



Funded by
the European Union



CODECO

Cognitive Decentralised
Edge Cloud Orchestration



CODECO Federated Operation Framework

Dr. Rute C. Sofia (sofia at fortiss dot org) – CODECO coordinator
fortiss - research Institute of the Free State of Bavaria
HiPEAC 2026 - ML4ECS Workshop, 26.01.2026

SCAN ME

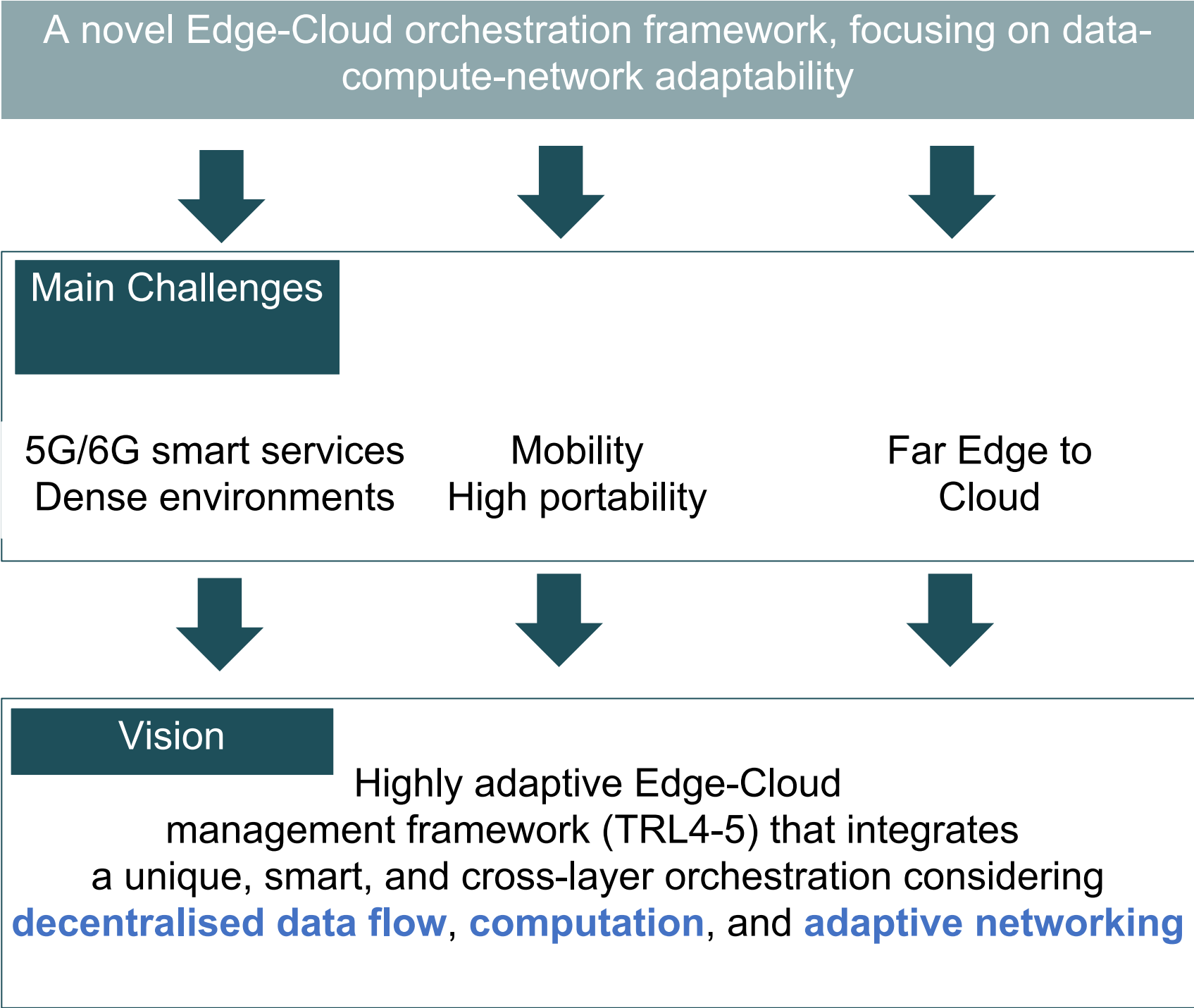


Funded by the European Union under Grant Agreement 101092696



Funded by the Swiss Federal Government

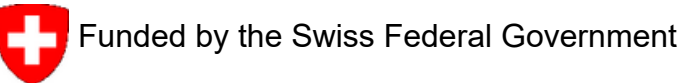
CODECO Overview



Start Date: 01 January 2023
End Date: 31 March 2026
Project ID: 101092696
Programme: Horizon Europe
Keywords: Edge, Cloud, Kubernetes, orchestration, IoT, federated Learning, data, network, computation
Main Contact Person (Coordinator)
Rute C. Sofia | sofia@fortiss.org | fortiss GmbH

CONSORTIUM

Affiliated Entities: City of Göttingen, ATOS IT, Universidad Carlos 3 de Madrid



Main Outcome



Open-source Orchestration
Toolkits
Apps
Synthetic Data Generator
IoT-Edge-Cloud infrastructure

