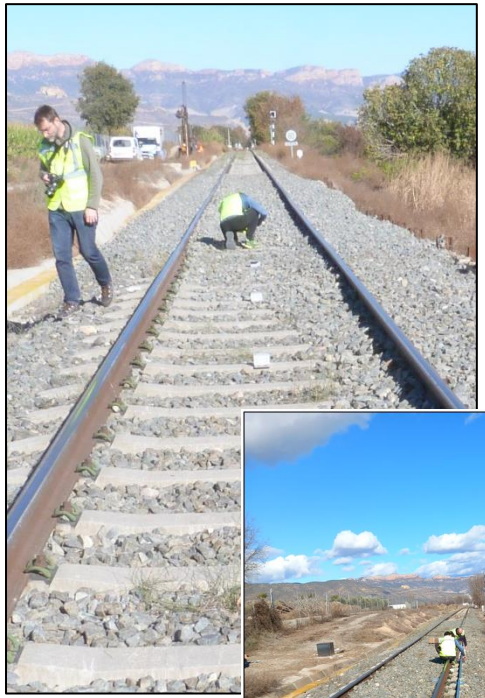




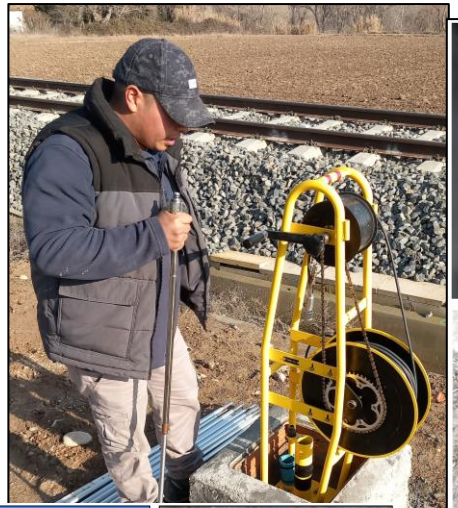
Railway Installation

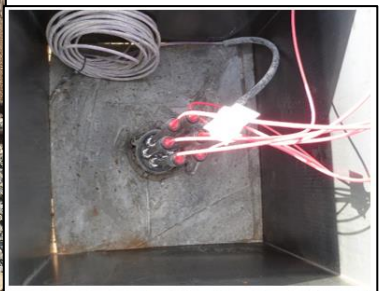
Installation

Gateway



Tiltmeters



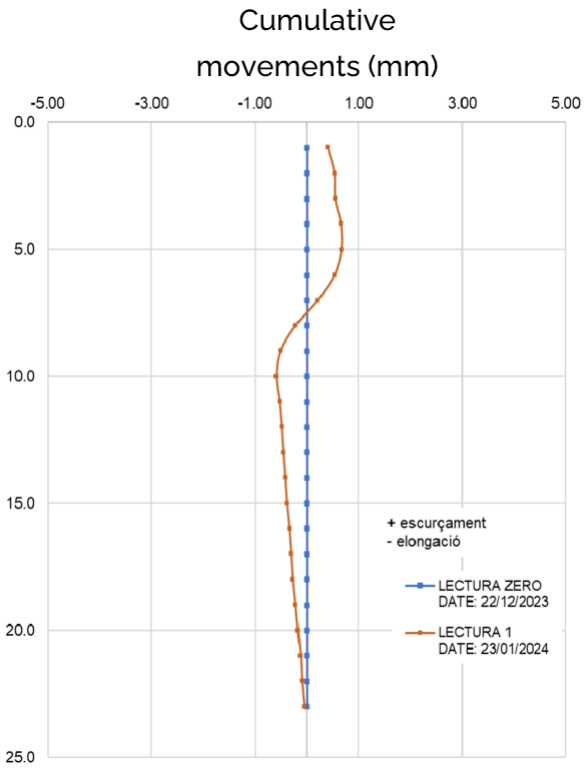


Extensometers

Tilt beams

Railway Installation

First results: real time data flow



ΔPressure (kPa)

chart scale (84 to 89 KPa)

ΔDeformation (mm)

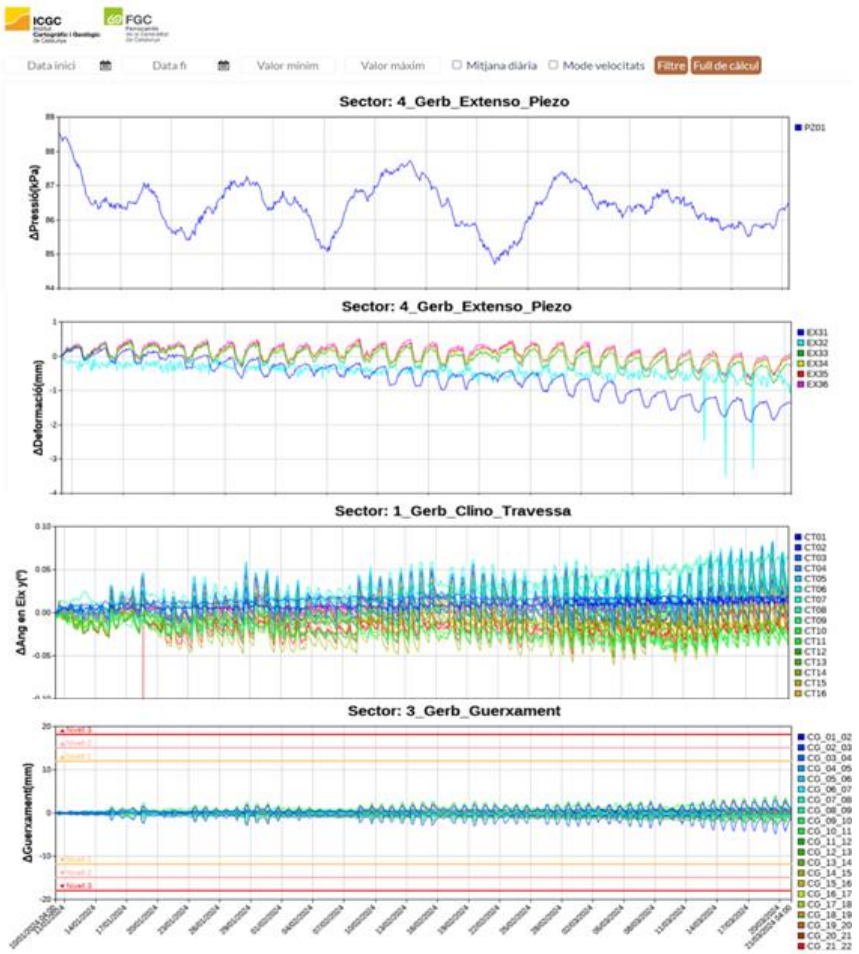
chart scale (-4 to 1 mm)

ΔAngular (y-axis)

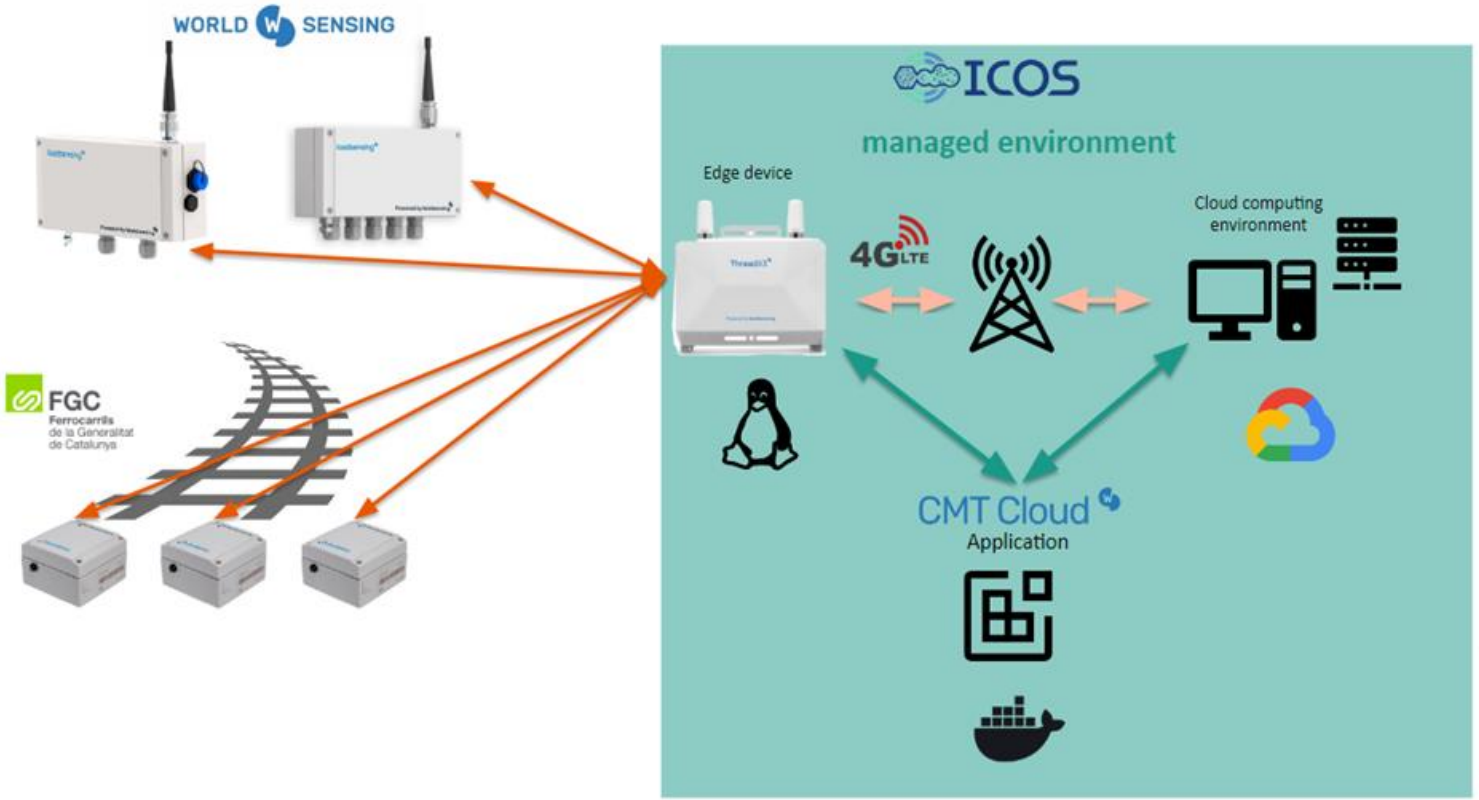
chart scale (-0.10 to 0.10 mm)

Δwarp (mm)

chart scale (-20 to 20 mm)



ICOS architecture applied to railway use case



Challenges and benefits from ICOS

Challenges: improving wireless networking protocols, efficient and optimal utilization of the available edge-to-cloud resources.

