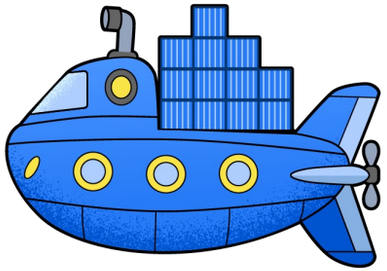


NEMO

NExt Generation Meta Operating System

NEMO
IN METAOS LANDSCAPE

Meta Operating Systems: Innovating the CEI landscape

Webinar, 3 April 2024

Dr Terpsi Velivassaki

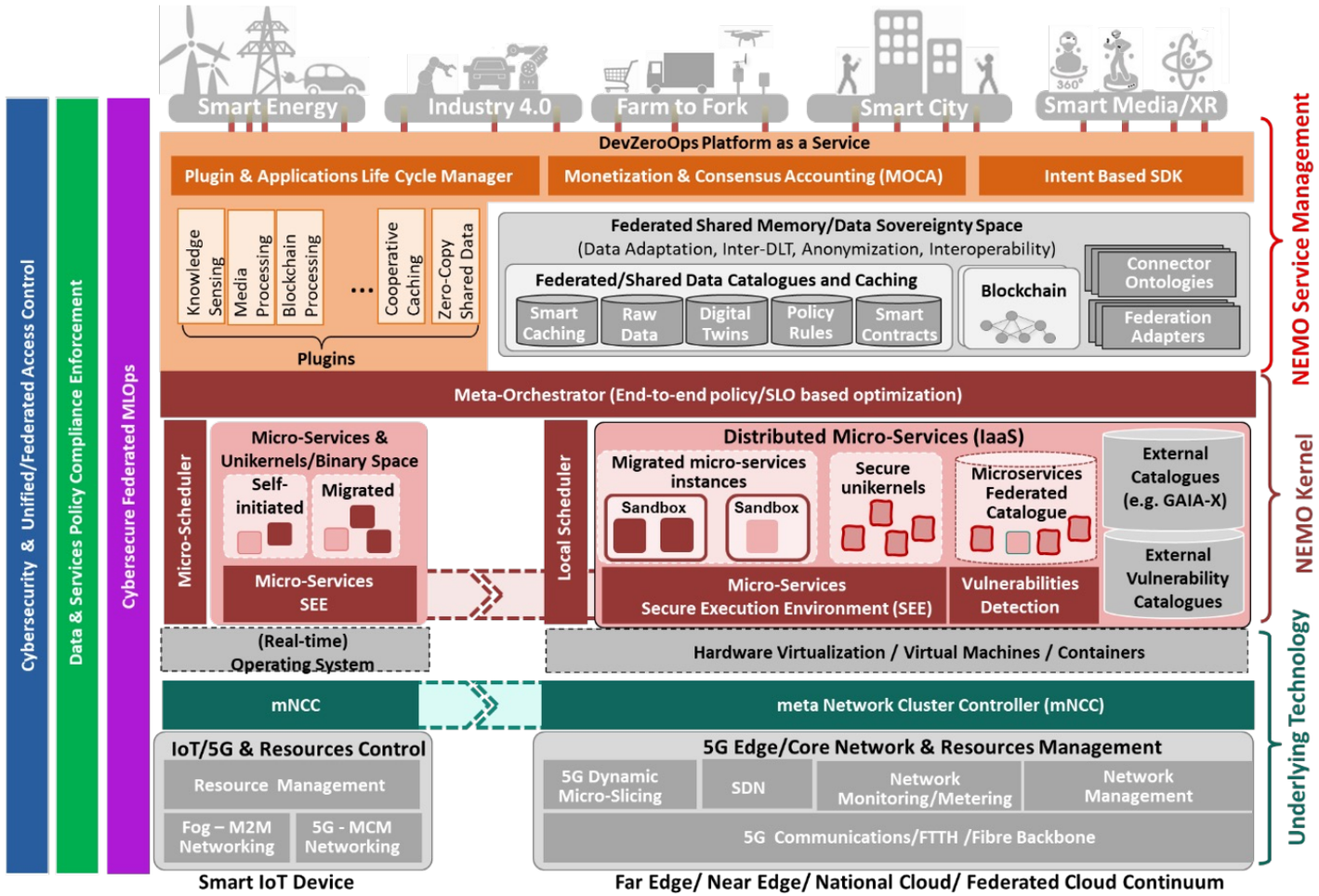
Synelixis Solutions

NEMO receives funding from the EU Horizon Europe research and innovation Programme under Grant Agreement No. 101070118