Eclipse KuDECO



Learning Hub



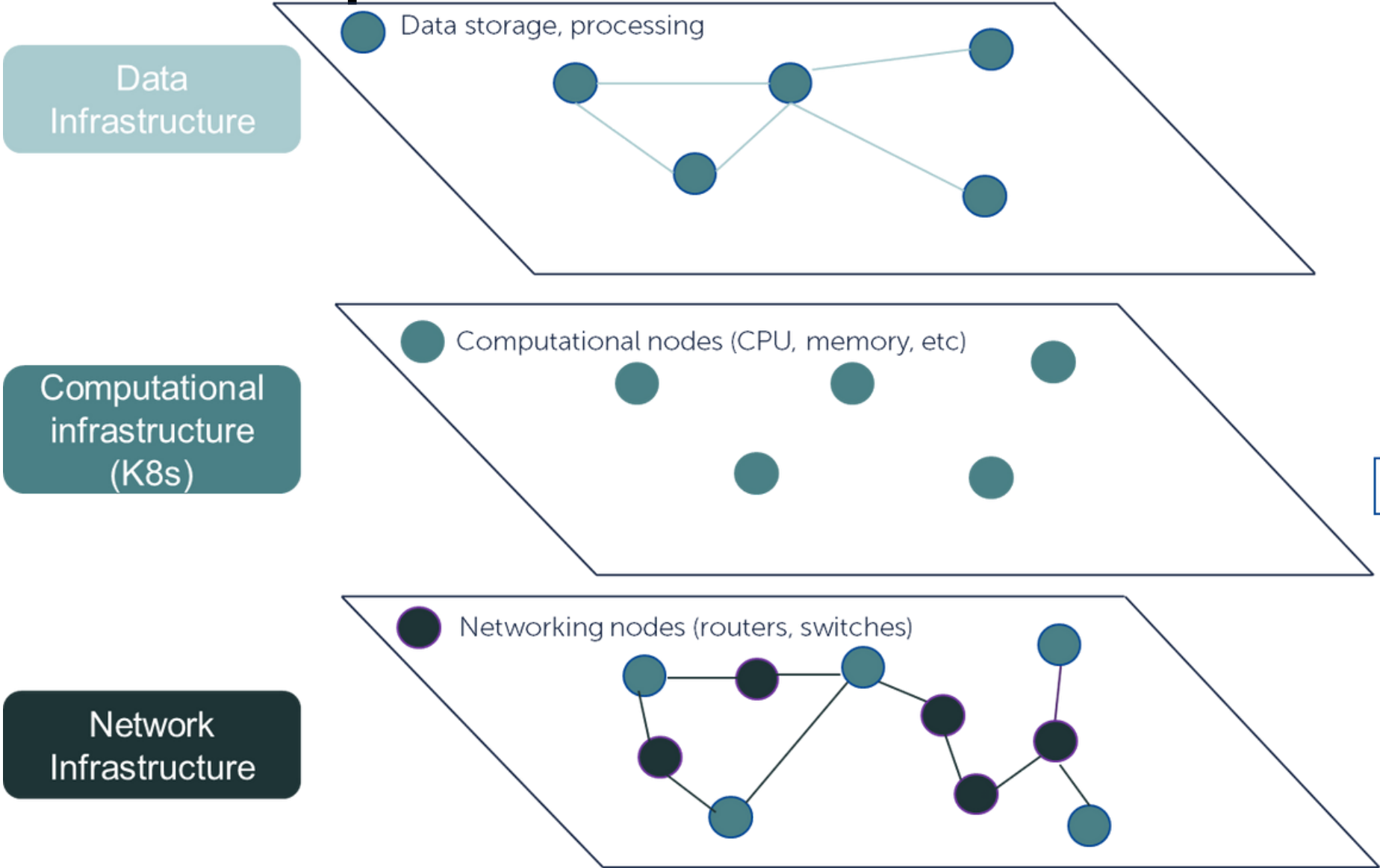
CODEF: Experimentation
Framework



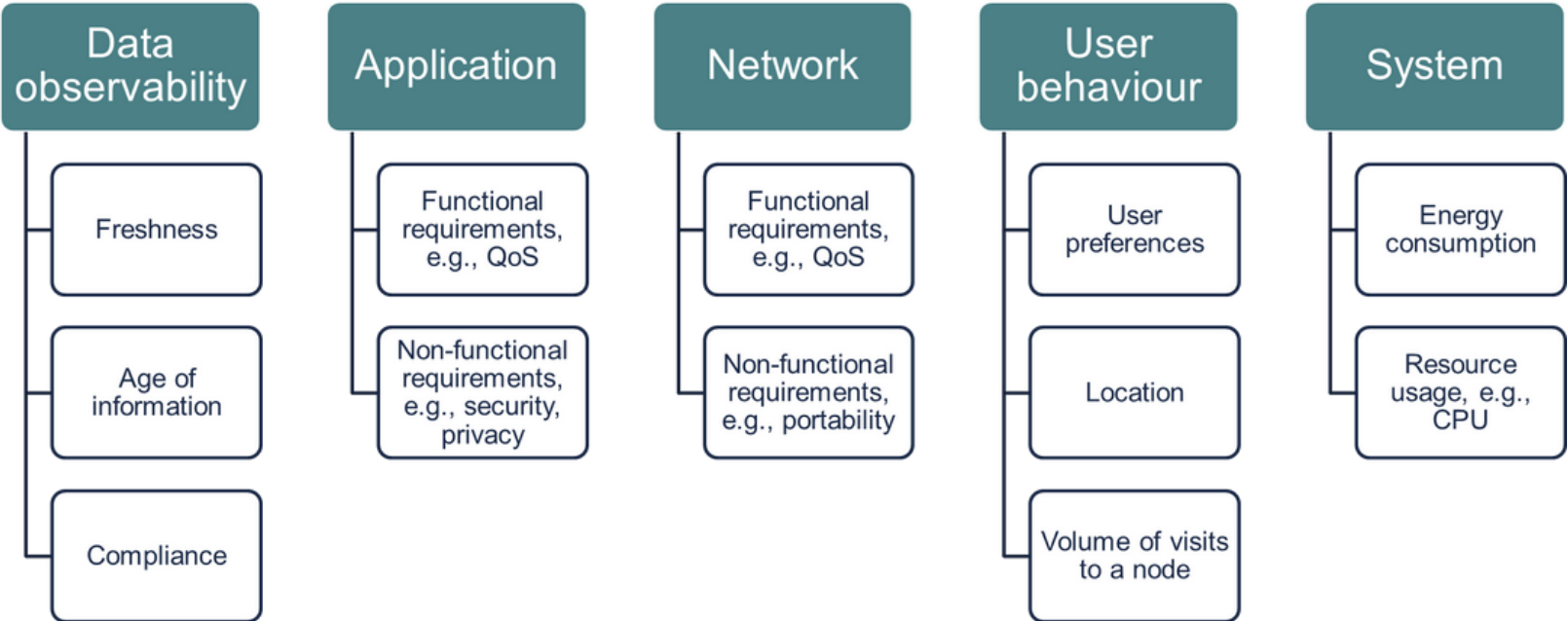
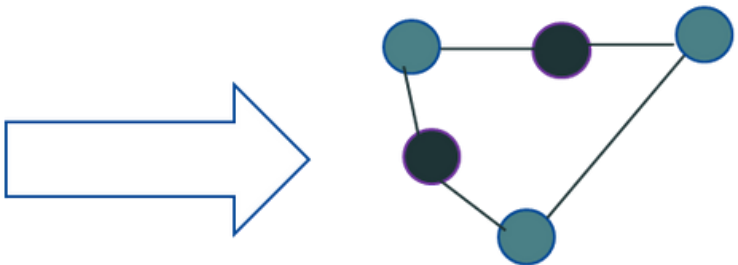
Use-cases