Expected Benefits from ICOS:

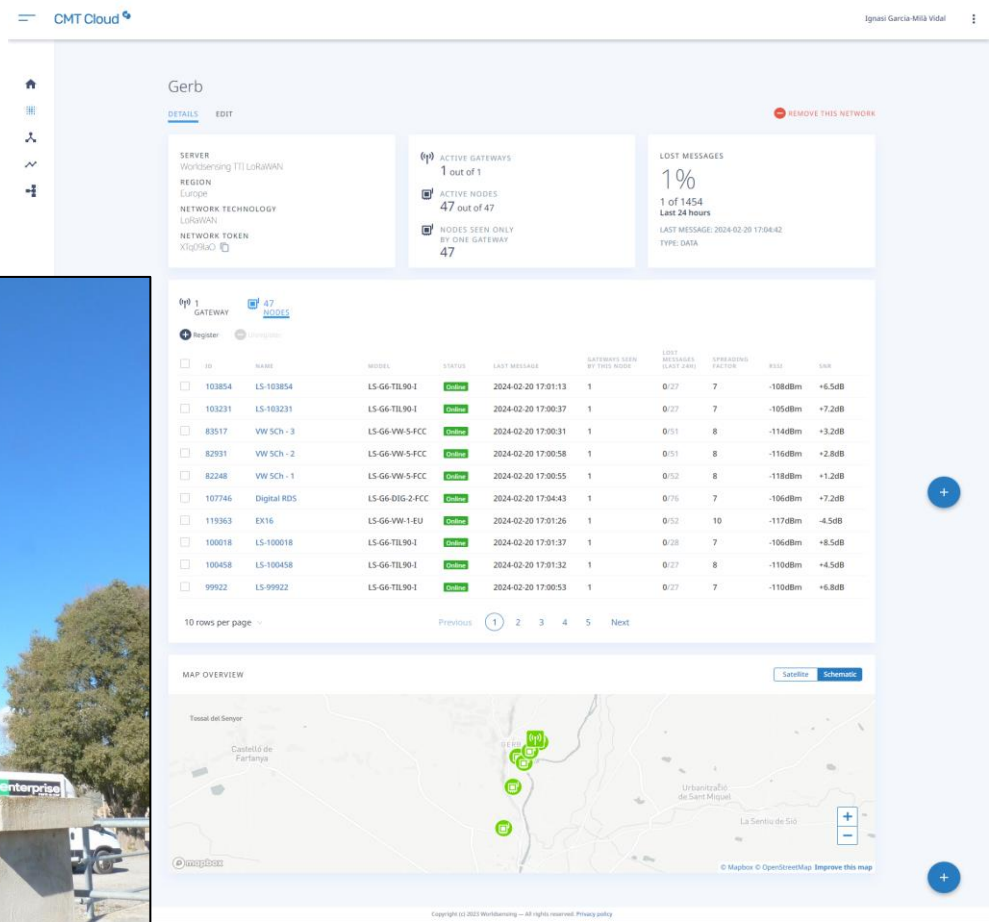
- Data integrity and synchronization (if connectivity problems between Edge-Cloud)
- Critical event detection for Safety (operate regardless of connectivity and taking local decisions)
- Prediction for maintenance planning (Decision on data transfer to upper layers)

Where are we now?

ICOS ecosystem set-up process

- Edge Infrastructure onboarding (Gateway)
- CMT Cloud deployment: app descriptor

Edge Device: Gateway



ICOS

Towards a functional continuum operating system

Thank you

izrazinska@worldsensing.com
cmiralpeix@fgc.cat

ICOS project has received funding from the European Union's Horizon Europe Framework Programme under the Grant Agreement N° 101070177.
Views and opinions expressed in this presentation are however those of the ICOS Consortium 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

Funded by the European Union

nephele

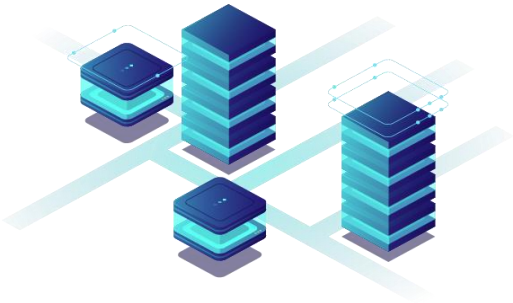
A lightweight software stack and synergetic meta-orchestration framework for the next generation compute continuum

Use case: AI-assisted Logistics Operations in the Port of Koper

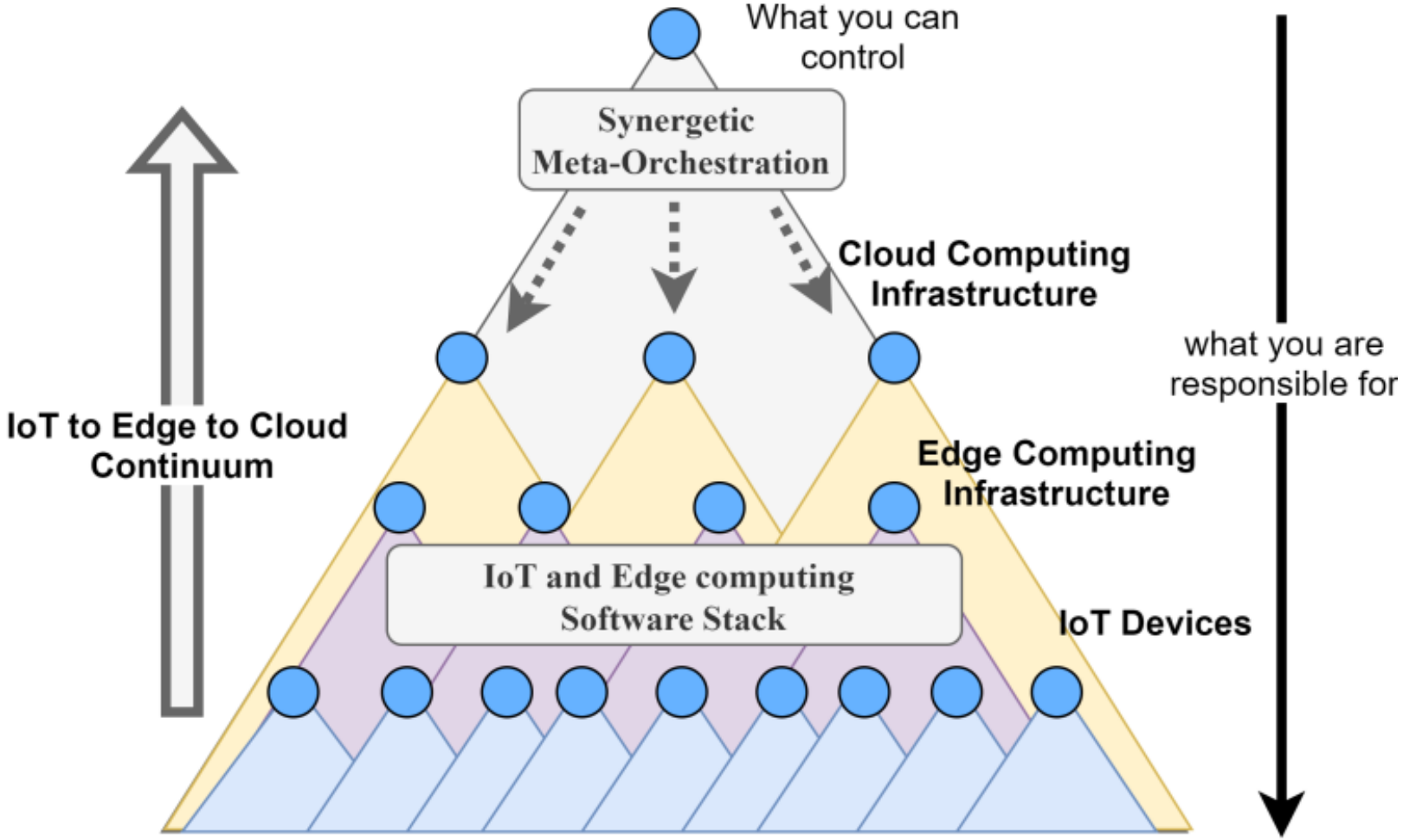
Rudolf Sušnik
INTERNET INSTITUTE

NEPHELE project in general

- Challenges for the Computing Continuum
  - need for **convergence of IoT technologies** based on novel architectural approaches, able to guarantee continuous and seamless openness and interoperability of the existing and emerging solutions.
  - need for the provision of an **integrated meta-orchestration environment for hyper-distributed applications**, where a **synergy** between cloud and edge computing orchestration platforms takes place
- Main Innovations in NEPHELE
  - an **IoT and edge computing software stack** for leveraging virtualization of IoT devices at the edge part of the infrastructure and supporting openness and interoperability aspects in a device-independent way.
  - a **synergetic meta-orchestration framework** for managing the coordination between cloud and edge computing orchestration platforms, through high-level scheduling supervision and definition, based on the adoption of a “system of systems” approach