Our story

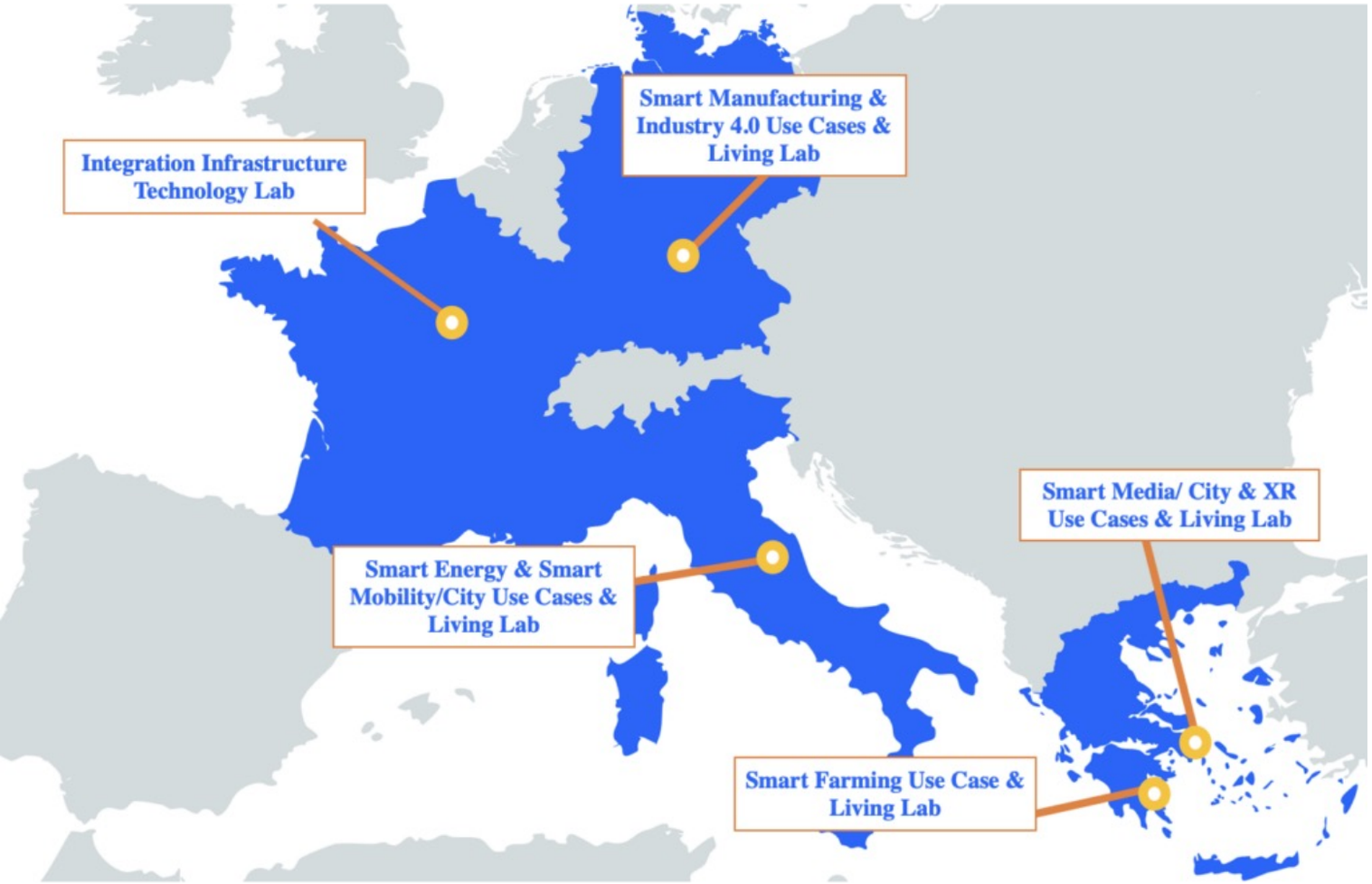
NEMO aims to build the meta-Operating System (metaOS), which will enable multi-cluster and multi-network orchestration of containerized workloads across the IoT, edge and cloud continuum. As a (meta-)OS, NEMO will be user-centric, facilitating users to develop and deploy on top of NEMO. Moreover, NEMO will enable cloud and infrastructure providers to integrate their computing and networking resources into NEMO's infrastructure.

