

Open Source Community Day

NEMO & ICOS

Contributions to OS communities

23 - 24 September



Co-located with
AIOTI Days 2025

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23/09/2025



CLOUD NATIVE
COMPUTING FOUNDATION



ICOS

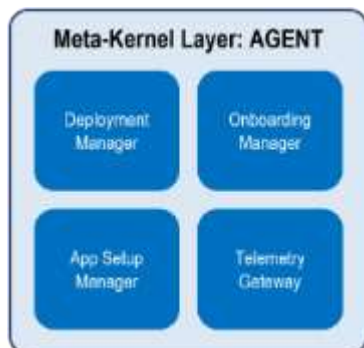
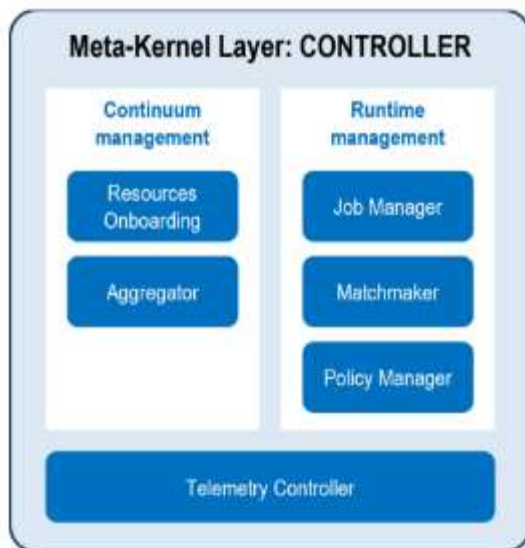


NEMO

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Towards a functional continuum operating system



ICOS represents an IoT2Cloud meta-Operating System that aims to manage the continuum by providing a framework that will be extensible, open, secure, adaptable, AI-powered as well as well highly performant and technology agnostic

Main domains of application

- **In-car Advanced Infotainment and Multimedia Management system**
- **Agriculture Operational Robotic Platform**
- **Railway Structural Alert Monitoring system**
- **Energy Management and Decision Support system**
- *30+ implementations through the Open Call programme*

Internal Use Cases results

Functionality validated:

Data synchronization and Intelligent deployment

KPIs achieved:

- Validation and Mapping of Germinated Plants 90% detection
- Weeds and Diseases Detection Effectiveness 60%
- Fertilizer Use Reduction 91,5%
- Herbicide Use Reduction 91%

UC1: Agriculture
Operational
Robotic Platform



Functionality validated:

Off-line application execution and Data Integrity

KPIs achieved:

- 83% Delay Reduction
- 100% service availability during offline periods
- Significant Cyber Security Risk Reduction Through Edge Execution

UC2: Railway
Structural Alert
Monitoring system



Functionality validated:

Off-line application execution and Dynamic Deployment

KPIs achieved:

- -40% Delay Reduction
- 100% service available during offline periods
- -10% cybersecurity threats in cloud

UC3: In-car Advanced
Infotainment and
Multimedia
Management system



Functionality validated:

Increase security and privacy and reduce latency.

KPIs achieved:

- 100% detection and mitigation of security threats
- +95% increase in service available using the same resources

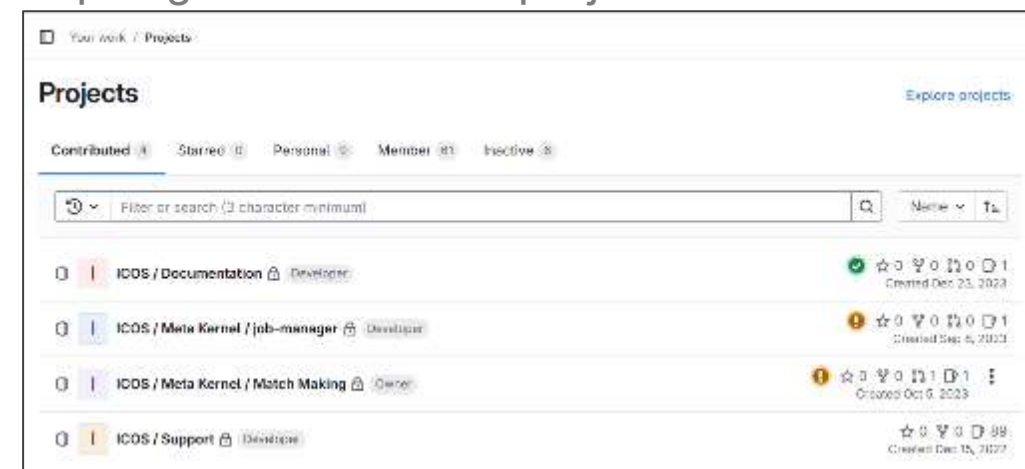
UC4: Energy
Management and
Decision Support
system