System of Systems approach



AI-assisted Logistics Operations in the Port of Koper

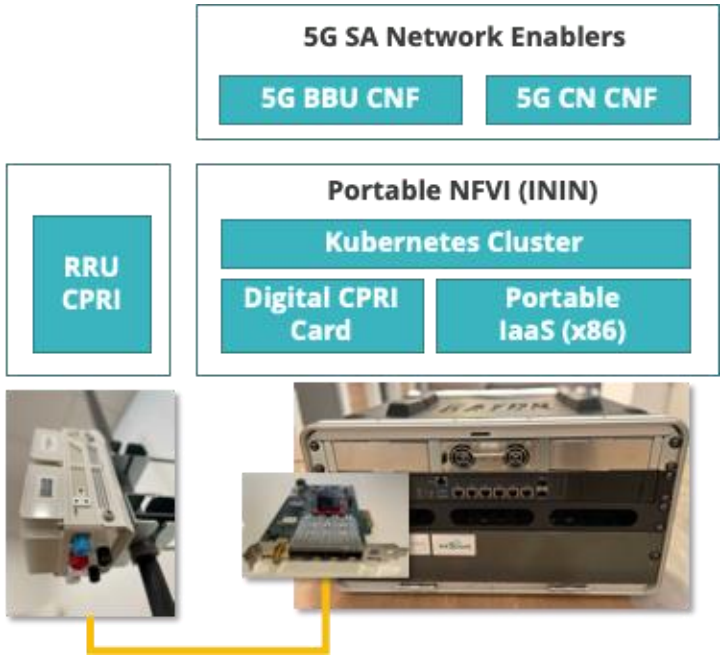
- Business perspective
  - optimizing the routing of cargo containers from the Container terminal yard to various Container Freight Stations within the port
  - reduced routing times
  - lower CO2 emissions
  - higher truck/forklift utilization
    - port trucks
    - reachstackers/forklifts
  - improved service level agreements

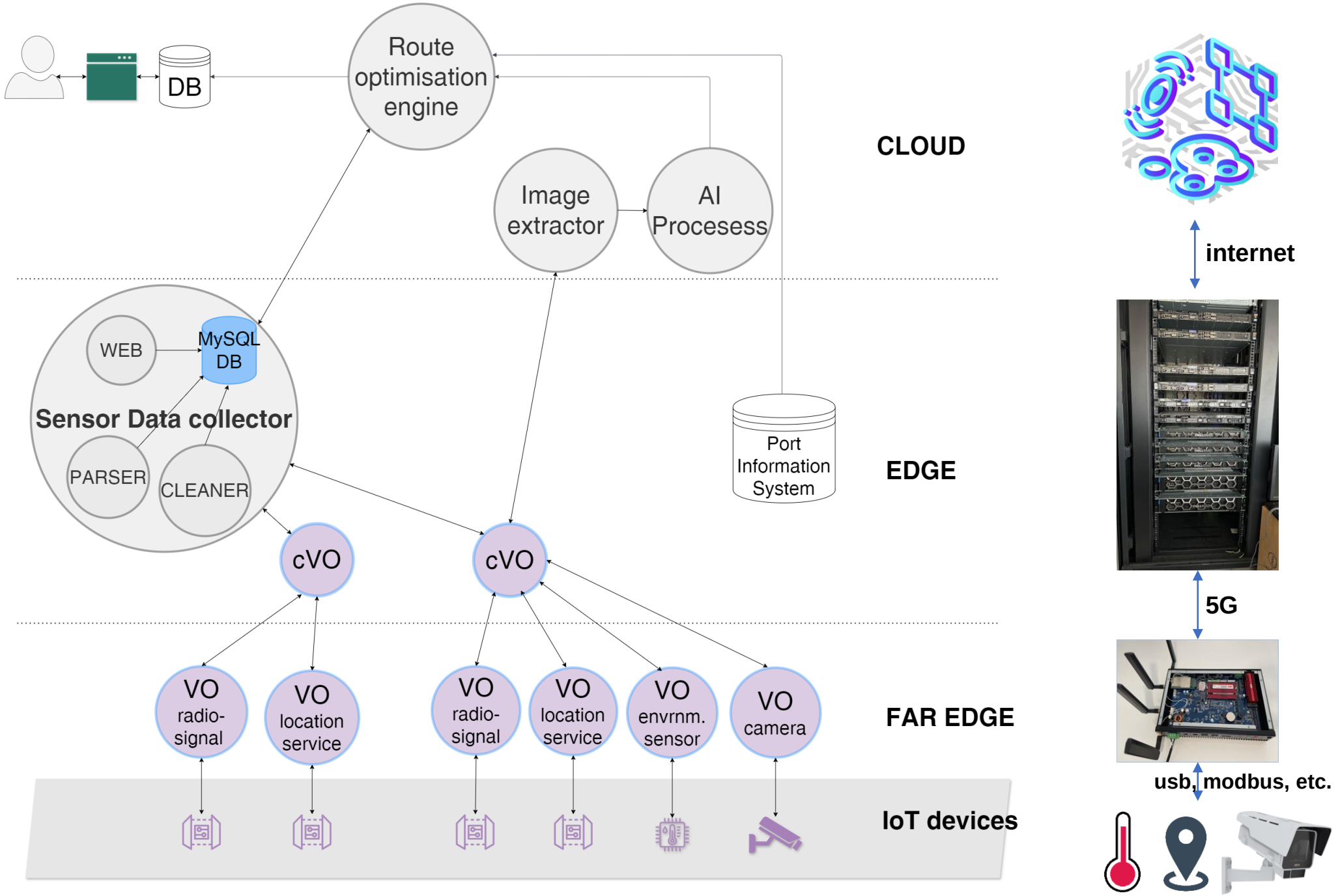
Technical challenges

- Identification of optimal route for the truck delivering cargo container from the terminal yard to warehouse
  - Euclidean Distance Method for the optimal route finding based on the minimization of the distances
  - Traveling Salesman Problem
    - Genetic Algorithm Optimizer to find out the optimal sequence of available warehouses
- Collecting relevant data from the field
  - video surveillance of the area of interest
    - available and non-available slots at warehouse area
    - traffic congestions
  - radio/network performance data
  - geo-location data (e.g., tracking port vehicles)
  - environmental data (temperature, humidity, CO, CO2)

Technical challenges

- Considering other business process related data
  - daily list of cargo containers to be delivered
  - availability of port vehicles
  - customers requirements
- Should work in real-time
  - integrated Time-Sensitive Networking (TSN) features
  - 5G network
  - Nephele cloud-edge-continuum approach




DB
Route optimisation engine
Image extractor
AI Procesess
CLOUD
internet
WEB
MySQL DB
Sensor Data collector
PARSER
CLEANER
Port Information System
EDGE
5G
cVO
cVO
VO radio-signal
VO location service
VO radio-signal
VO location service
VO envrnm. sensor
VO camera
FAR EDGE
usb, modbus, etc.
IoT devices

Business related performance benefits

- Delivery/routing times reduction
  - provides the opportunity to increase the volume of cargo delivery within a working day, or, to use less equipment (e.g., number of trucks) to do the same volume of cargo delivery
- Truck utilization increase
  - provides the opportunity to increase a single truck cargo delivery volume, thus improving truck's efficiency
- Reducing delivery errors
  - provides the opportunity to increase quality of service, i.e., satisfaction of the customers
- Reducing CO2 emissions of reachstackers
  - provides the opportunity of reducing CO2 emissions related to port activities

Conclusions

- Expected TRL at the end of the project is TRL 5 – 6
  - depends on certain component
- Relationships during further development of the solution
  - realistic field testing
  - further optimizations
  - addressing additional “pain points”
  - exploitation plan and business development
- Targeted customer segments
  - port operators
  - freight forwarders
  - general cargo distribution

nephele

Thank you!

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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 N°101069732

aerOS
EUROPEAN IOT-EDGE-CLOUD

aerOS - Smart edge services for the Port Continuum

Sheraz Aslam, Ph.D. – Cyprus University of Technology

Cloud-Edge-IoT innovations in Transportation: Market Insights and Use Cases,

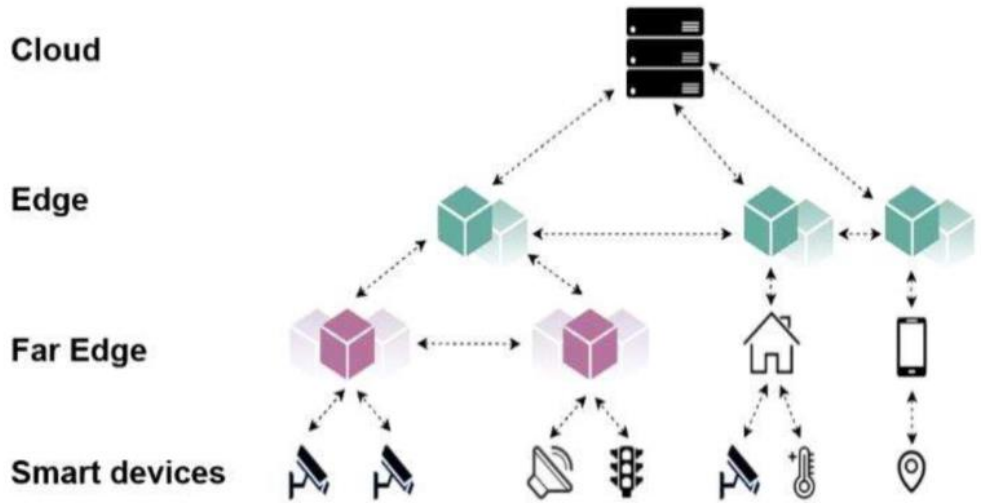
July 05, 2024

aerOS in numbers

Edge-cloud continuum, Frugal explainable AI, orchestration, virtualisation, networking, data governance and sovereignty, trustworthiness, decentralised computing

Sep 2022– Ago 2025 (36 months)

27 partners from 11 countries



Processing needs to be performed closer to the data sources (often smart devices), in an effort to minimise latency, save bandwidth, improve security, guarantee privacy and increase autonomy

The challenge of seamlessly integrating various edge technologies into a homogeneous "continuum" remains open

- Cloud centricity and cost
- Network management
- All-around virtualisation
- Security & trust

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Main goal and ideas

aerOS overarching goal is to design and build a virtualised, platform-agnostic **meta operating system for the IoT edge-cloud continuum**, independent from underlying hardware and operating system(s)

aerOS will…

…deliver virtualised services to enable orchestration and efficient support for frugal, explainable AI

…expose an API available anywhere and anytime, flexible, resilient and platform-agnostic

…include a set of infrastructural services and features addressing cybersecurity, trustworthiness and manageability