NEMO vision



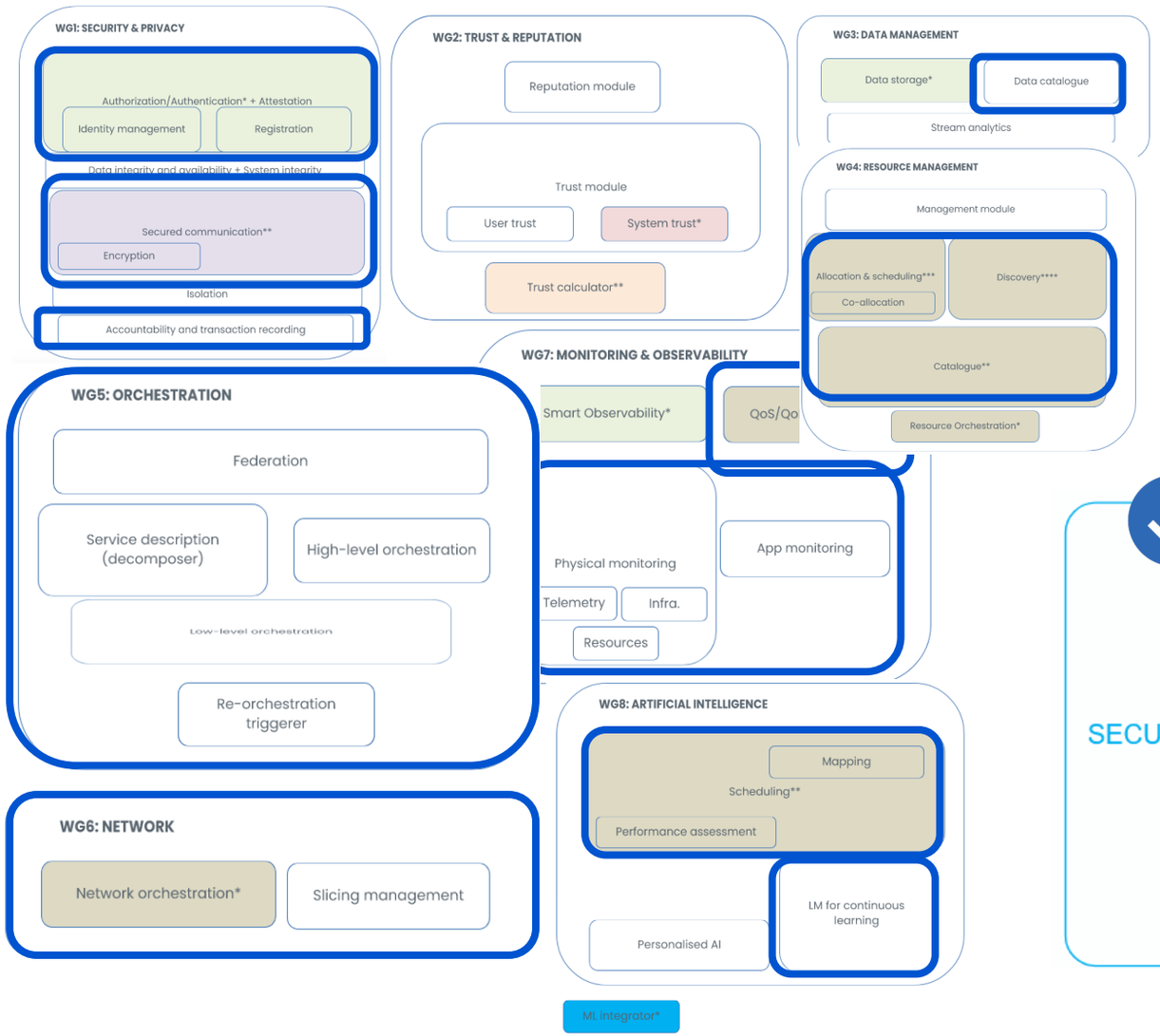
- On-device Intelligence to enable AIoT (inter-)acting as self-aware, (semi-) autonomous entities
- Transparent IoT-to-Edge-to-Cloud continuum
- Intent based DevZeroOps tools and plugin mechanisms
- Open and modular meta-Operating System (mOS)
- Massive AIoT applications and **high penetration**