Approach IoT-Edge-Cloud infrastructure

Data-Compute-Network



CODECO data-compute network perspective
Placement based on realistic CEI infrastructure

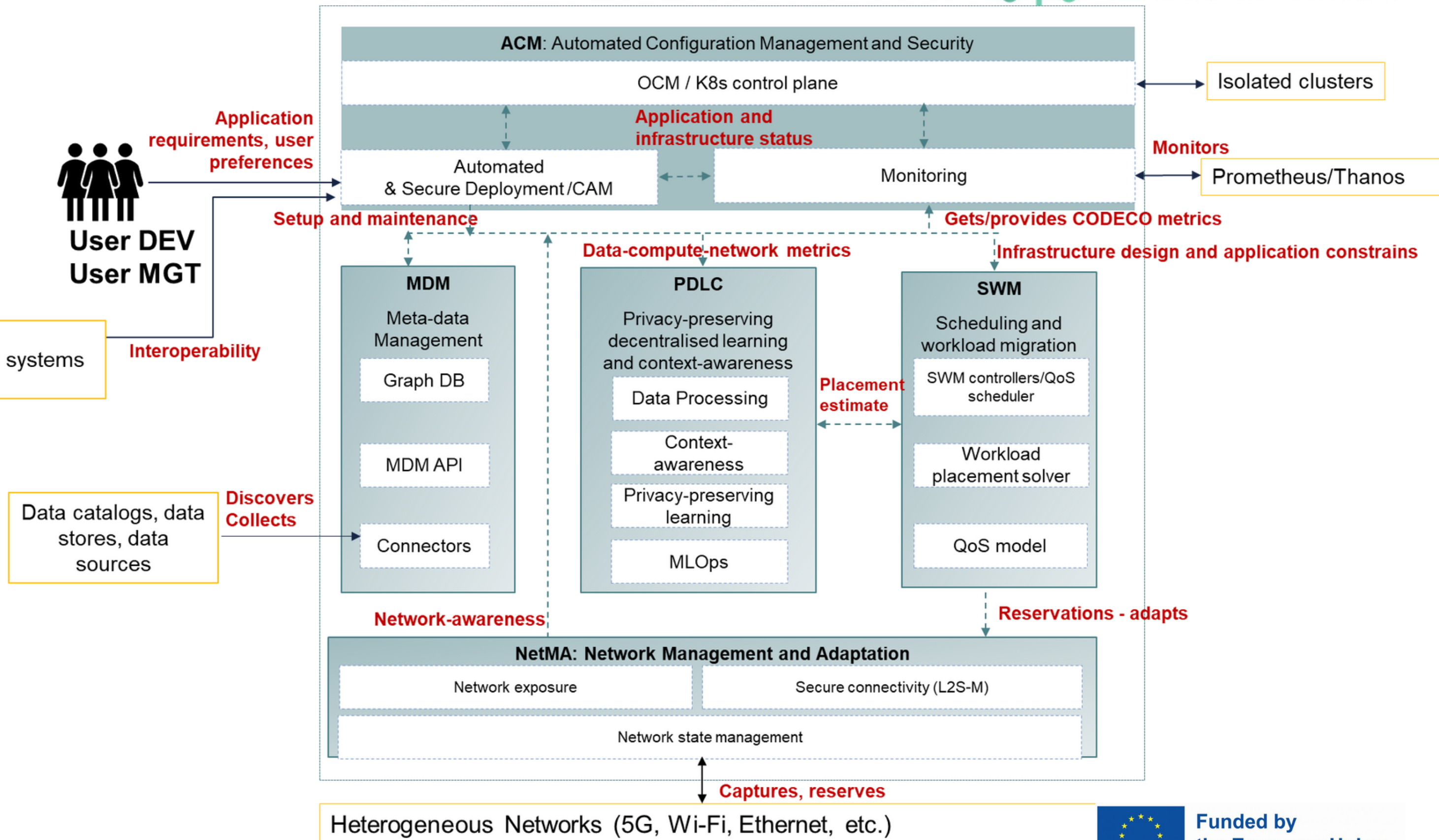


Zenodo (Publications and Deliverables)

CODECO Components



- **ACM:** Entrypoint to user; lifecycle management
- **PDLC:** AI/ML and metadata aggregation – energy-awareness and resilience estimations
- **NetMA:** Network awareness, secure connectivity
- **MDM:** Data status and awareness
- **SWM:** New scheduler informed re-scheduling (weighing estimations)