Use cases

- **Manufacturing:** Data-Driven Cognitive Production Lines (Manufacturing Autonomy Level 4 – MAL4)
- **Renewable energy:** Containerised Edge Computing near Renewable Energy Sources
- **Machinery:** High Performance Computing Platform for Connected and Cooperative Agricultural Mobile Machinery to Enable CO2 Neutral Farming (HPCP-F
- **Smart Buildings:** Energy Efficient, Health Safe & Sustainable Smart Buildings
- **Maritime ports:** Smart edge services for the Port Continuum

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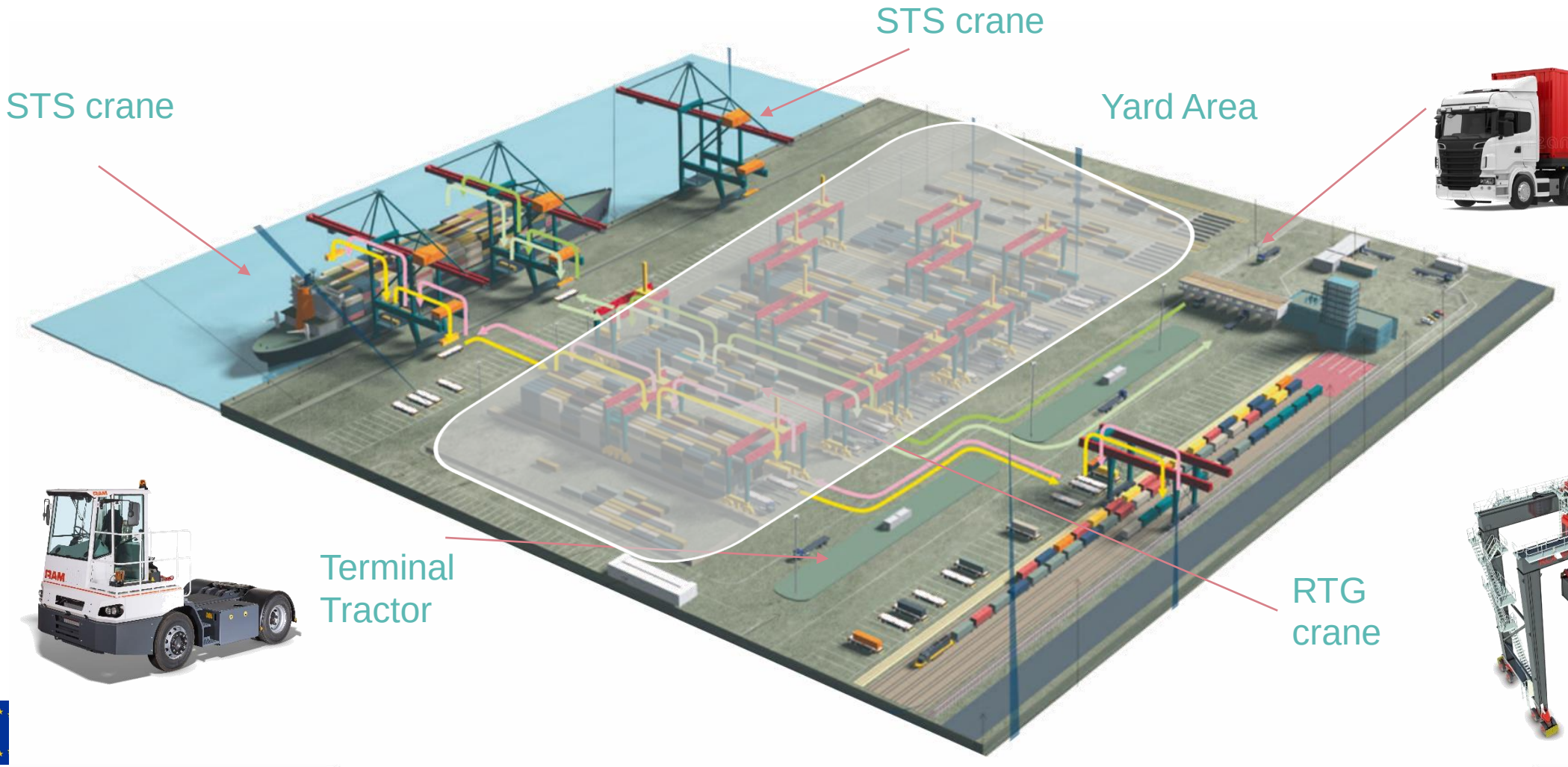
Maritime Logistics

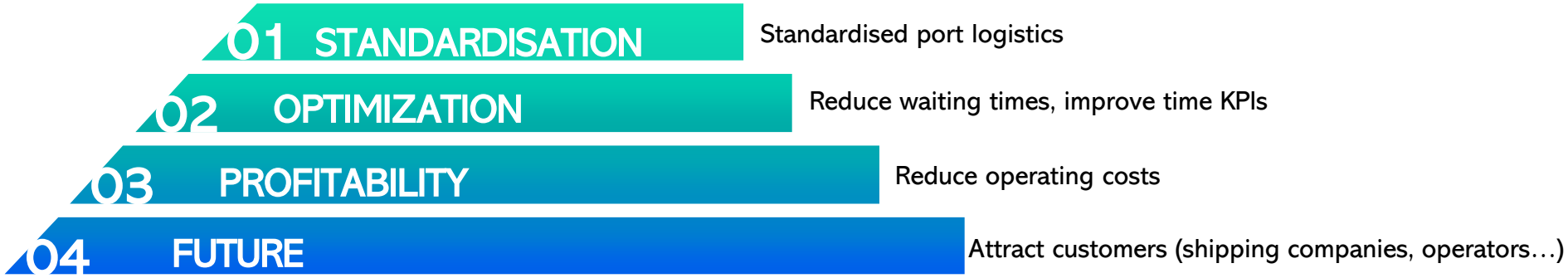
Complexity of maritime logistics due to the essential coordination of the different actors involved (e.g. port authorities, terminals, shipping agents, third parties, customs, …)



Maritime Logistics: the digitalisation journey

Using digital technologies to automate and optimize industrial processes

Digitalisation of the Port Community



Container Terminal Challenges

- Huge **amount of data**
- Very challenging conditions for stable **wireless connectivity** (redundancy and resilience)
- Not possible to do **M2M** communication
- **high bandwidth** (cameras) + **low latency** (minimum disruption) required
- **External parties** do not have digital connection to the terminal CHEs
- The workers are **not able to interpret** so huge amount of new **data**

Tools for cost reduction

- IoT and Big Data Platform that delivers intelligent insights based on real time operational data
- Automate yard operations with contextual information of the yard to improve safety and productivity
- Optimise vessel and berth operations by connecting all maritime agents through a single digitalised platform
- Synchronise operators' radio to the radio channel used by the Quay Crane it is serving

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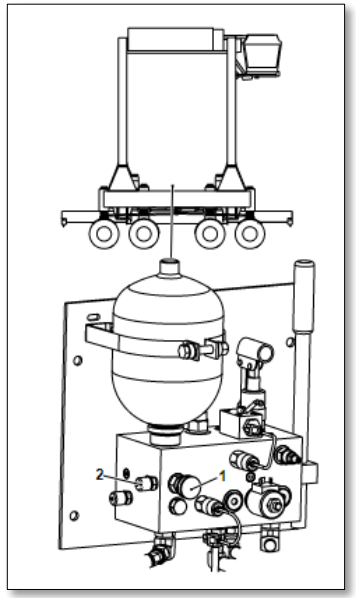
Pilot in a nutshell

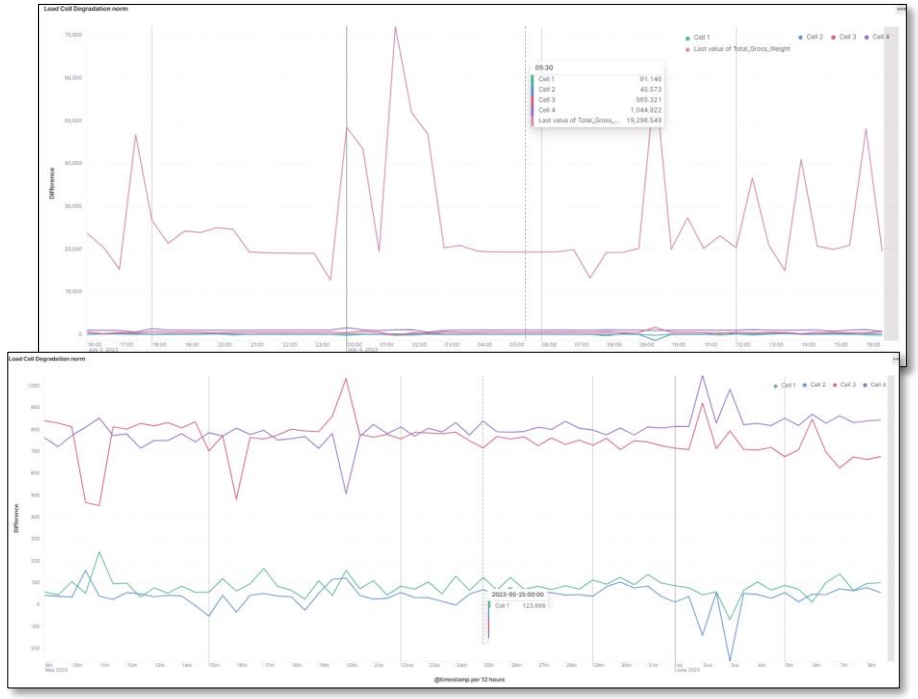
- Partners:
  - Eurogate Container Terminal Limassol (EGCTL)
  - Cyprus University of Technology (CUT)
  - Prodevelop (PRO)
- Location: Limassol (Cyprus)
- Two scenarios:
  - Predictive maintenance of Container Handling Equipment
  - Risk prevention via Computer Vision on the edge

PILOT 4 SCENARIO 1

Predictive maintenance of Container Handling Equipment

- Predictive maintenance can help identify maintenance issues ahead of time, allowing terminal staff to perform cost-effective duties and to extend the lifespan of the industrial assets with minimal cost. Proprietary software solutions like the TOS and CMMS will be able to exchange data in a secure, trusted environment, allowing the maintenance team to take better decisions faster.
- **aerOS support: self-*, analytics and AI tools, tailored to distributed autonomously-orchestrated continuum.**