Validation and Piloting

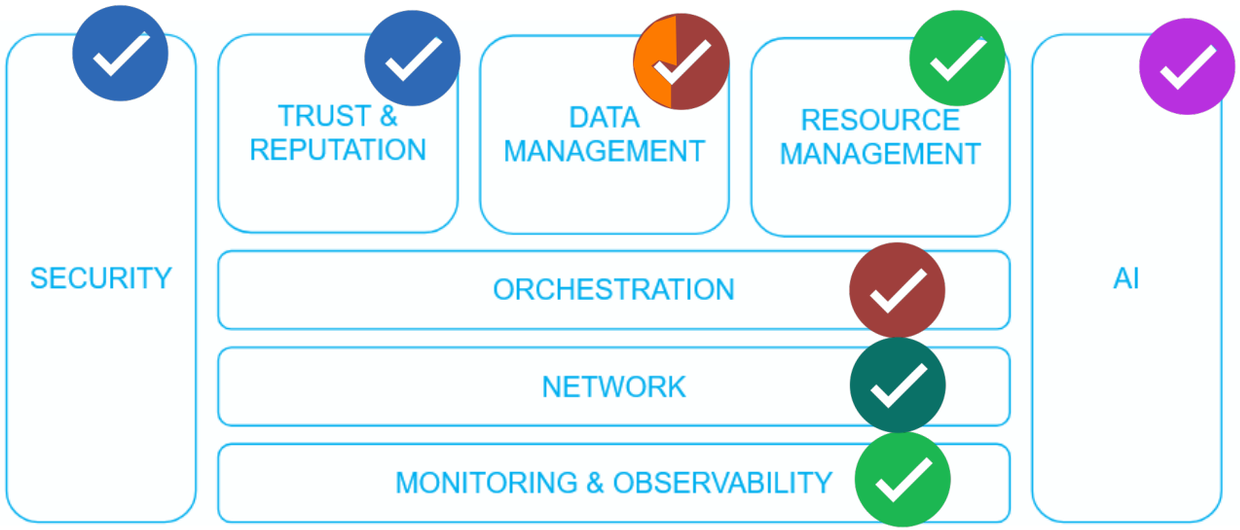


- 5+1 Living Labs
  - Smart Farming and Precision Agriculture
  - Smart Energy & Smart Mobility
  - Smart Manufacturing & Industry 4.0
  - Smart Media/ City & XR
  - OneLab (IoT) Lab
  - IoT/5G Lab
- 9 use cases & 10 new use cases via Open call #2

NEMO in the metaOS landscape



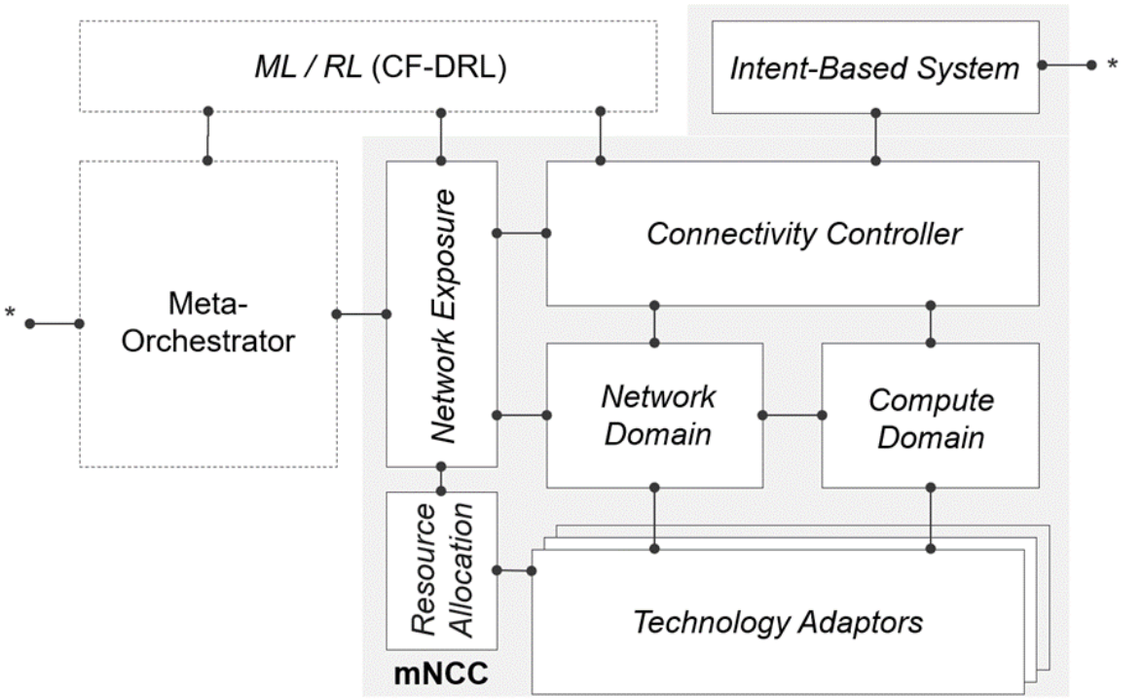
- NEMO innovations address most topics of EUCEI RA
- Greater focus on NETWORK & ORCHESTRATION



