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MLSysOps

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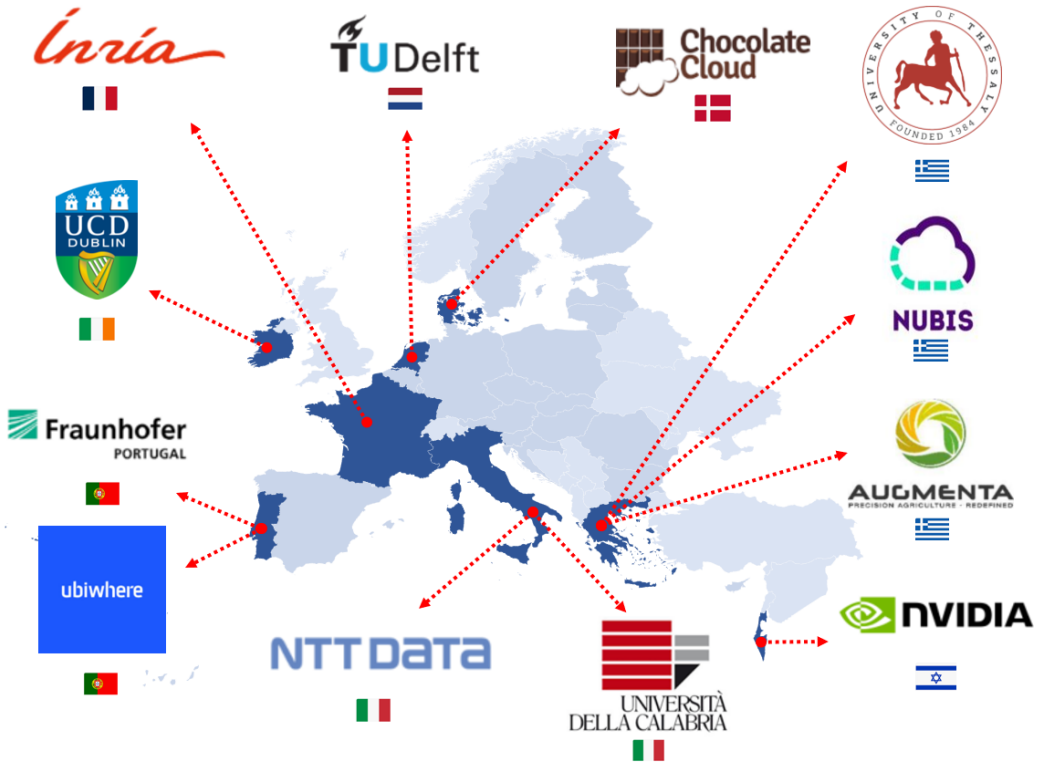
Machine Learning for Autonomic System Operation
in the Heterogeneous Edge-Cloud Continuum



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Trends & challenges

Continuum systems

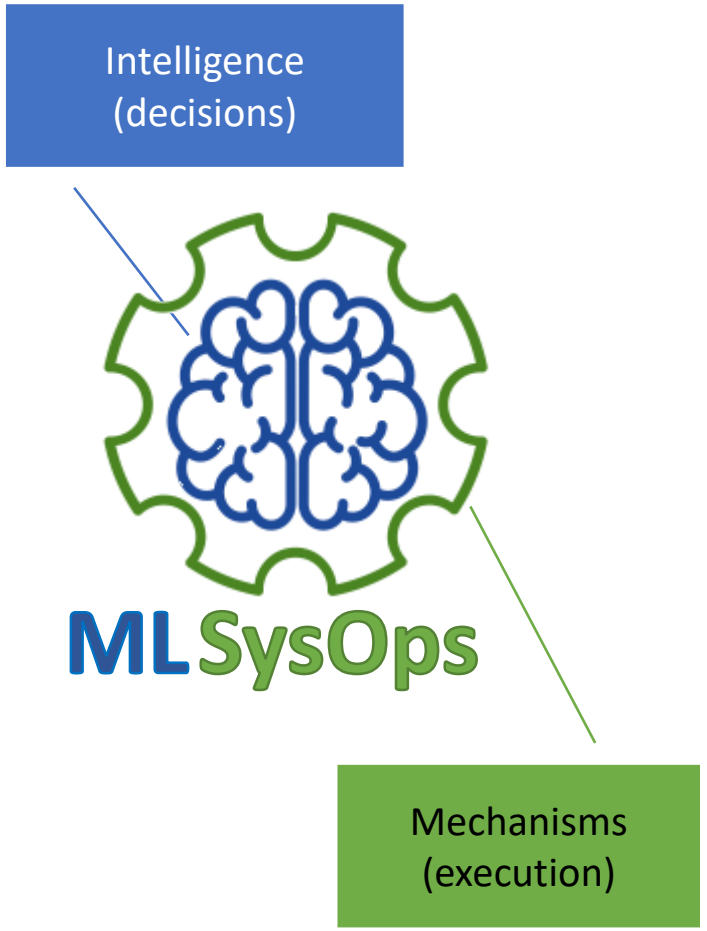
- Applications are moving outside the cloud and start involving nodes and resources toward or directly at the edge of the Internet
  - including powerful but also resource-constrained IoT devices
- Scale, heterogeneity, dynamics, and complexity increases
- Practically impossible to monitor/manage by a human or a set of fixed rules