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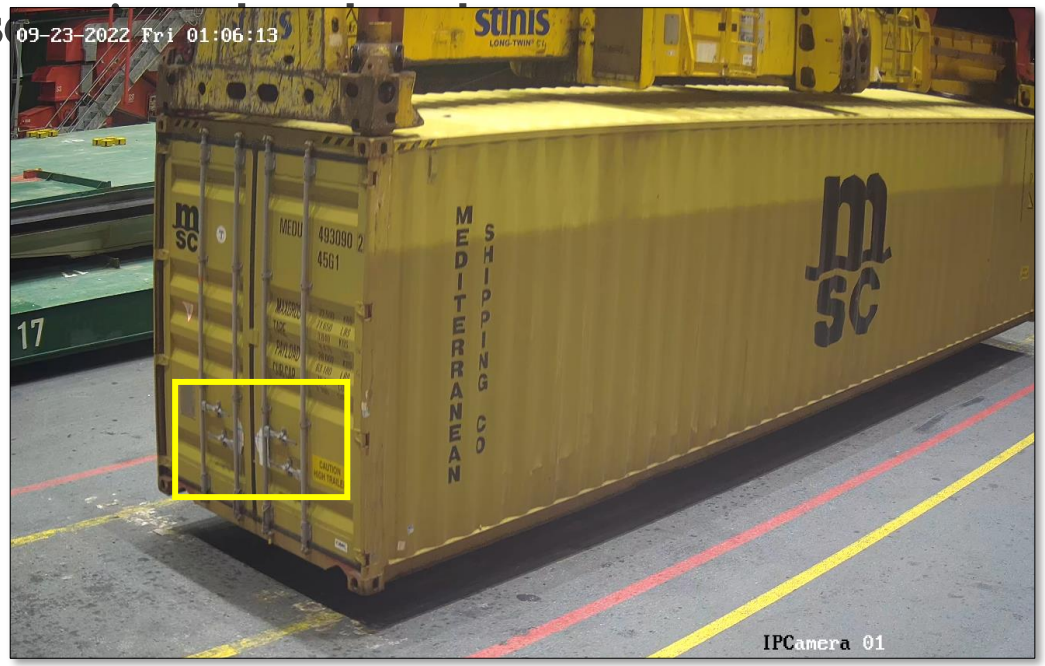
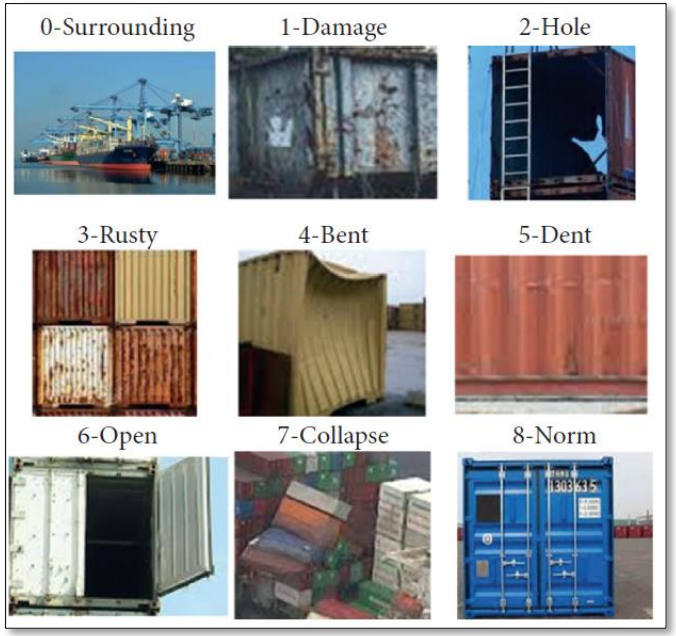
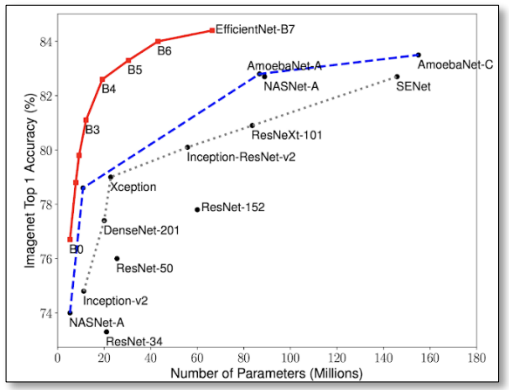
PILOT 4 SCENARIO 2

Risk prevention via computer vision in the edge

- CV algorithms at the edge will allow the terminal to automatically:
  1. Identify containers with damages
  2. Check the proper container seals
- **aerOS support: Intelligent orchestration of distributed applications for video stream inference at the edge; a secure, trustable and self-orchestrated IoT edge-cloud continuum via leveraging s**







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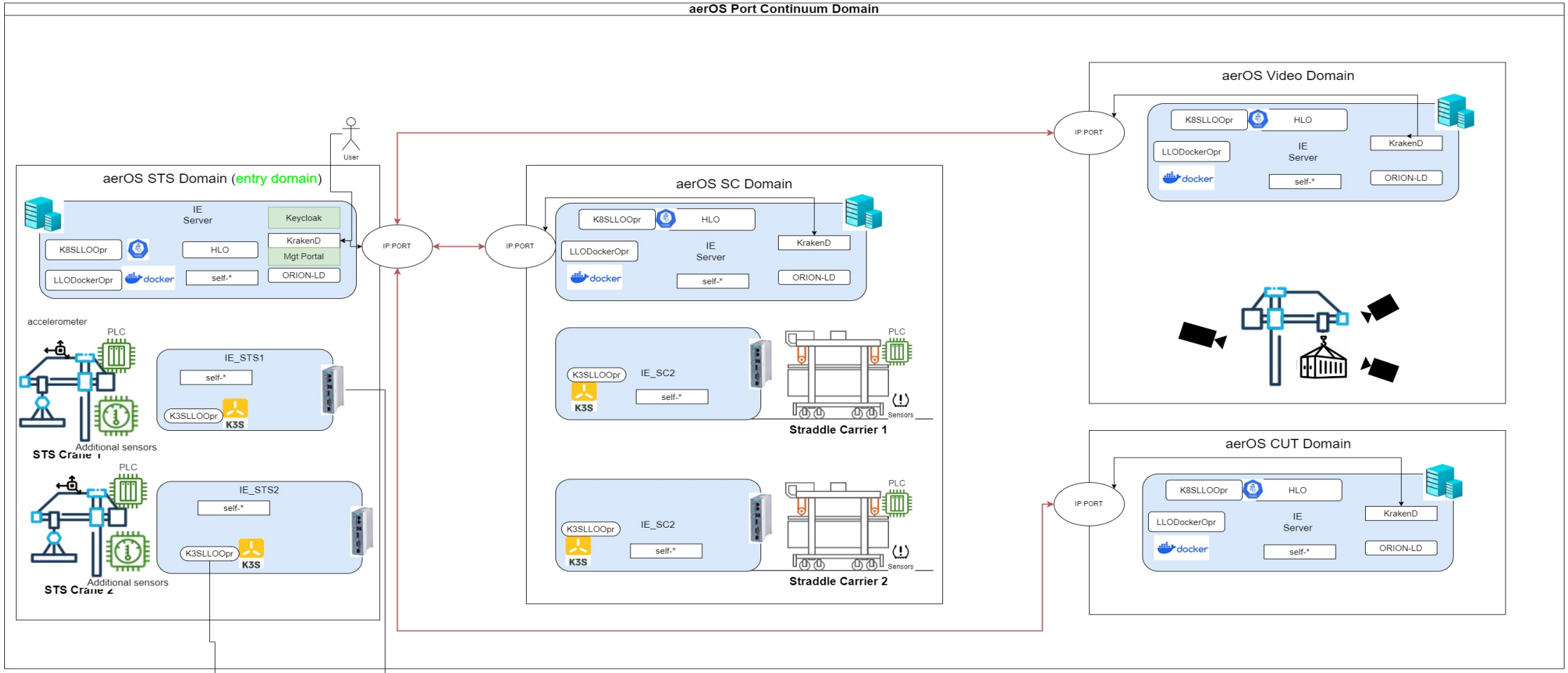
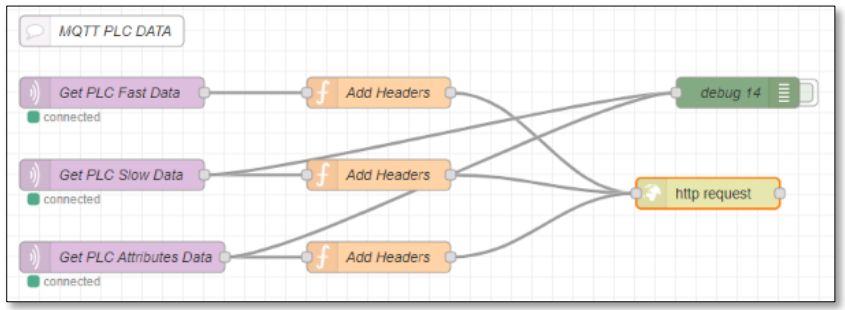
Mapping to aerOS architecture and services