Network Infrastructure Management

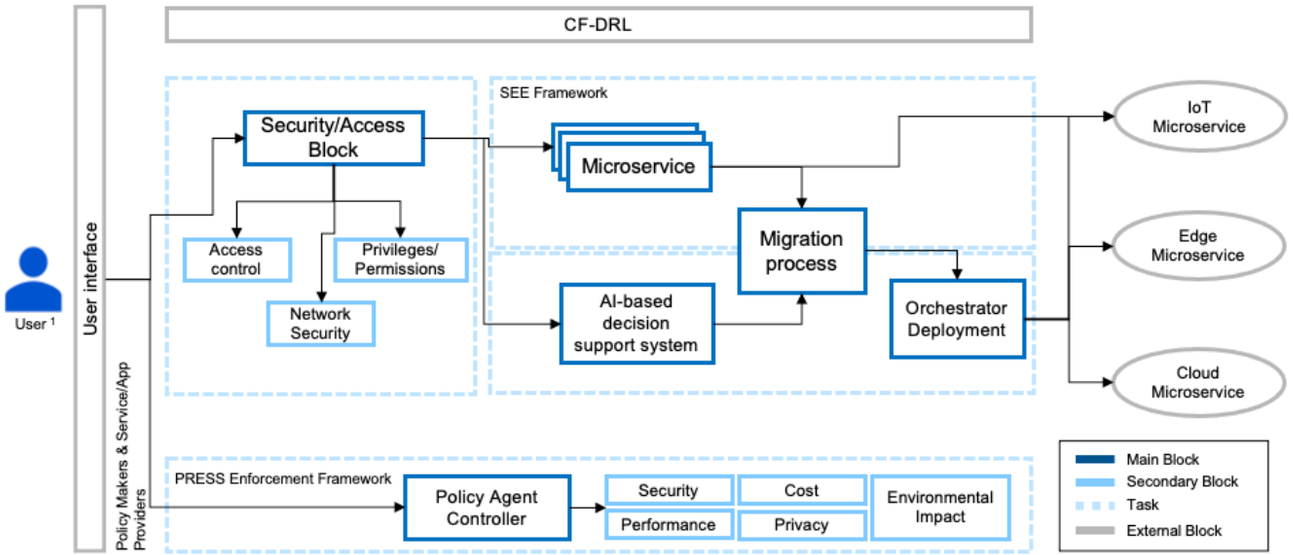
NEMO

- Federated Meta-Network Cluster Controller
  - Intent-based Networking for service delivery across domains
  - Micro-slices as connectivity service between far-edge/edge/cloud
  - Multipath communication
  - Service migration
- 5G Core with TSN
  - 5G LAN
  - Network slice creation



NEMO Kernel

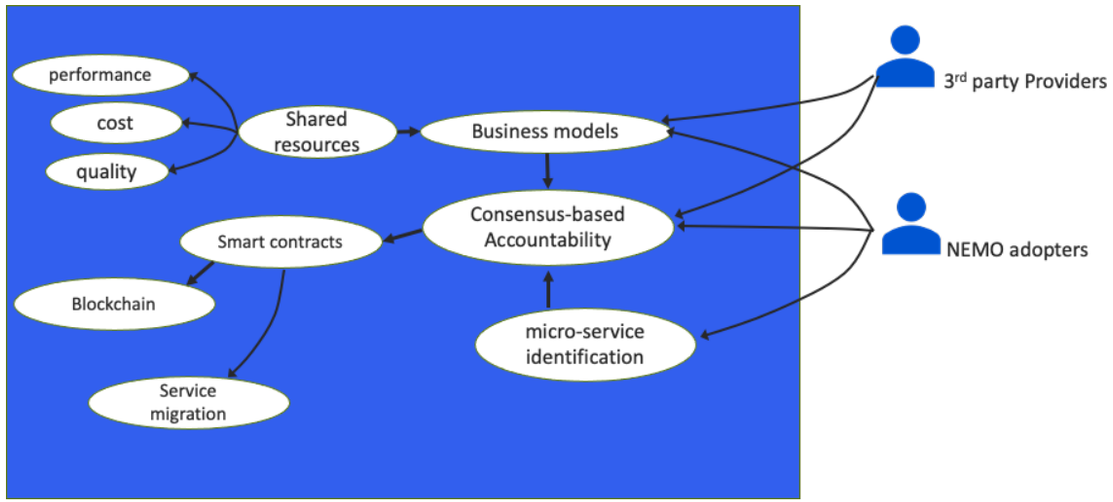
- Meta-Orchestrator
  - Central orchestrator of distributed workflows in the continuum
  - Intelligent decision making for optimal resource utilization
  - Interoperability & sustainability leveraging SoTA open source tools
- Intent-based Migration Controller
  - executing workload actions on the MetaOS
  - aligned to Intent-based Networking principles
- Cybersecure Microservices' Digital Twin
  - Extension of Meta-Level DT to Micro-services
  - Enhanced Cybersecurity with DLT
- Secure Execution Environment
  - Unikernel & TEE runtime
  - Migration extension for Kubernetes