CODECO Architecture

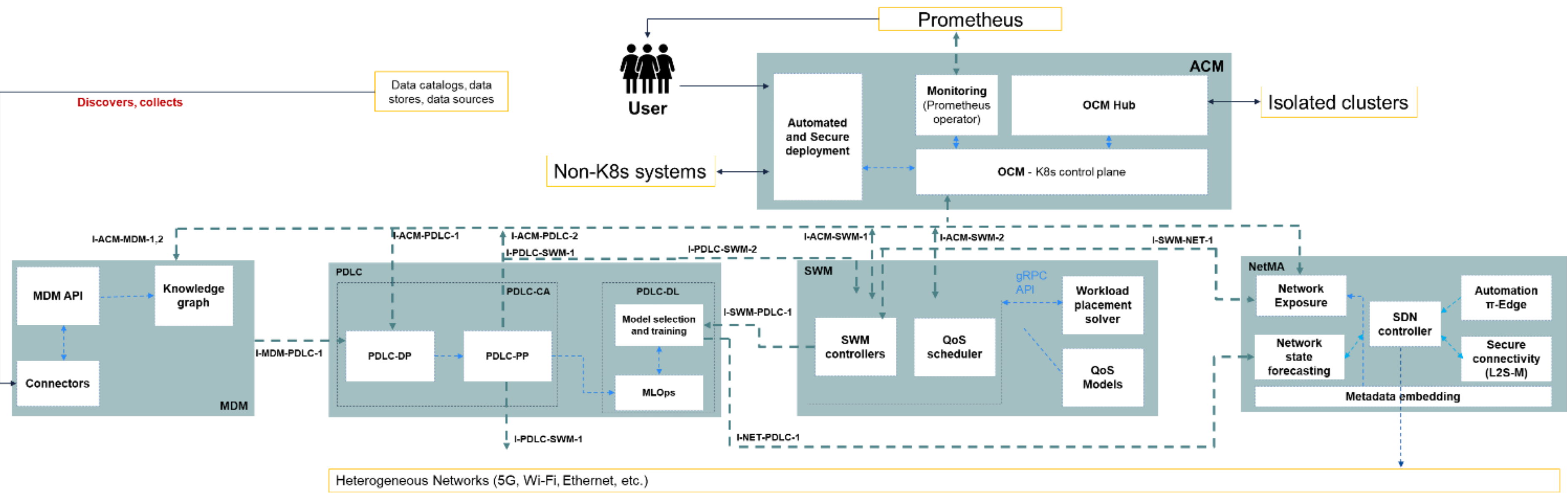
Single Cluster Operation



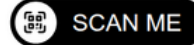
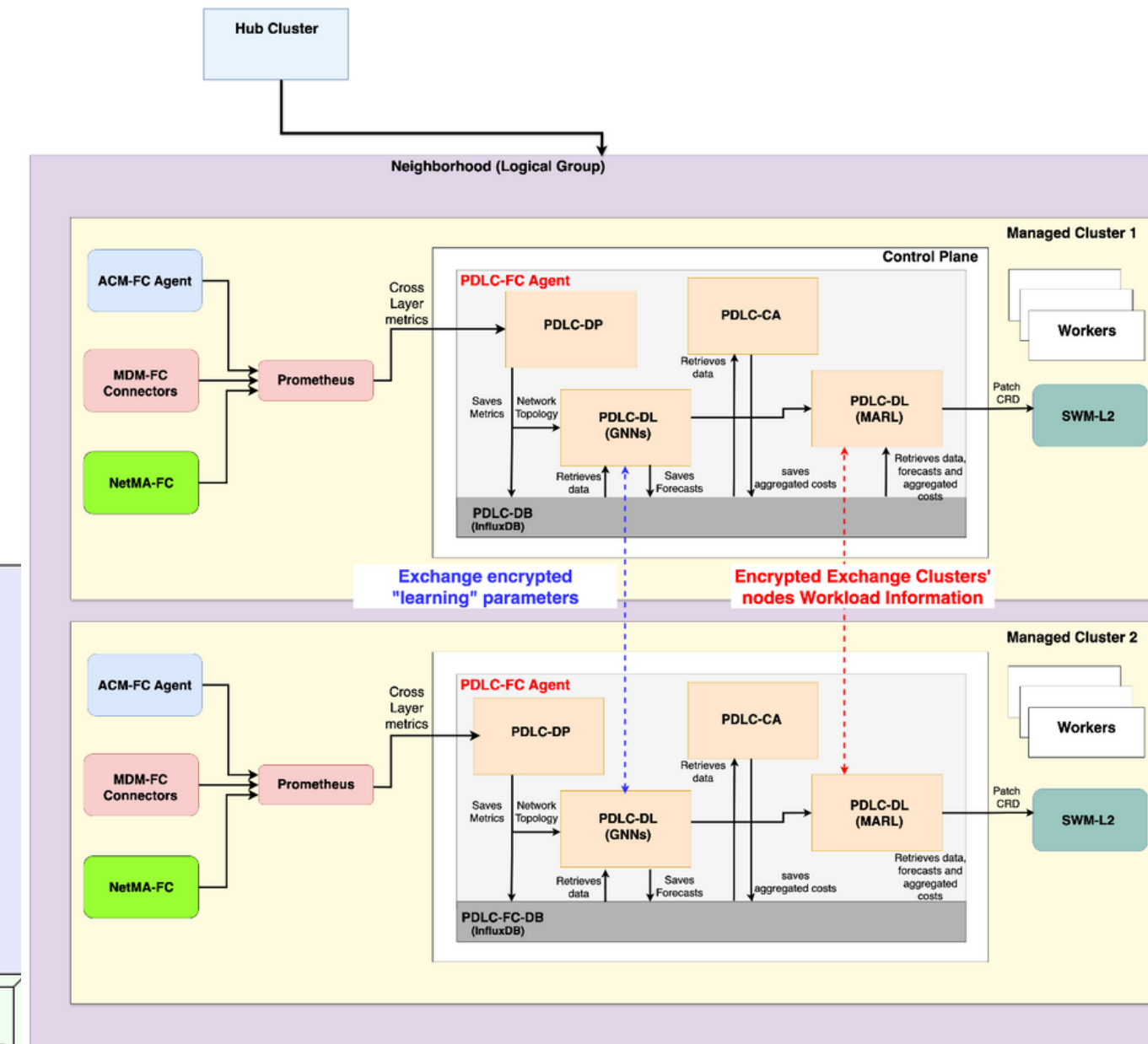
Architectural design and principles:
R. C. Sofia (Ed.) et al., (2024). CODECO Deliverable D10 - Technological Guidelines, Reference Architecture, and Open-source Ecosystem Design. Zenodo. <https://doi.org/10.5281/zenodo.12819444>



Software companion document:
Georgios, S. (Ed .) . et . al . (2024). CODECO D12 - Basic Operation Components and Toolkit version 2.0. Zenodo. <https://doi.org/10.5281/zenodo.12819424>