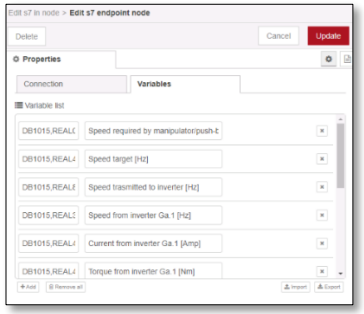


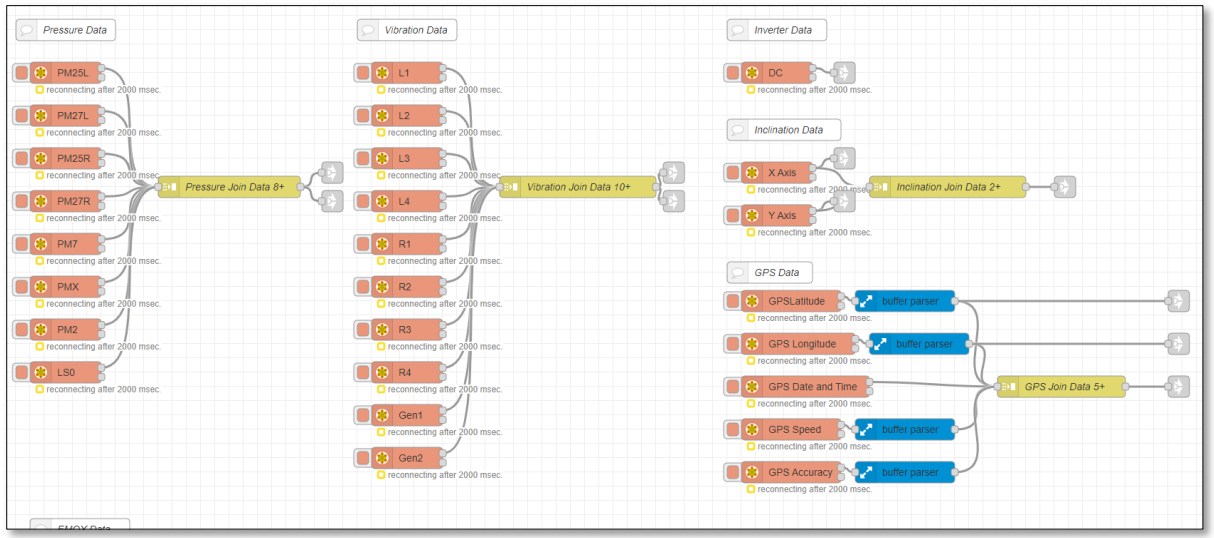
grant agreement N°101069732

Results achieved so far - PILOT 4 SCENARIO 1

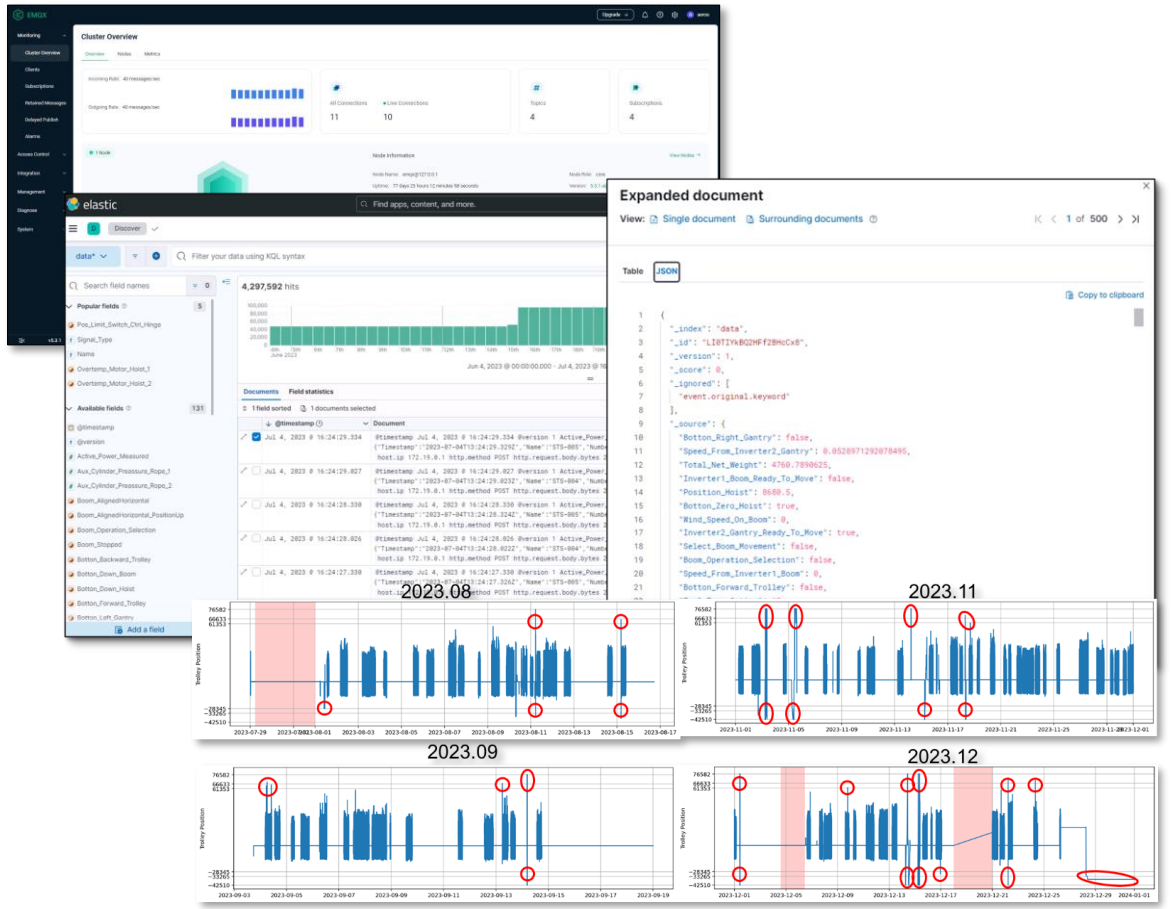
DATA ACQUISITION







DATA COLLECTION AND ANALYSIS



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Results achieved so far - PILOT 4 SCENARIO 2

aerOS
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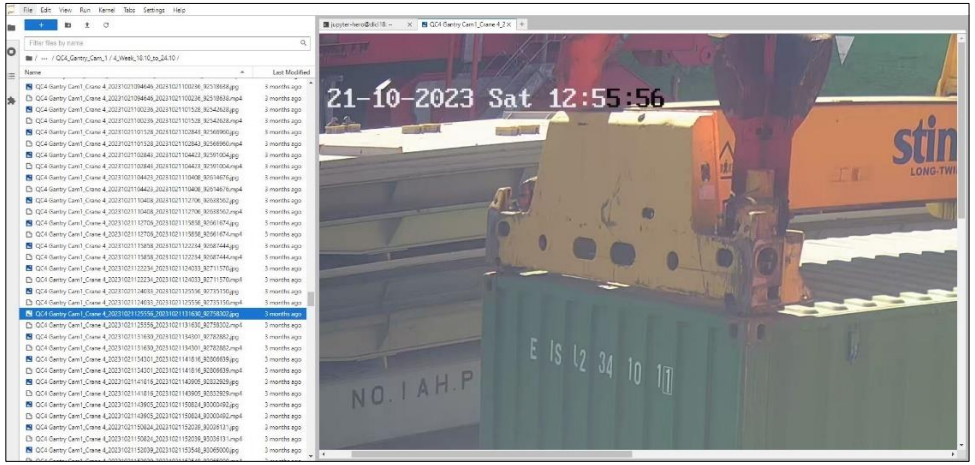
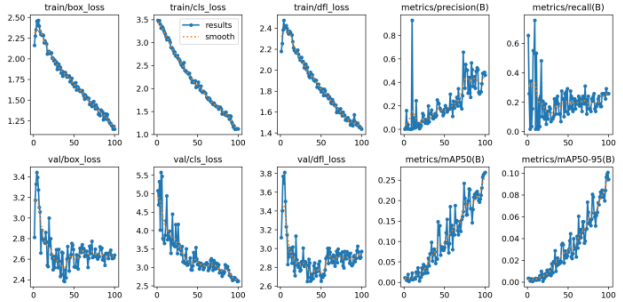
VIDEO COLLECTION



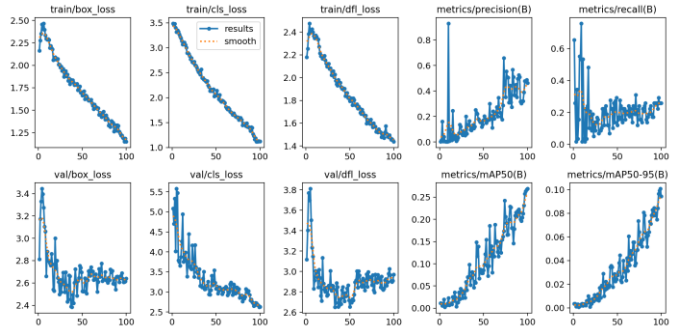
DAMAGE DETECTION

- Dataset: 500 image variations (640 pixel)
- Pre-trained AI model: YOLOv8m
- Accuracy metric: mAP50 = **0.28**



CONTAINER DETECTION

- Dataset: 690 image variations (640 pixel)
- Pre-trained AI model: YOLOv8m
- Accuracy metric: mAP50 = **0.95**



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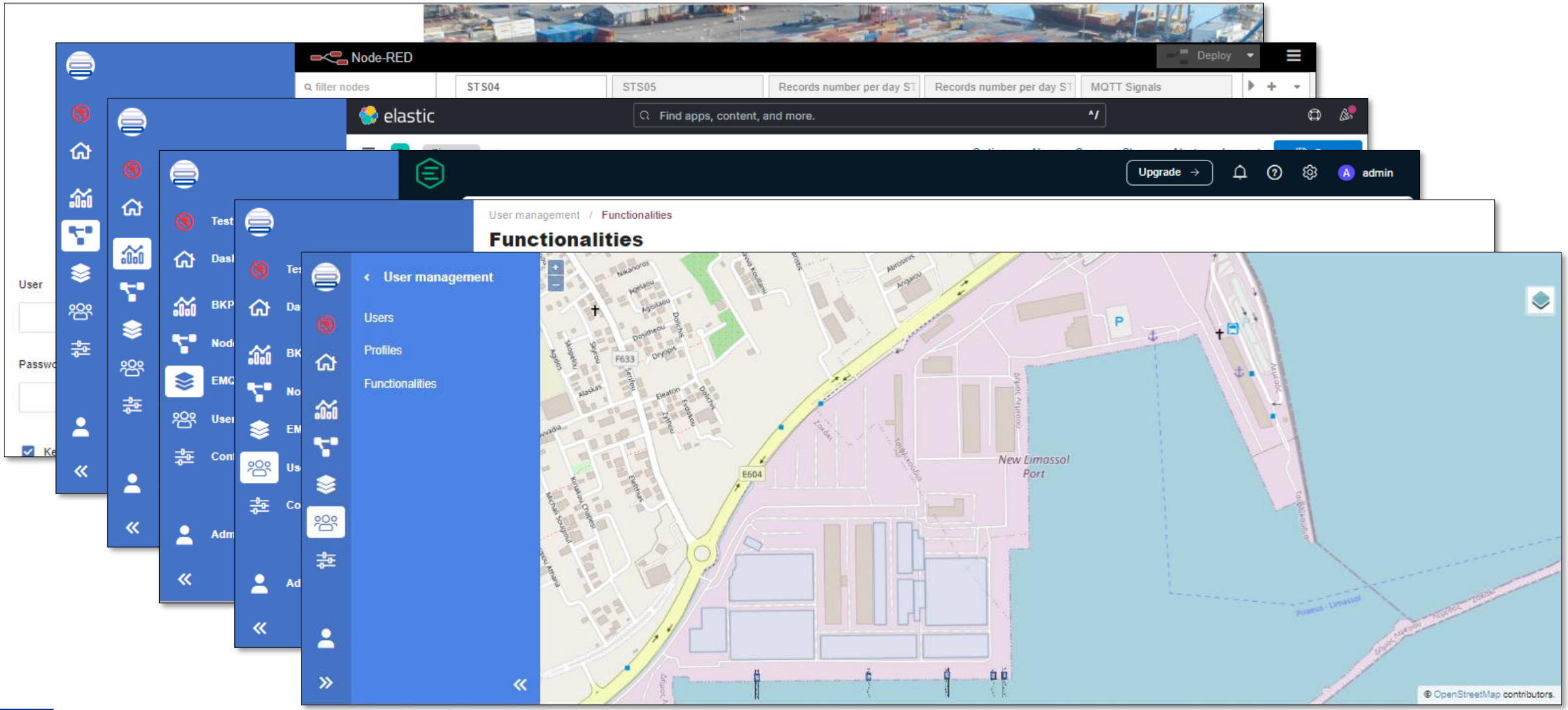
Results achieved so far - PILOT 4