*The vision of **autonomic computing systems**, which can manage themselves with little or no involvement of the application/system administrator, becomes more relevant than ever before!*

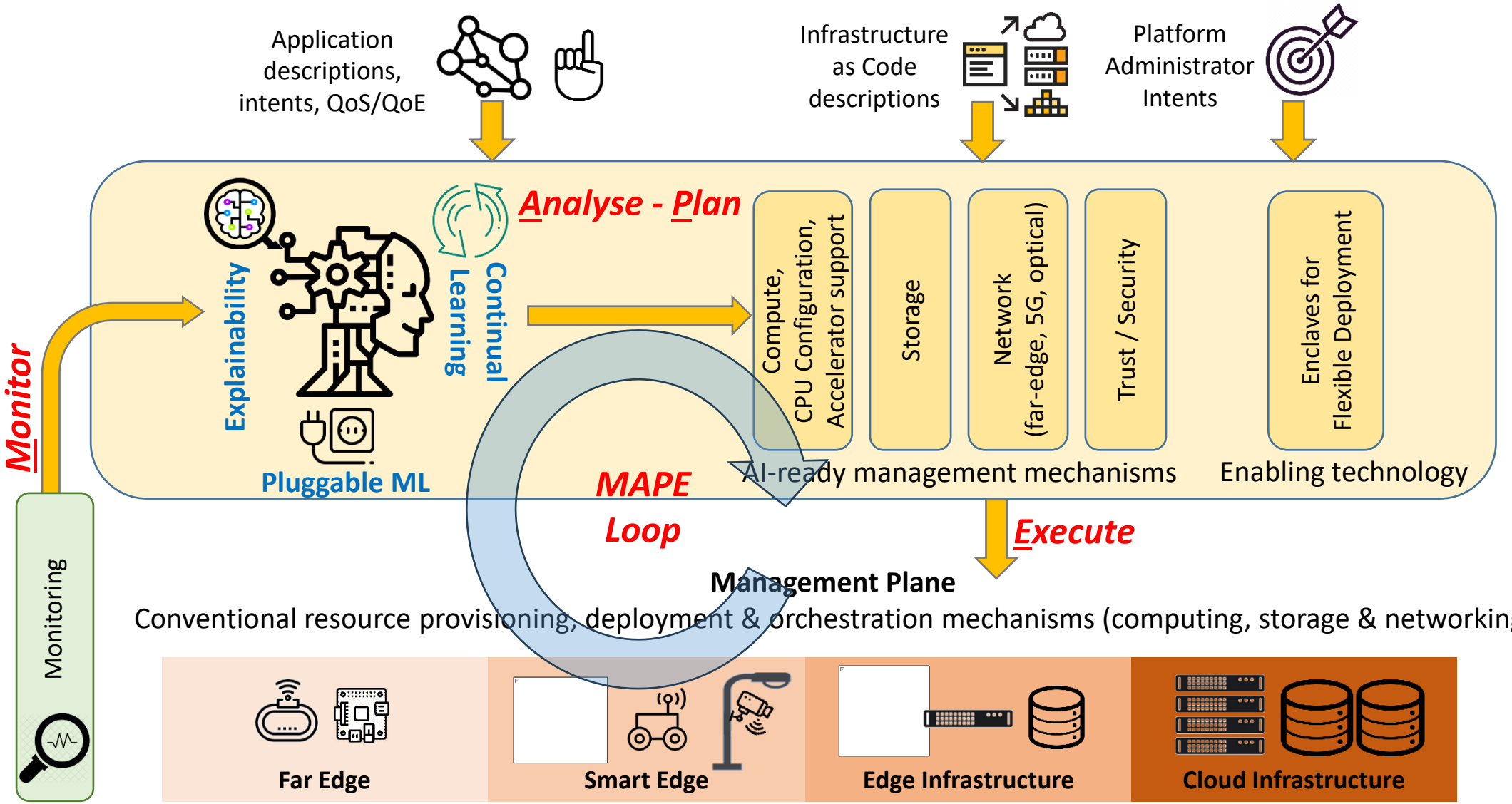
The MLSysOps project (2023-2025)