CODECO

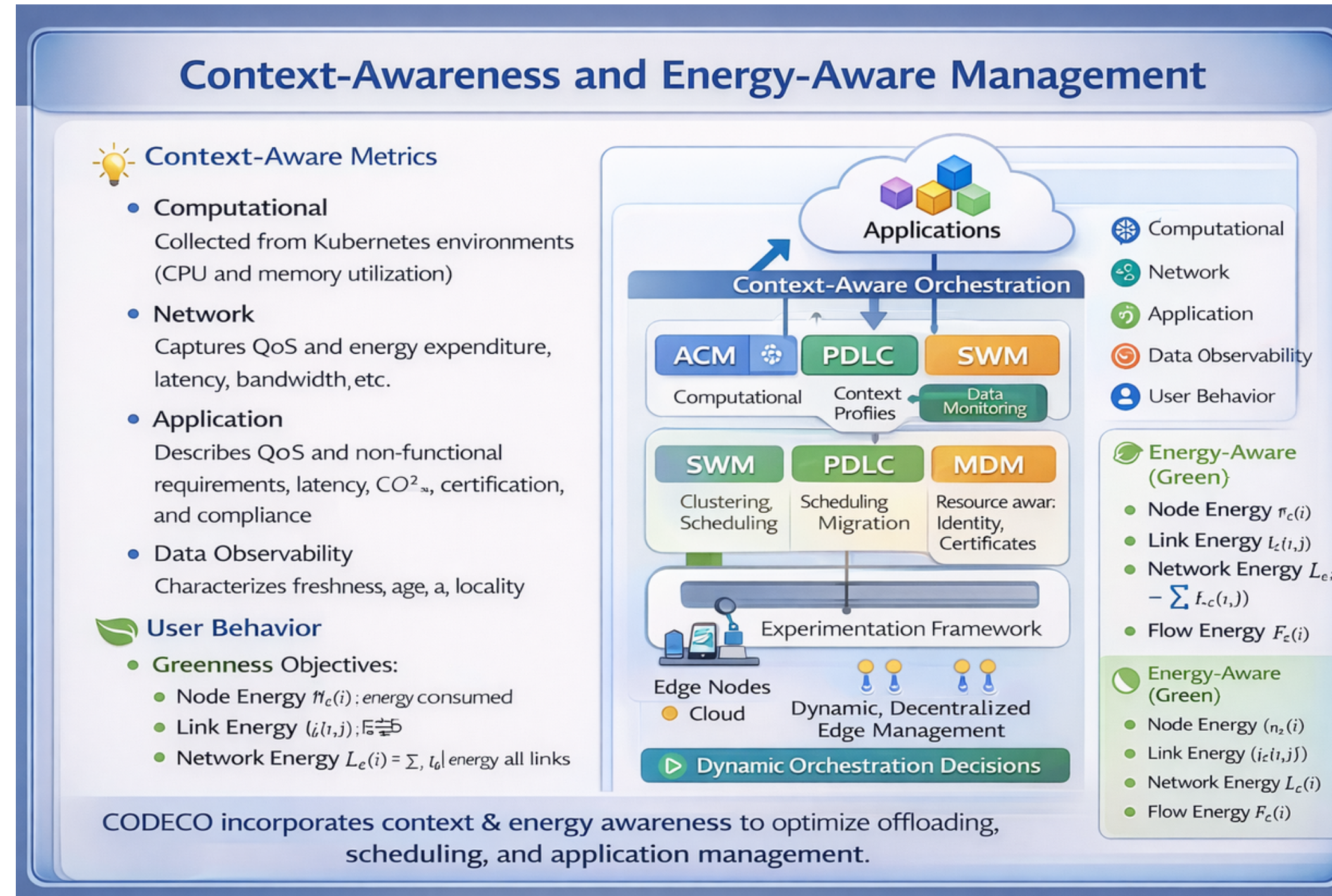
☐

CODECO Architecture Federated Operation



SCAN ME

Rute C. Sofia, Josh Salomon, Ray Carrol, Luis Garces-Erice, Peter Urbanetz, Jurgen Gesswein, Rizkallah Touma, Alejandro Espinosa, Luis M. Contreras, Vasileios Theodorou, George Papathanail, Georgios Koukis, Vassilis Tsaoussidis, Alberto del Rio, David Jimenez, Efterpi Paraskevoulakou, Panagiotis Karamolegkos, John Soldatos, Borja Dorado Nogales, and Alejandro Tjaarda, **Towards Scalable Federated Container Orchestration: the CODECO approach**. Jan 2026, <https://doi.org/10.48550/arXiv.2601.1335>



Disclaimer: AI-generated image for illustration purposes.