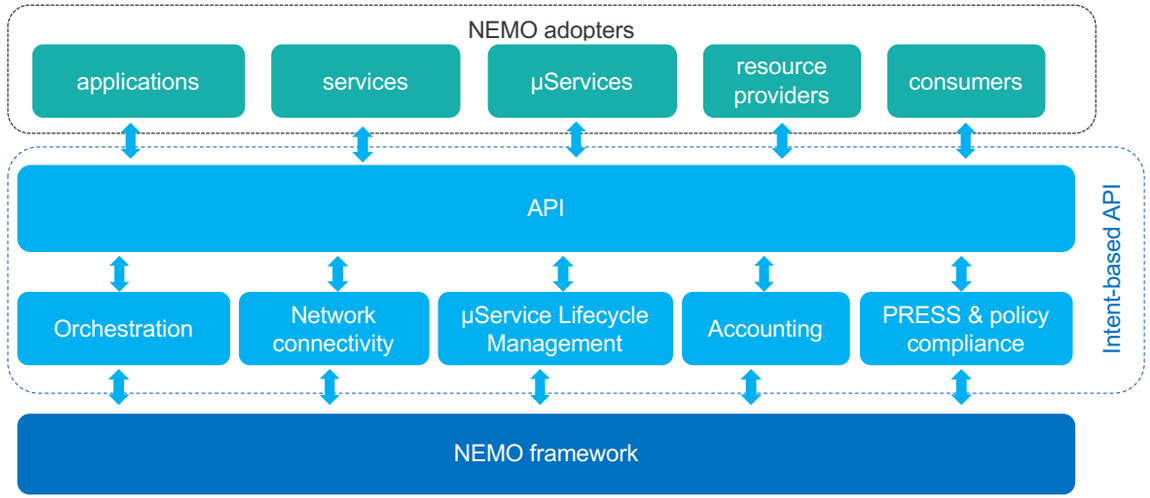


1. User / Smart IoT / Near Edge / Far Edge / National Cloud /Federated Cloud Continuum

NEMO Service Management

- Plugin & Applications Lifecycle Manager
  - Unified LCM for NEMO workloads
  - Critical service events monitoring
  - Service security monitoring
- Monetization and Consensus-based Accountability
  - Secure resources allocation transactions
  - End-to-end consensus-based accounting mechanism
  - DLT smart contracts integration
- Intent-based SDK/API
  - Intent-based microservices' programming tools
  - Exposing NEMO functionality
  - Supporting meta-OS openness & developers' friendly