*Autonomic system management and configuration in the **cloud-edge-IoT continuum** using **AI/ML methods***

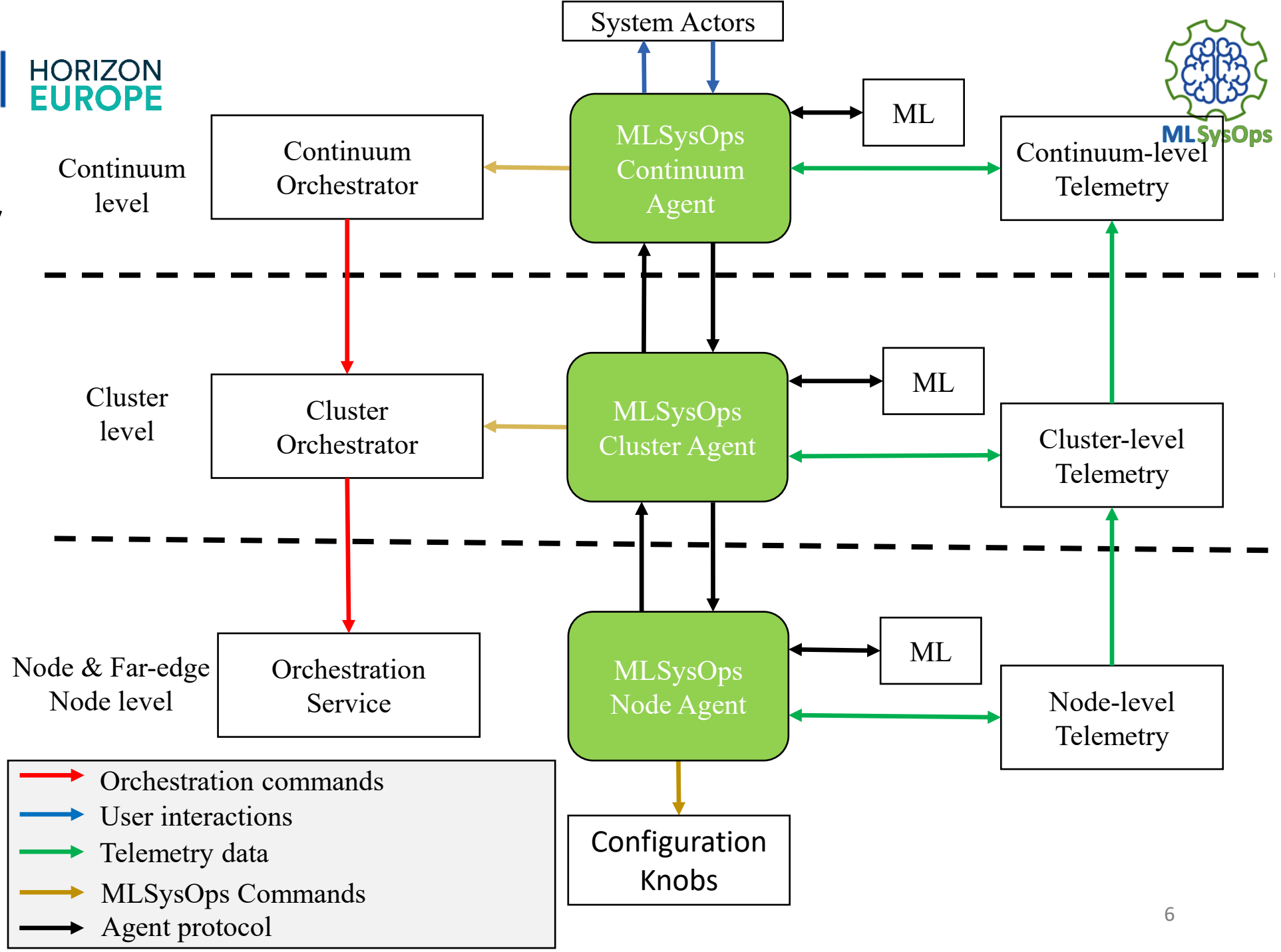
- Focus on modular, distributed applications (deployed inside containers)
- System metrics to optimize
  - Performance, resource efficiency, energy efficiency, low carbon intensity, trust
- Explore different management aspects
  - Application Deployment, computing, storage, communication/networking, trust
- Disassociate management from control
  - Develop AI/ML-ready (policy-neutral) mechanisms
  - Take decisions using suitable ML models
- Key AI/ML properties
  - Distributed / hierarchical approach → Separation of concerns
  - Continual learning / efficient model retraining
  - Explainability
- Extensive data generation and evaluation via real-world application testbeds, research testbeds, and simulators