Funded by
the European Union



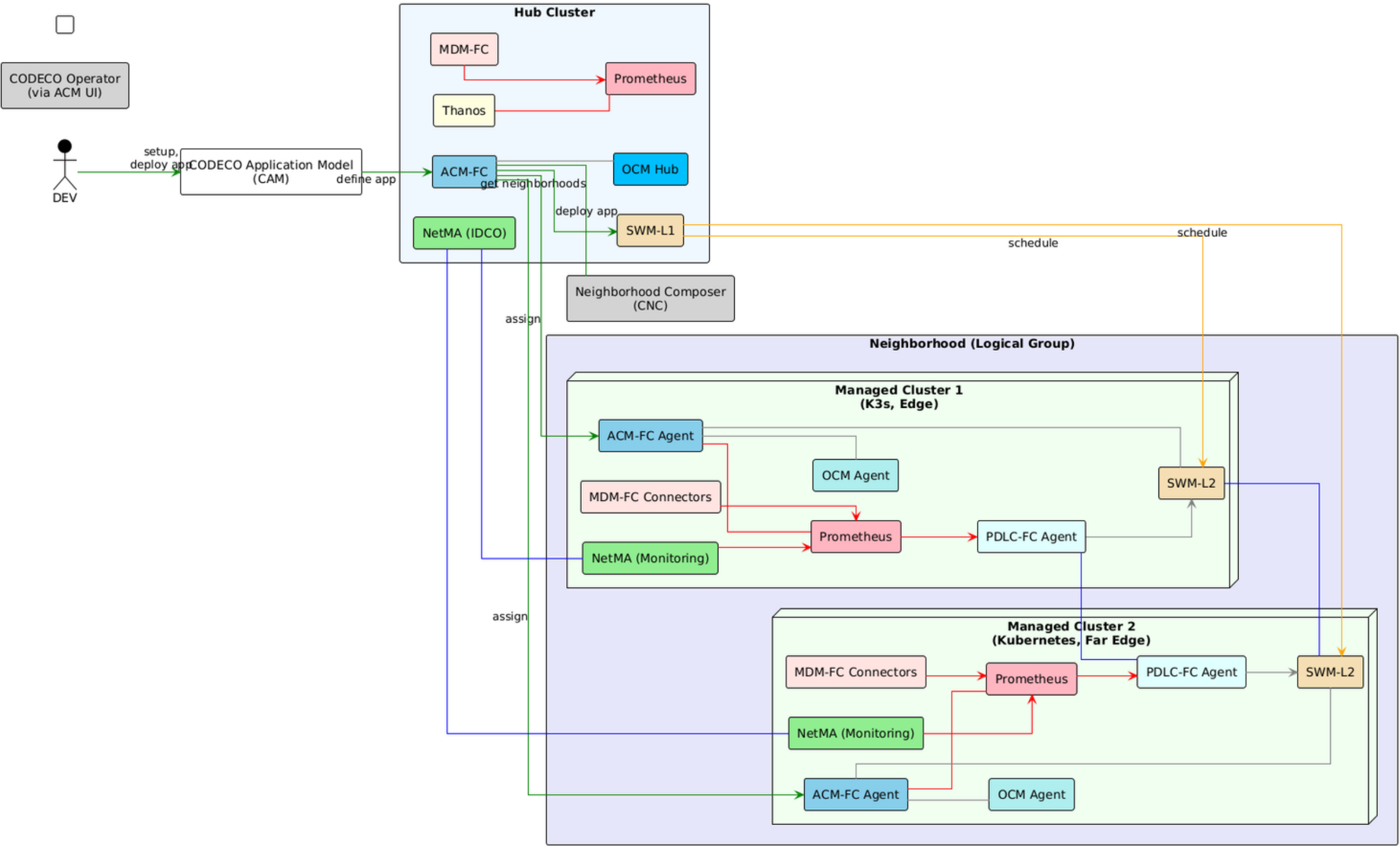
Funded by the Swiss Federal Government

CODECO Architecture Federated Operation



SCAN ME

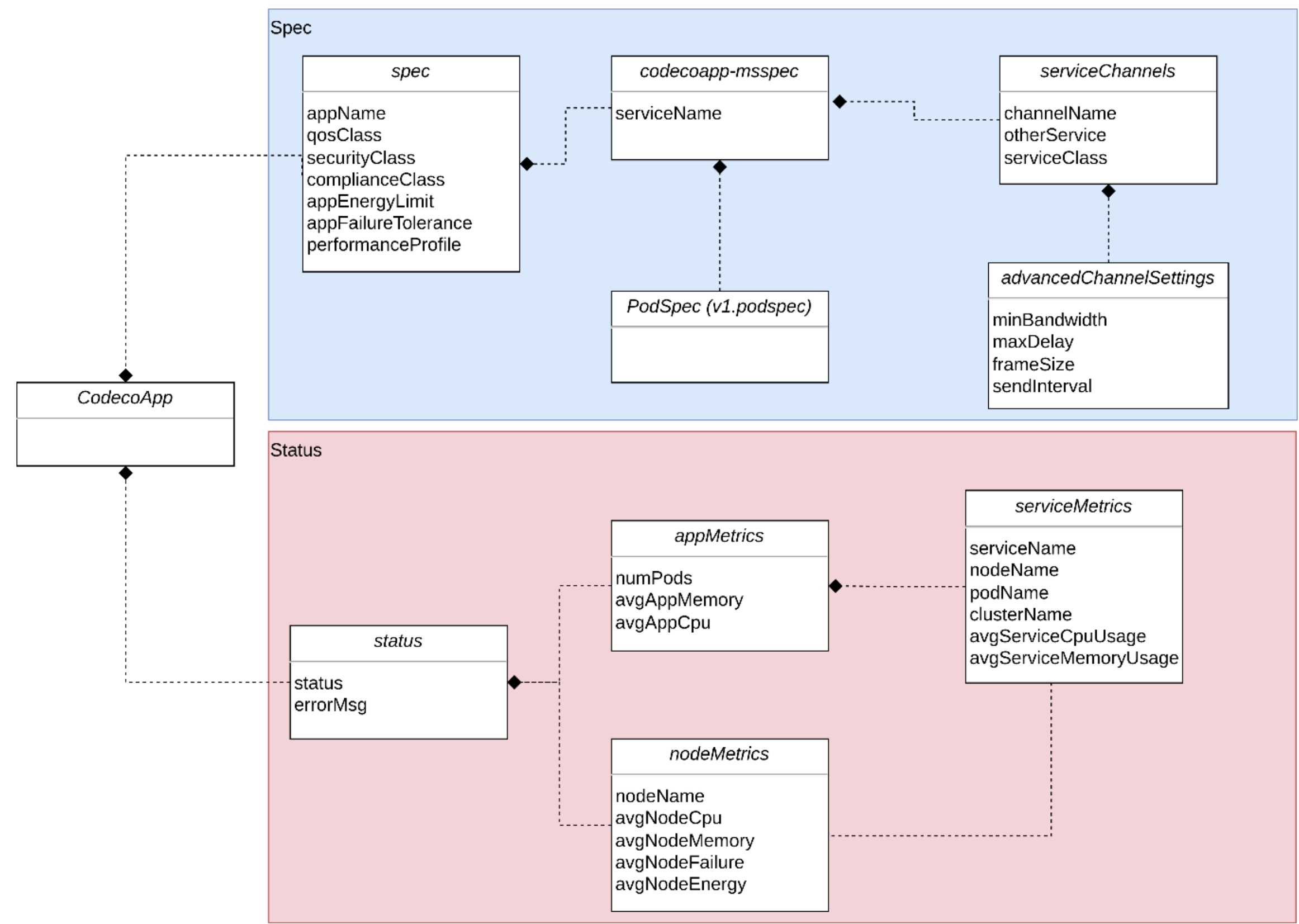
Rute C. Sofia, Josh Salomon, Ray Carrol, Luis Garces-Erice, Peter Urbanetz, Jurgen Gesswein , Rizkallah Touma, Alejandro Espinosa, Luis M. Contreras, Vasileios Theodorou, George Papathanail, Georgios Koukis, Vassilis Tsaoussidis, Alberto del Rio, David Jimenez, Efterpi Paraskevoulakou, Panagiotis Karamolegkos, John Soldatos, Borja Dorado Nogales, and Alejandro Tjaarda, **Towards Scalable Federated Container Orchestration: the CODECO approach.** Jan 2026, <https://doi.org/10.48550/arXiv.2601.1335>