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EUROPEAN IOT-EDGE-CLOUD

THANK YOU

Sheraz Aslam

✉ *Sheraz.aslam@cut.ac.cy*

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MobiSpaces
new data spaces for green mobility

UC#1 – Task 6.2

MidTerm Review – 18th april 2024

Task 6.2 UC1 iRoute “Intelligent Transport Routing”

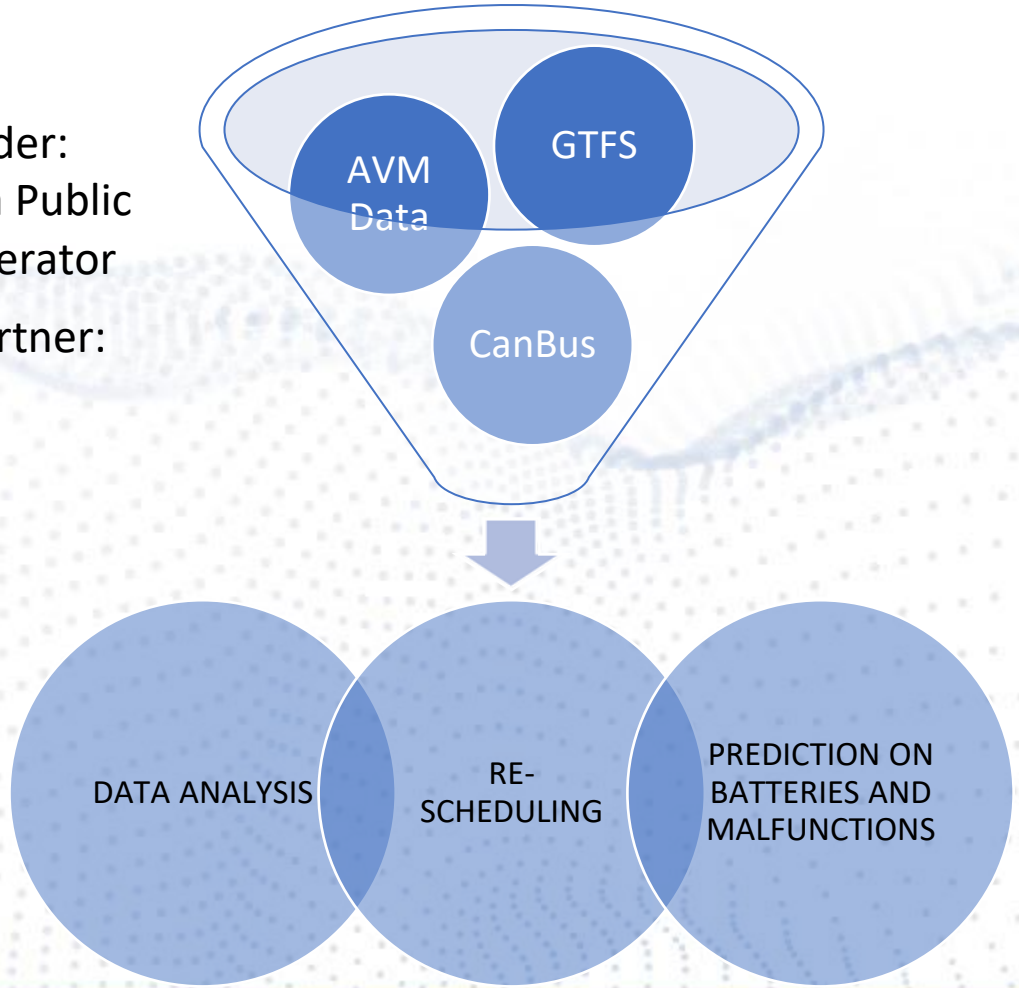
UC CONTEXT

Genova, Italy

Use Case Leader: **AMT**, Genova Public Transport Operator

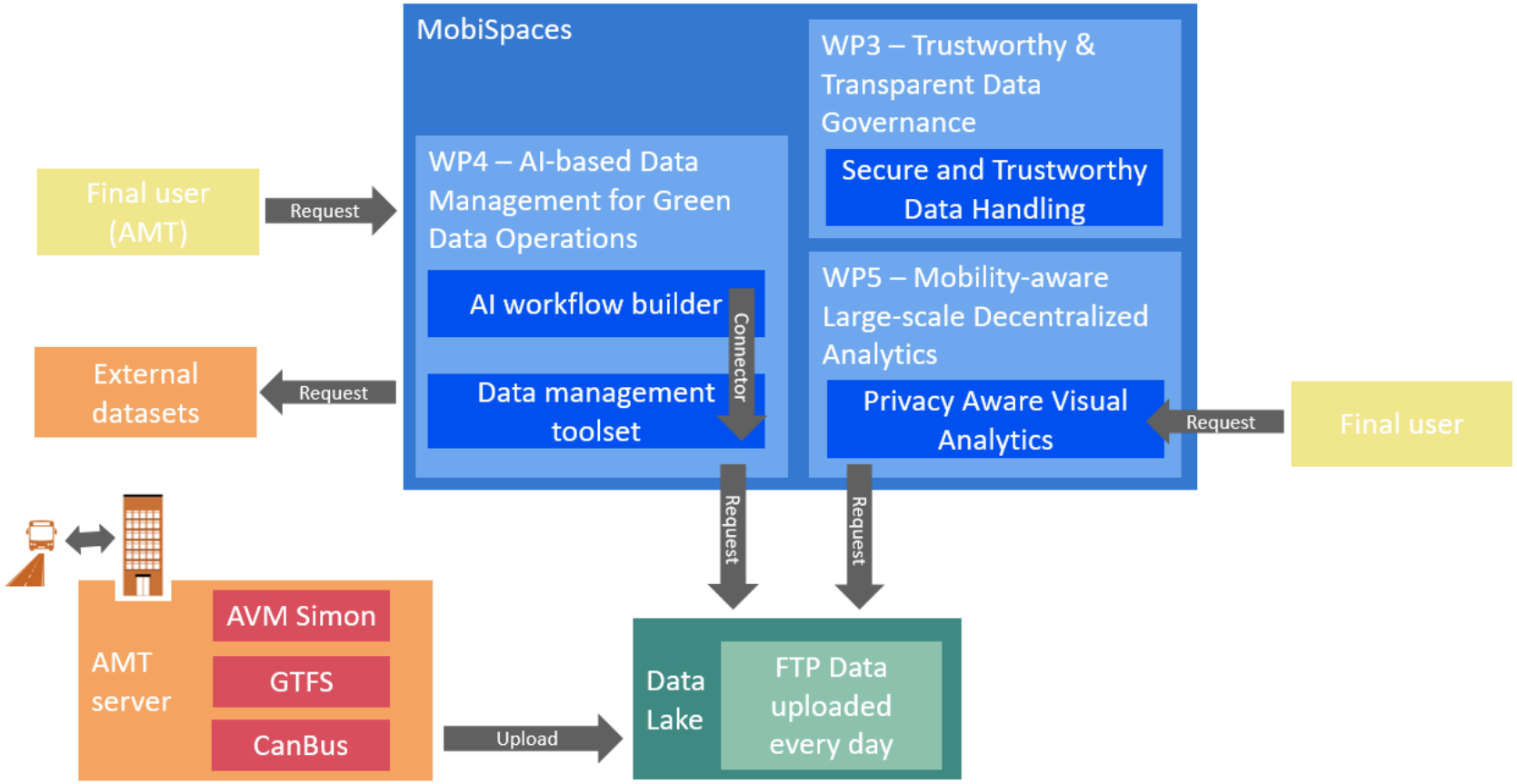
Technical Partner: **Engineering**

Use Case stories related to **E-bus fleet management**: scheduling optimization, predictive maintenance and service analysis



Task 6.2 UC1 iRoute “Intelligent Transport Routing”

ARCHITECTURE



Task 6.2 UC1 iRoute “Intelligent Transport Routing”

METHOD

DATASET ORGANIZATION

- AMT datasets have been organized and explained to make them usable by the partners