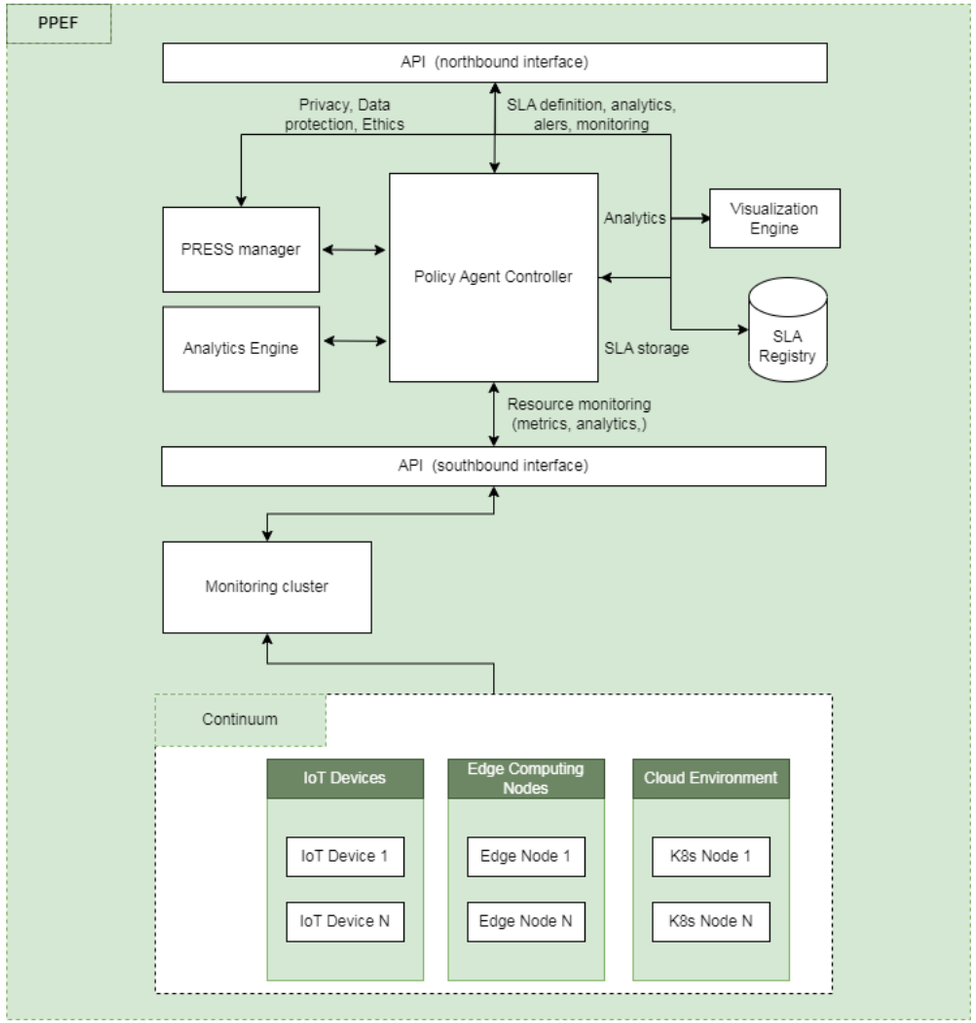




Security, privacy and policy enforcement

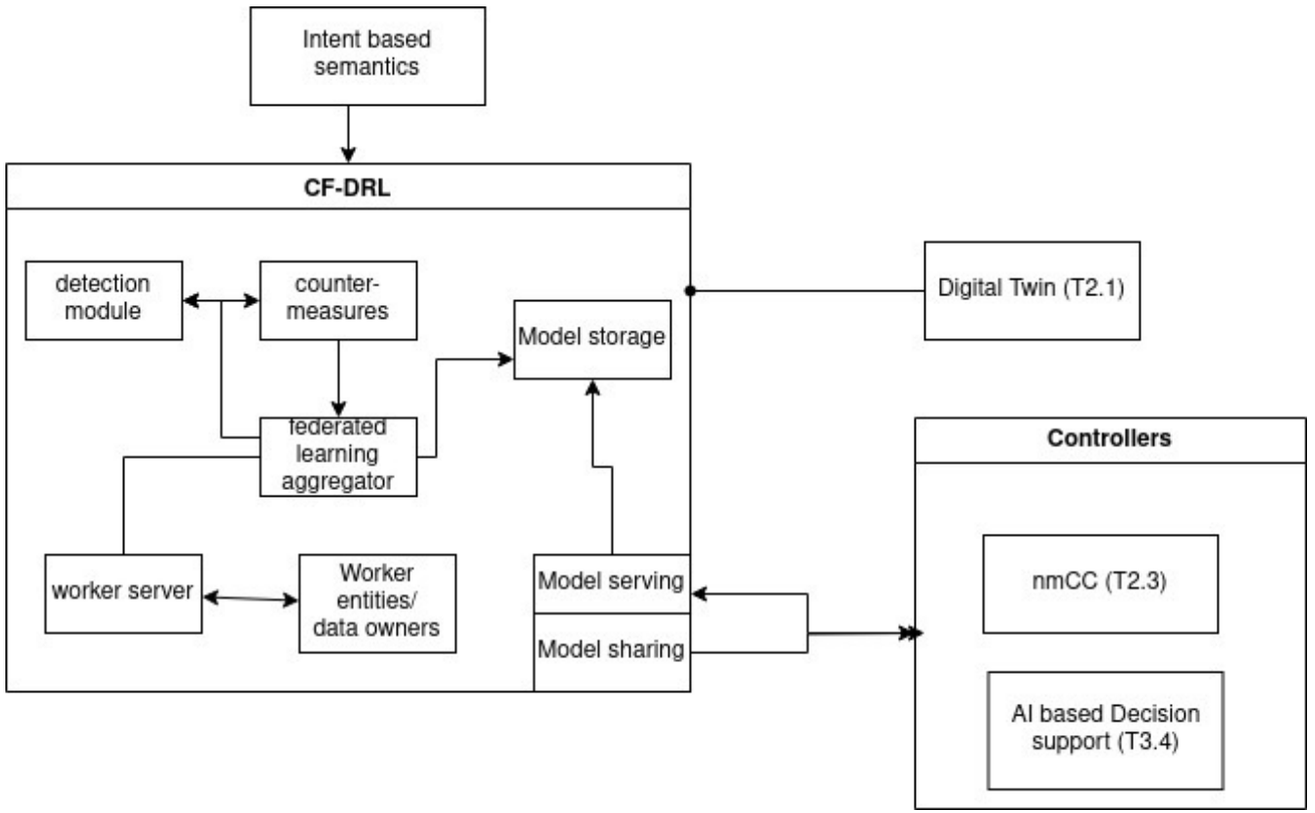
- NEMO PRESS & Policy Enforcement
  - Policy definition and automated compliance
  - Node & service observability
  - Addressing also PRESS & energy efficiency requirements

- NEMO Cybersecurity & Unified/ Federated Access Control
  - Identity Management & Access Control
  - ZeroTrust privileged access control
  - Chained multi-criteria access (AAA, IP white/blacklisting, rate limiting, …)
  - Intercommunications' security
  - Encrypted pub/sub message bus