Management Function	
Management Function	CODECO Components
Intent and Policy Management	ACM-FC (CAM), OCM Hub ACM-FC
Scope and Federation Management	Neighborhood Composer (CNC), ACM-FC Neighborhood Manager ACM-FC
Decision Support and Context-Awareness	PDLC-FC (CA, GNNs, MARL) PDLC-FC
Scheduling and Migration Enforcement	SWM-FC (SWM-L1, SWM-L2) SWM-FC
Network Configuration and Connectivity	NetMA-FC (NSM, Nemessys-FC, Secure Connectivity) NetMA-FC
Data Governance and Data Awareness	MDM-FC (Metadata Graph, Connectors, API) MDM-FC
Data Governance and Data Awareness	ACM-FC, MDM-FC, NetMA-FC
Observability and Feedback	ACM-FC, MDM-FC, NetMA-FC, ACM-FC



ACM | CODECO Application Model

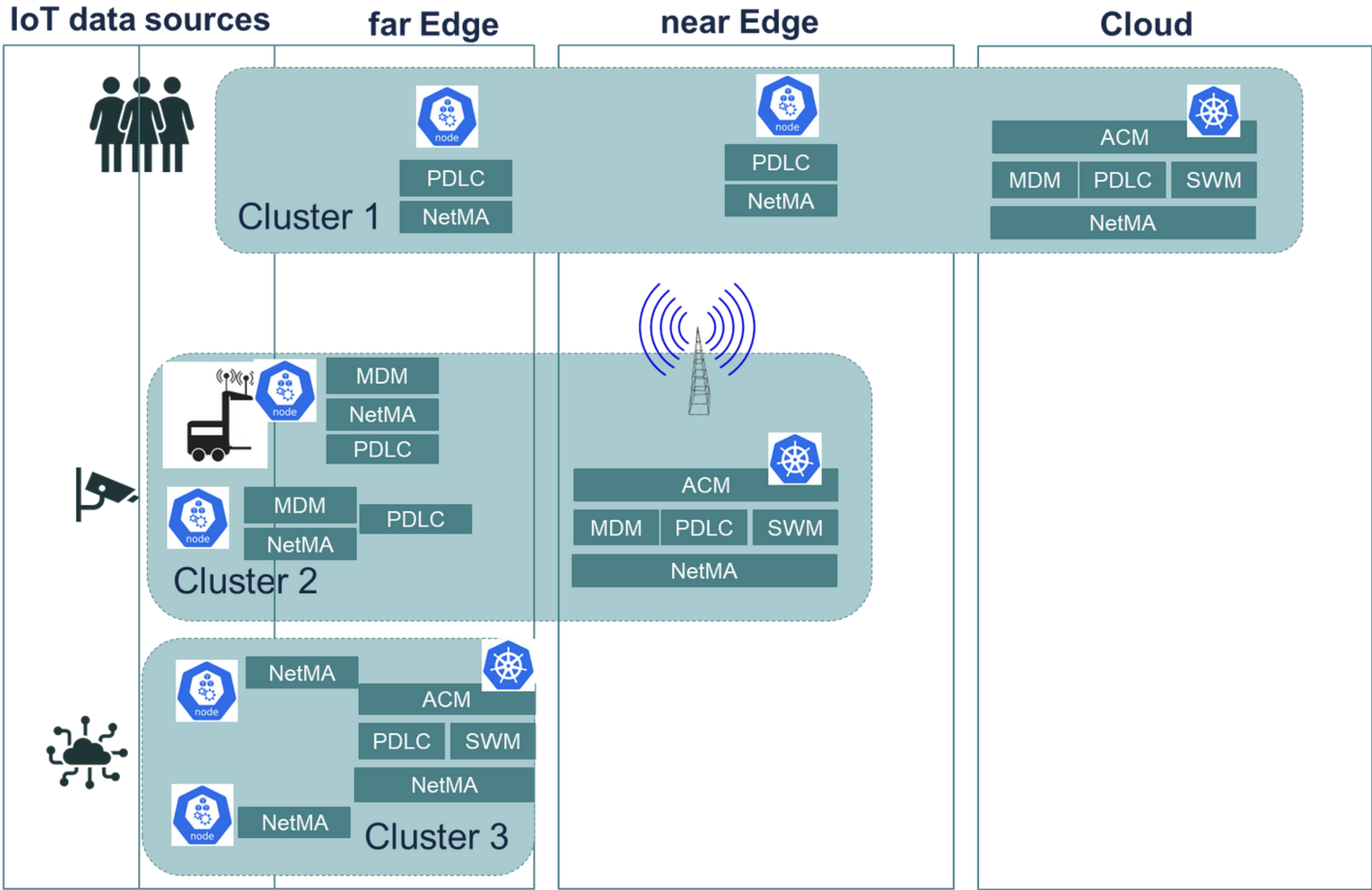


CODECO In the Edge-Cloud Continuum

Examples

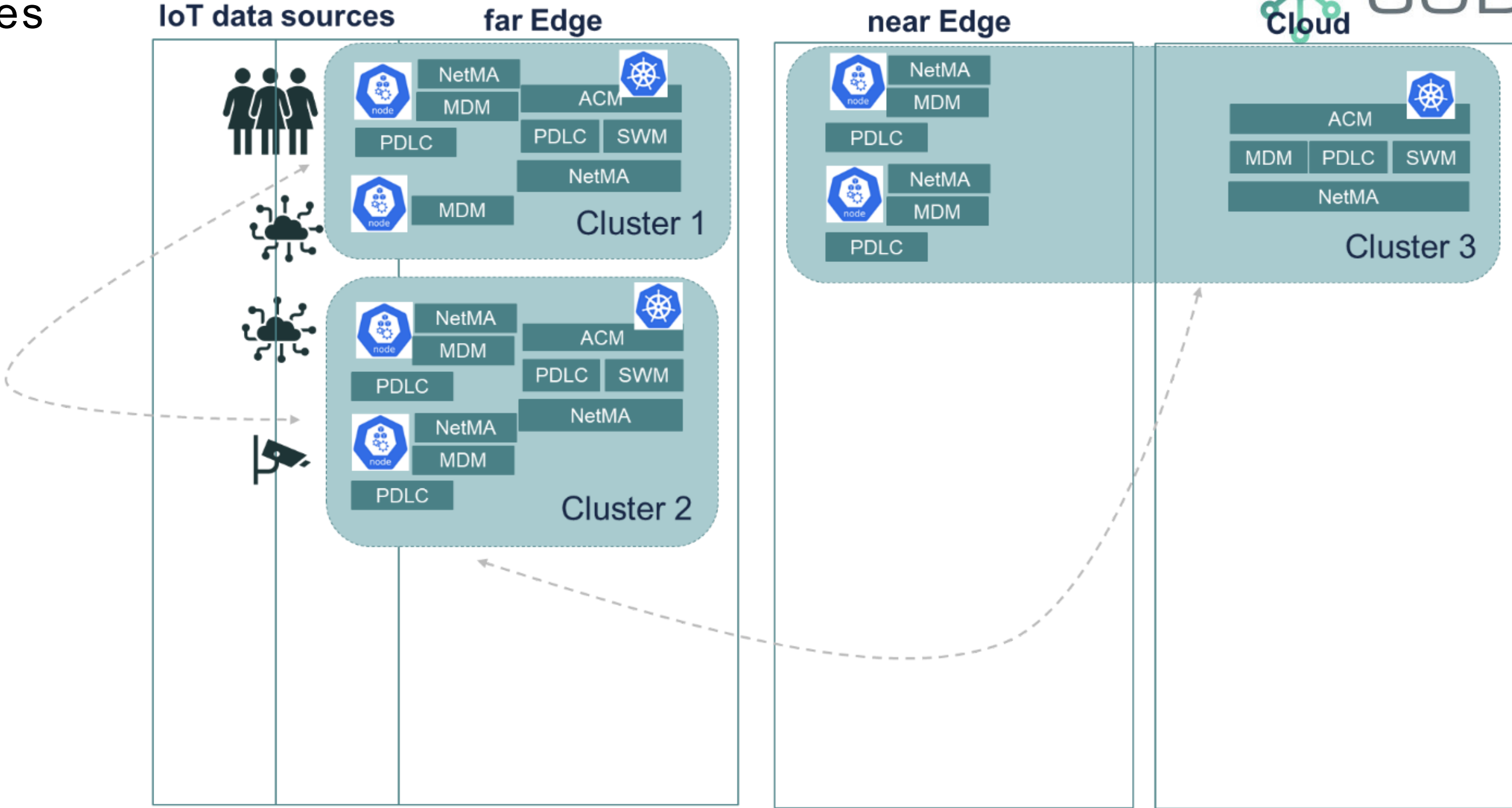


Single Cluster



CODECO In the Edge-Cloud Continuum

Examples



Federated Clusters

CODECO Comparison with other Approaches



Dimension	CODECO	Liqo	PHARE	Karmada
Primary focus	Cross-layer co-orchestration	Resource sharing, off-loading	Federated edge placement	Multi-cluster propagation
Federation model	Bounded neighborhoods	Peer-to-peer virtual clusters	Federated edge clusters	Hub-and-spoke
Governance	Hybrid (central policy, local exec.)	Decentralized peering	Centralized per deployment	Centralized hub
Scheduling scope	Neighborhood-scoped	Local + remote offloading	Cross-cluster	Cross-cluster
Scheduling strategy	Deterministic + AI guidance	Scheduler extensions	Heuristic / optimization	Policy-driven
AI / learning	Decentralized, privacy-preserving	None	None	None
Network awareness	First-class (metrics, cost maps)	Basic connectivity	Limited / implicit	Limited (policy hints)