How? Concept

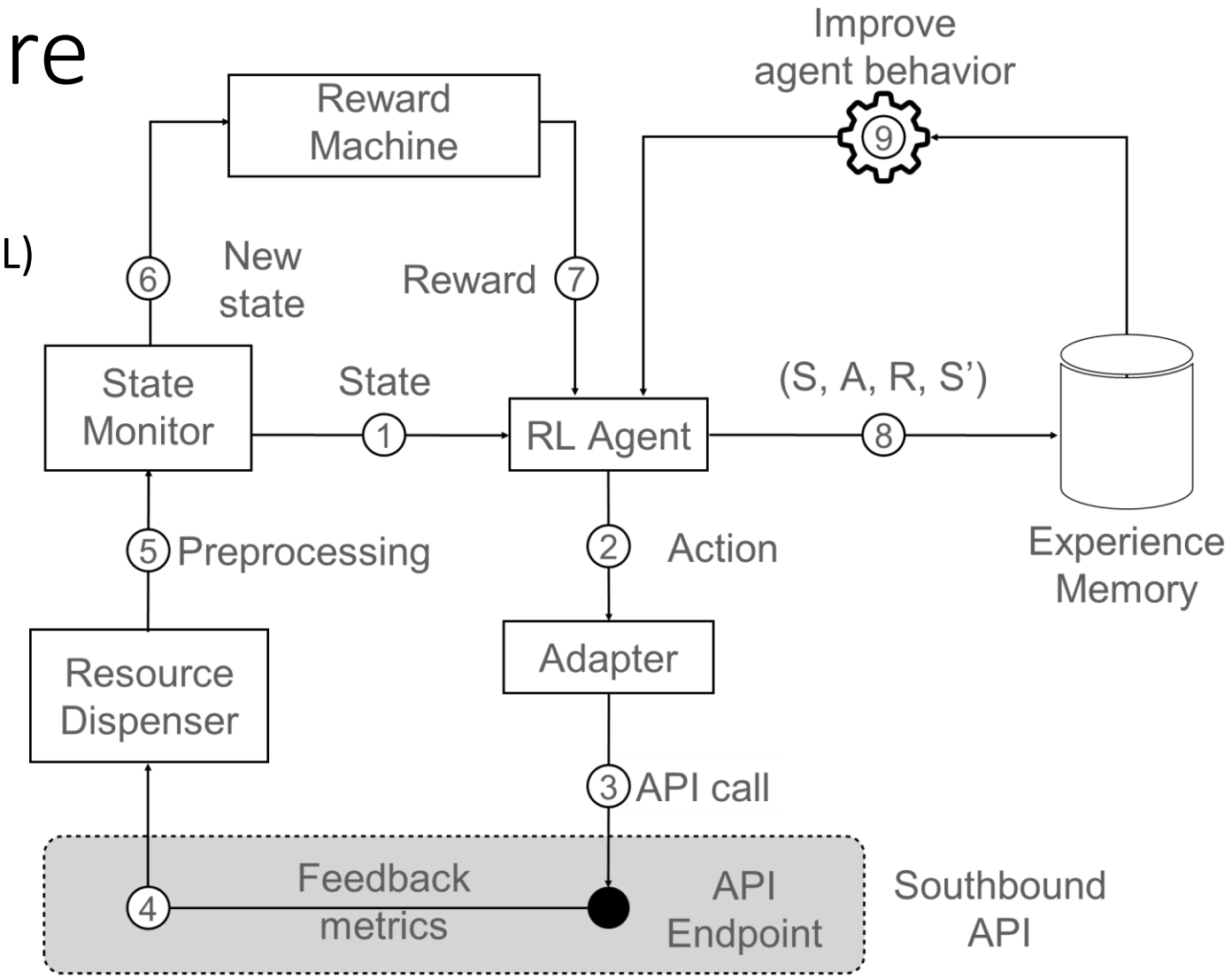

Application descriptions, intents, QoS/QoE
Infrastructure as Code descriptions
Platform Administrator Intents
Monitor
Explainability
Continual Learning
Analyse - Plan
Pluggable ML
Compute, CPU Configuration, Accelerator support
Storage
Network (far-edge, 5G, optical)
Trust / Security
Enclaves for Flexible Deployment
AI-ready management mechanisms
Enabling technology
MAPE Loop
Execute
Monitoring
Management Plane
Conventional resource provisioning, deployment & orchestration mechanisms (computing, storage & networking)
Far Edge
Smart Edge
Edge Infrastructure
Cloud Infrastructure

How? Hierarchy



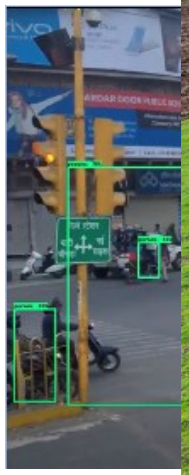
ML Architecture

Based on Reinforcement Learning (RL) ecosystem



Two real-world application use cases

Smart Agriculture