1. GTFS
2. AVM Data
3. CanBus Data

Preparation of a complete document about datasets available to all partners →

AMT DATA Description

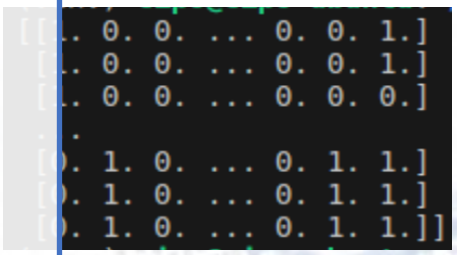
A MobiSpaces outcome

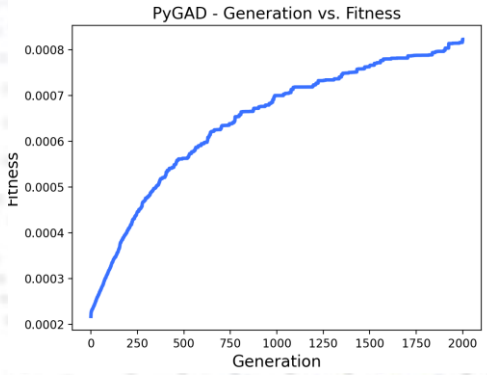
Task 6.2 UC1 iRoute “Intelligent Transport Routing”

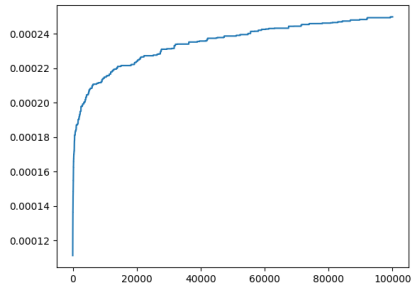
METHOD

OPTIMIZATION PROBLEM

- ENG partner developed the scheduling algorithm

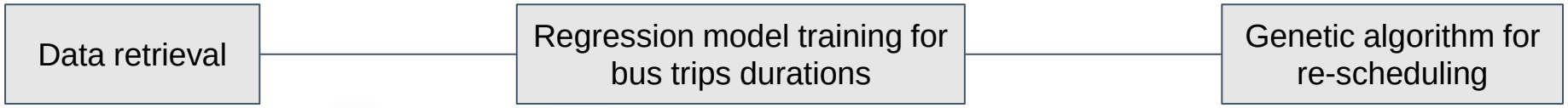






Task 6.2 UC1 iRoute “Intelligent Transport Routing”

OPTIMIZATION OF FLEET ALLOCATION

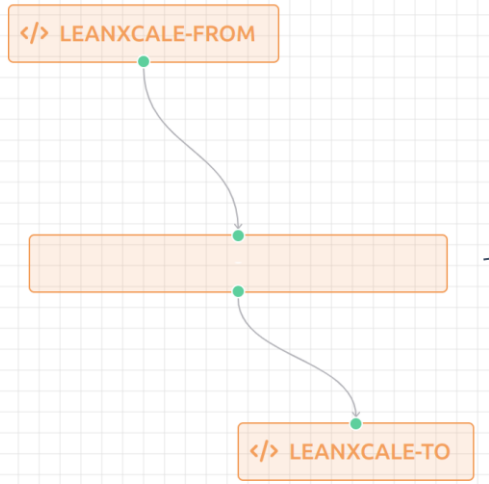


Task 6.2 UC1 iRoute “Intelligent Transport Routing”

OPTIMIZATION OF FLEET ALLOCATION

Data retrieval → Regression model training for bus trips durations → Genetic algorithm for re-scheduling

Connectors have been developed inside the workflow builder in order to read from LXS DB.



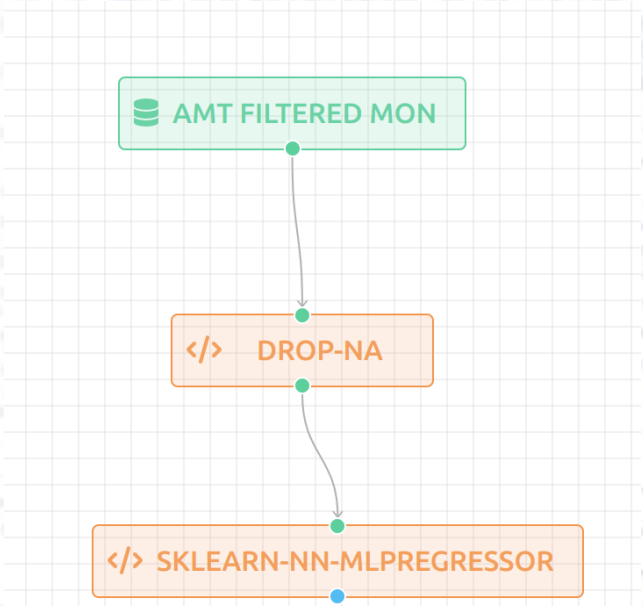
Other preprocessing and analyst blocks to be included here

Task 6.2 UC1 iRoute “Intelligent Transport Routing”

OPTIMIZATION OF FLEET ALLOCATION

Data retrieval → **Regression model training for bus trips durations** → Genetic algorithm for re-scheduling

Data are preprocessed, then nulls are removed and a non-linear regression algorithm, based on a NN, is trained.

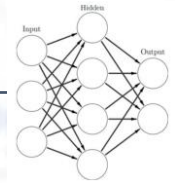


Task 6.2 UC1 iRoute “Intelligent Transport Routing”

OPTIMIZATION OF FLEET ALLOCATION

Data retrieval → **Regression model training for bus trips durations** → Genetic algorithm for re-scheduling

Model inputs



Model output

- month:
- dayofweek:
- hour:
- from_stop_code:
- to_stop_code:

10 (october)
dayofweek: 4 (Saturday)
hour: 21 (9:00 p.m.)
from_stop_code: 025
to_stop_code: 126

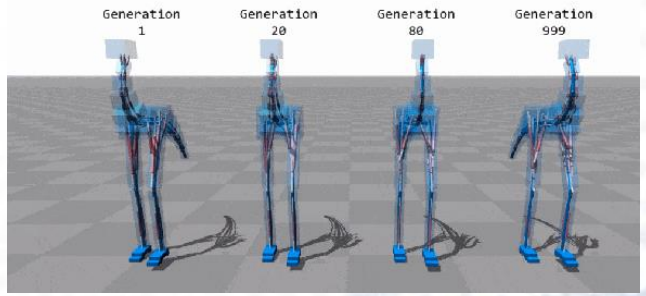
Predicted duration of the trip, e.g. 127 seconds

Task 6.2 UC1 iRoute “Intelligent Transport Routing”

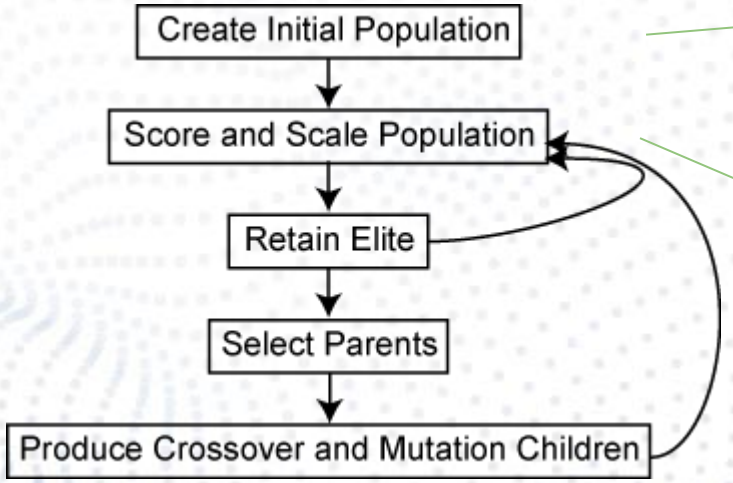
OPTIMIZATION OF FLEET ALLOCATION

Data retrieval → Regression model training for bus trips durations → **Genetic algorithm for re-scheduling**

Genetic algorithm:



Example of a GA learning how to walk



Genetic Representation

Fitness function

Task 6.2 UC1 iRoute “Intelligent Transport Routing”

OPTIMIZATION OF FLEET ALLOCATION

Data retrieval → Regression model training for bus trips durations → **Genetic algorithm for re-scheduling**

Fitness function:

The fitness function is defined as follows:

$$F = \frac{1}{\sum_{i=1}^{n} x_i w_i}$$

where x is a vector containing a series of parameters that estimates possible losses of the state, while w are weights (which are considered hyper-parameters to be tuning during training).

x parameters take into account all the constraints that make a trip feasible or convenient (e.g., no two buses must take the same trip; if a bus is on another trip cannot take one that starts in that moment etc.).

Screenshot taken from an internal document summarising the algorithm used.

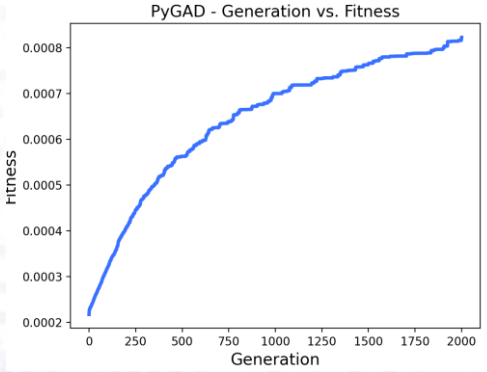
Task 6.2 UC1 iRoute “Intelligent Transport Routing”

OPTIMIZATION OF FLEET ALLOCATION

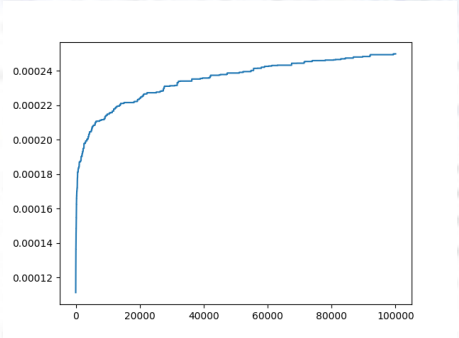
Tests on real data

- Monitoring data have been preprocessed and used to train the regressor model
- AMT APIs have been used to get info about Line 3 selecting scheduled trips to associate buses
- Genetic Algorithm has been applied to the data in order to find an optimal state
- Learning curve has a good trend, confirming that the algorithm is learning.

Training curve on test data (limited):

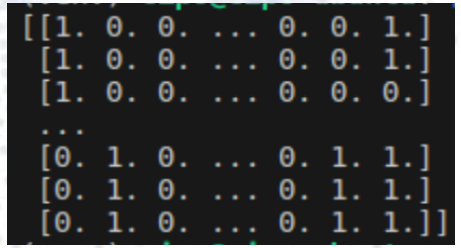


On 2000 generations



On 100000 generations

Resulting state



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