Inter-cluster networking	Secure overlays, SDN-assisted	Gateway-based	External / assumed	External (e.g., Submariner)
Data / metadata awareness	Explicit metadata graph	None	Limited	None
Privacy and sovereignty	Local telemetry, protected exchange	Trust-based sharing	Not addressed	Not addressed
Edge autonomy	Designed for intermittency	Partial	Limited	Limited
Multi-provider support	Explicitly targeted	Implicit	Research-oriented	Enterprise / cloud
Runtime adaptation	Proactive + reactive	Reactive	Reactive	Reactive
Kubernetes integration	Native (CRDs, OCM-based)	Native	Prototype	Native



SCAN ME

Rute C. Sofia, Josh Salomon, Ray Carrol, Luis Garces-Erice, Peter Urbanetz, Jurgen Gesswein, Rizkallah Touna, Alejandro Espinosa, Luis M. Contreras, Vasileios Theodorou, George Papathanail, Georgios Koukis, Vassilis Tsaoussidis, Alberto del Rio, David Jimenez, Efterpi Paraskevoulakou, Panagiotis Karamolegkos, John Soldatos, Borja Dorado Nogales, and Alejandro Tjaarda, **Towards Scalable Federated Container Orchestration: the CODECO approach**. Jan 2026, <https://doi.org/10.48550/arXiv.2601.1335>

CODECO | Get Engaged!





CODECO

Cognitive Decentralised
Edge Cloud Orchestration

Booth 23

AI-Powered Kubernetes Orchestration

For Cloud-Edge-IoT applications

Learning Hub



Toolkits



Experimentation Framework



Eclipse KuDECO



Use-cases





Funded by
the European Union

under Grant Agreement 101092696

DISCOVER!



Website



Publications

ENGAGE and GET AWARDS!





IRCEP

INNOVATION AND RESEARCH
COMMUNITY ENGAGEMENT

Until 28.02.2026: Experimentation & Validation Challenges



Funded by
the European Union



Funded by the Swiss Federal Government

THANK YOU!



Affiliated Entities: City of Göttingen, ATOS IT, Universidad Carlos 3 de Madrid