Nuvla.io: Mgmt & Orchestration	SixSq	Free
NuvlaEdge	SixSq	PAYG
Node Feature Discovery	NCSRD	Apache 2.0
Telemetrum	ENG	Apache 2.0
ICOS Shell	TUBS/UPC	Apache 2.0
Matchmaking	UPC	Apache 2.0
Job Manager	ATOS	Apache 2.0
Deployment Manager	ATOS	Apache 2.0
Aggregator	ATOS	Apache 2.0
ClusterLink	IBM	Apache 2.0
PyCOMPSs	BSC	Apache 2.0
Decentralized computation offloading	NKUA	Proprietary
Security Layer coordination	XLAB	Apache 2.0
Security Scan	XLAB	Apache 2.0
LOg MOnitoring System	XLAB	Proprietary
Tetragon Wazuh Agent	NCSRD	Apache 2.0

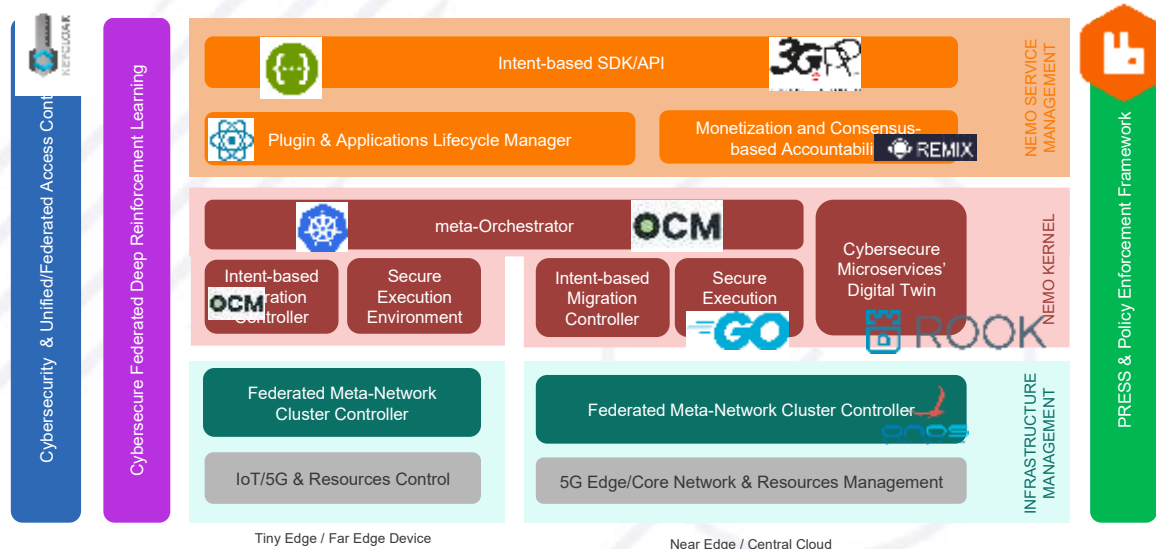
AI coordination: API Community ed.	CeADAR	GNU GPL v3
AI coordination: API Developer edition	CeADAR	Proprietary
AI analytics: predictive telemetry	CeADAR	GNU GPL v3
AI analytics: ML models (Bento)	CeADAR	Proprietary
AI analytics: Continuum models	CeADAR	GNU GPL v3
AI model repository	CeADAR	GNU GPL v3
dataClay	BSC	BSD3-clause

<https://github.com/icos-project>



Next Generation Meta Operating System

meta-os.eu



NEMO aims at:

- Defining an **open, scalable, cybersecure** and **federated** mOS focusing on the AIoT-to-edge-to-cloud continuum
- Bringing **cognitive intelligence** closer to the data, where decisions are made, while supporting integrally any mOS' and apps' decision.
- Delivering a **federated meta-Network Cluster Controller** (mNCC) and associated network adapters to offer a time-triggered multipath/multitenant/multi-cloud clusters, while supporting zero-delay failback/self-healing "by design".
- Deliver a novel SLO-sensitive *meta-Orchestrator*, offering optimal micro-services scheduling/ migration.
- Design and implement ZeroOps Management tools to support NEMO on-time cluster nodes auto-configuration and improve developer productivity via intent-based programming.
- Introduce a novel Monetization and Consensus-based Accounting (MOCA) mechanism to enable flexible business models and accelerate pre-commercial exploitation.

Main domains explored

Agriculture, Energy, Smart Cities, Industry, XR, etc

Smart Farming

What was implemented:

- ✓ Drone-based monitoring and precision bio-spraying of olive trees
- ✓ AI/ML pipelines executed remotely via NEMO
- ✓ Automated identification and reporting of olive tree diseases
- ✓ Implementation of a User Interface for monitoring the devices' status and data collected

Key Benefits:

- ✓ Automated spraying with minimal human effort
- ✓ Precise targeting of affected tree areas
- ✓ Reduced pesticide use and improved crop health
- ✓ Lower operational costs by offloading heavy AI/ML processing to edge/cloud infrastructure



Smart Energy/Mobility

What was implemented:

- ✓ Real-time grid monitoring with PMUs and edge gateways
- ✓ Local event detection at the edge, with selective high-frequency data sent to the cloud
- ✓ Remote updates and service management enabled by NEMO
- ✓ Integration of forecasting and optimization tools for EV charging flexibility

Key Benefits:

- ✓ Improved grid awareness and ability to localize faults
- ✓ Reduced bandwidth needs while maintaining high observability
- ✓ Smarter EV charging aligned with renewable generation and grid needs
- ✓ Efficient flexibility data exchange between DSO and CPO, optimizing grid operations



Smart Industry

What was implemented:

- ✓ scTracking application for end-to-end monitoring of supply chain activities
- ✓ ML-based cobot vision for intelligent object picking
- ✓ Log-based analytics for full traceability of parts in real time
- ✓ Human-centered safety system with sensors (cameras, radar, LiDAR) and AGV collision avoidance
- ✓ NEMO-enabled orchestration across IoT/5G edge and cloud infrastructure

Key Benefits:

- ✓ Automated and transparent supply chain workflows, reducing manual effort
- ✓ Improved accuracy and speed in part handling through cobot-vision integration
- ✓ Real-time monitoring and visualization of logistics operations
- ✓ Safer work environments with human-AGV collision prediction and avoidance
- ✓ Cost and time reduction >20% and improved sustainability of manufacturing



Smart Media City/XR

Cloud-Edge-IoT Living Labs for Media – Entertainment – Culture

SmartMedia/City

What was implemented:

- ✓ AI/ML-driven data analysis and XR enrichment of live sporting event media
- ✓ Automated processing, annotation and rendering of content from smartphones, GoPros, IP cameras, and drones
- ✓ Hybrid execution of workflows across devices, edge, and cloud via NEMO
- ✓ VPN-based connectivity enabling secure, flexible remote production

Key Benefits:

- ✓ Enhanced spectator experience with curated, real-time content delivery
- ✓ Demonstrated feasibility of distributed media workflows in real-world live events
- ✓ Reduced travel and logistics through centralized management and remote production
- ✓ Sustainable business solution for media channels, considering CO₂ emissions and green energy usage

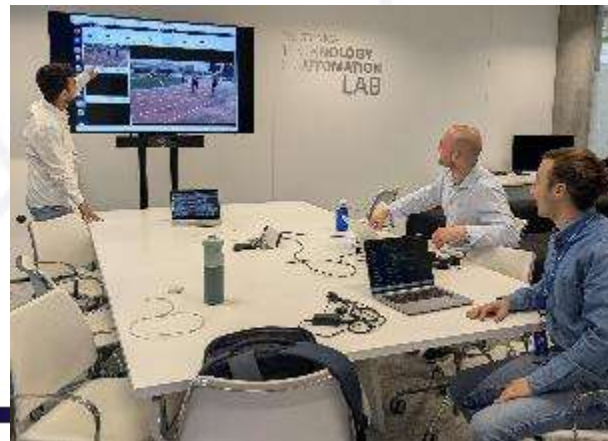
Smart Media XR

What was implemented:

- ✓ VR Head-Mounted Display enhanced with biometric feedback from smartwatch sensors
- ✓ Large Dome Theatre VR experience with gesture recognition for group interactivity
- ✓ NEMO-enabled microservices across IoT devices, edge, and cloud for scalability

Key Benefits:

- ✓ Emotion-adaptive VR experiences that respond to user comfort and engagement
- ✓ Simplified setup with single-computer architecture replacing complex clusters
- ✓ 25% improvement in immersive experience, validated by museum educators and visitors



	IoT	Edge	Cloud
Platform	NEMO Meta Operating System		
Virtualization Infrastructure	K3s/Docker	K8s/K3s/Docker	K8s/Docker
Applications	Kepler, kong, Prometheus, Linkerd, Thanos, Multus-CNI, LCM	Kepler, kong, Prometheus, Linkerd, Thanos, Multus-CNI, LCM	Kepler, kong, Prometheus, Linkerd, Thanos, Multus-CNI, LCM
Resource Management	mNCC, Intent based management controller, PPEF	Intent based management controller, mNCC, PPEF	MO, MOCA, mNCC, PPEF
Device Management	-	MO	MO
Orchestration Management	-	MO, OCM	MO, OCM
Data Management/ Processing/ Storage	S3 storage	Rook-ceph, s3 storage,	Rook-ceph, s3 storage, redis, postgres
Embedded Operating System	Linux-based OS	Linux-based OS	Linux-based OS
Security and Privacy	Keycloak, falco, Linkerd	Keycloak, falco, Linkerd	Keycloak, falco, Linkerd
API Management	-	Intent-based API	Intent-based API
Protocols / Device Connectivity	Multus-CNI, RabbitMQ, HTTP, Ethernet, IEEE 802.11 family		
Physical Connectivity	Wi-Fi, Cellular communications	Wi-Fi, LAN	LAN

<https://gitlab.eclipse.org/eclipse-research-labs/nemo-project>

Thank you!



<https://www.icos-project.eu/>

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<https://meta-os.eu/>

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