Improve
control
modules deployed on smart lampposts and/or
to datacenters.

Improve existing system via AI/ML-driven control to jointly manage/configure the image processing application pipeline on a tractor and a companion drone.

Coming soon…

- ML4ECS workshop (@ HiPEAC 2025)
  - In collaboration with EDGELESS + CODECO projects

- Hackathlon organization (late 2025)
  - Familiarize developers with the MLSysOps framework
  - Foster application & ML models development

- Open-source components of the MLSysOps framework

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MLSysOps

https://mlsysops.eu

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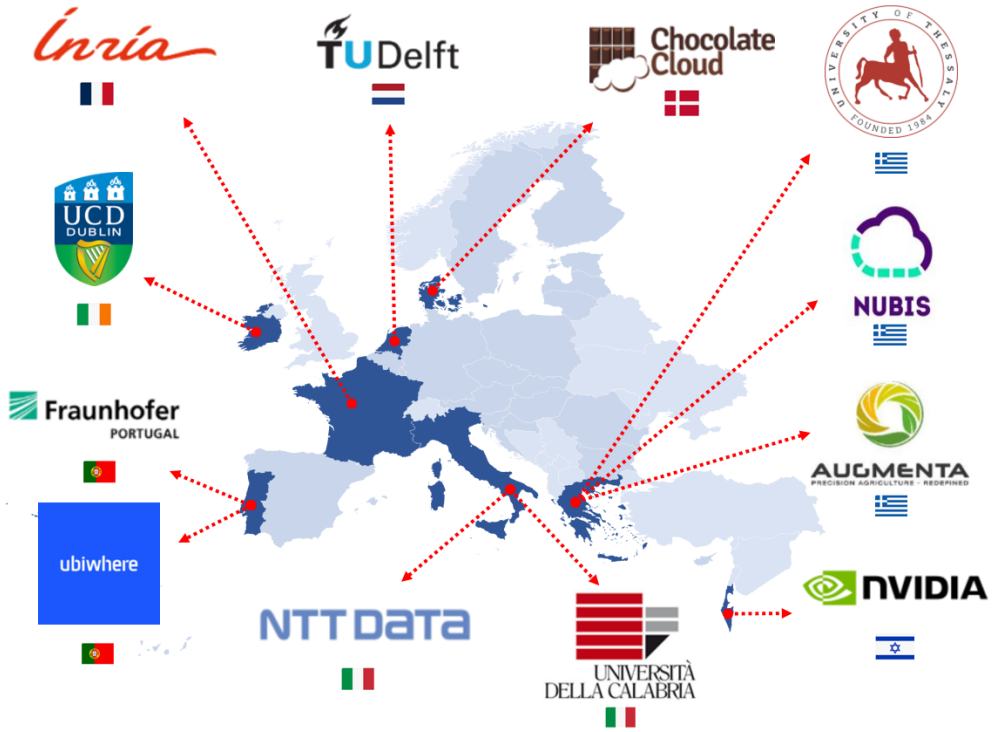

Newsletter https://mlsysops.eu/communication/

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