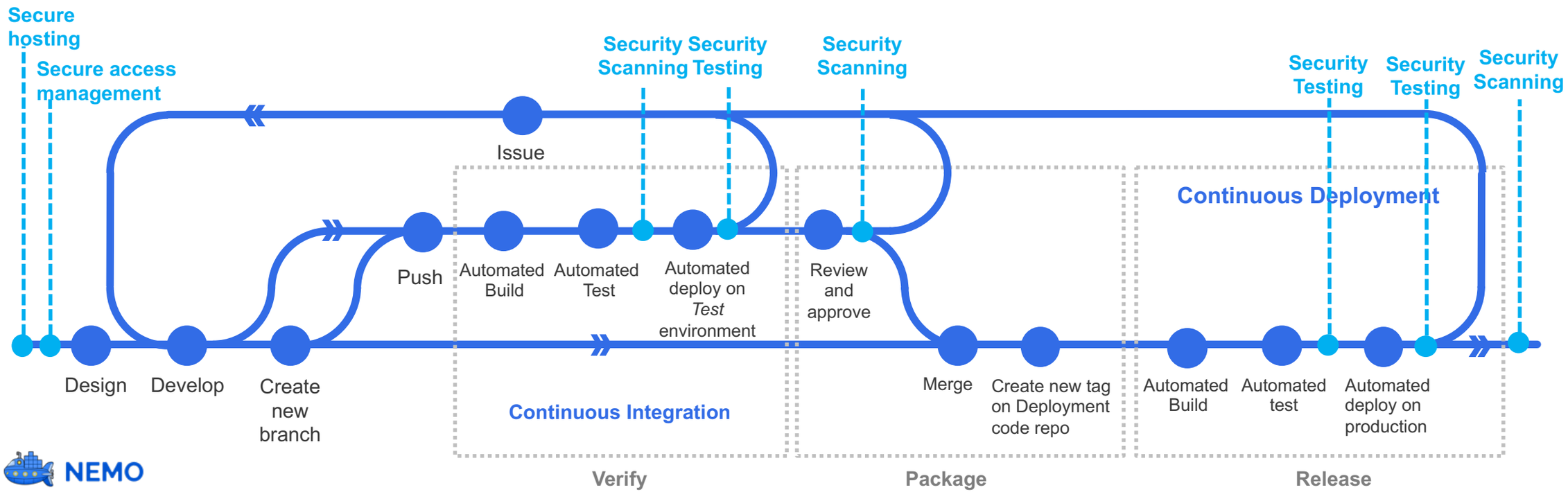


Federated MLOps

- Cybersecure Federated Deep Reinforcement Learning
  - Federated Learning
  - Reinforcement Learning
  - Gossip Learning
  - Cybersecurity & Privacy-Preservation
  - GAN-based Dataset Generation
  - ML-based attack detection
  - AI/ML-based Attack mitigation



NEMO DevSecOps / ZeroOps

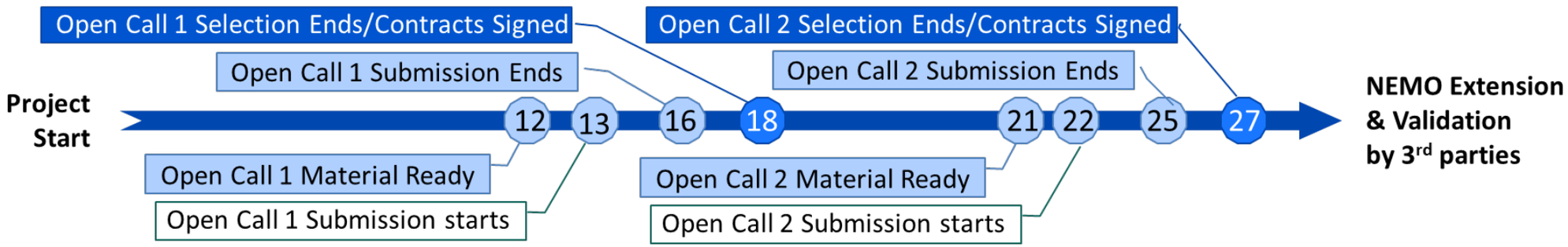


What can be anticipated for the future of the continuum?

NEMO

- Generative AI integration in automating
  - MLOps, DevSecOps, metaOS-human interaction
- Strategic approach towards a cybersecure MetaOS (Cybersecurity Code of Conduct for MetaOS)
- Automatic PRESS & GDPR compliance by design & by default
- Wireless and wired network integration for real-time immersive applications (5G/6G, TSN, SDN)
- Miniaturization of orchestration frameworks
- Open source protection from unexpected close-sourcing
- Greenification EU-wide metaOS
- Large scale piloting
- Incentives for building/investing on the metaOS

Open Calls



1st Open Call (closed)

- €900K total funding
- max 150K / project
- 6 projects selected

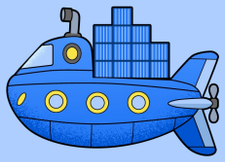
- Target:
  - NEMO meta-architecture extensions
  - software components/plugins
  - new network or service/resources metering/automated control components or
  - porting NEMO on new, highly heterogeneous IoT devices

2nd Open Call (pending)

- €900K total funding
- max 90K / project
- at least 10 projects to be funded
- Opening: June 2024

- Target
  - NEMO use cases extension
  - new apps using NEMO

Thank you for your attention



NEMO

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SYNELIXIS

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