nephele

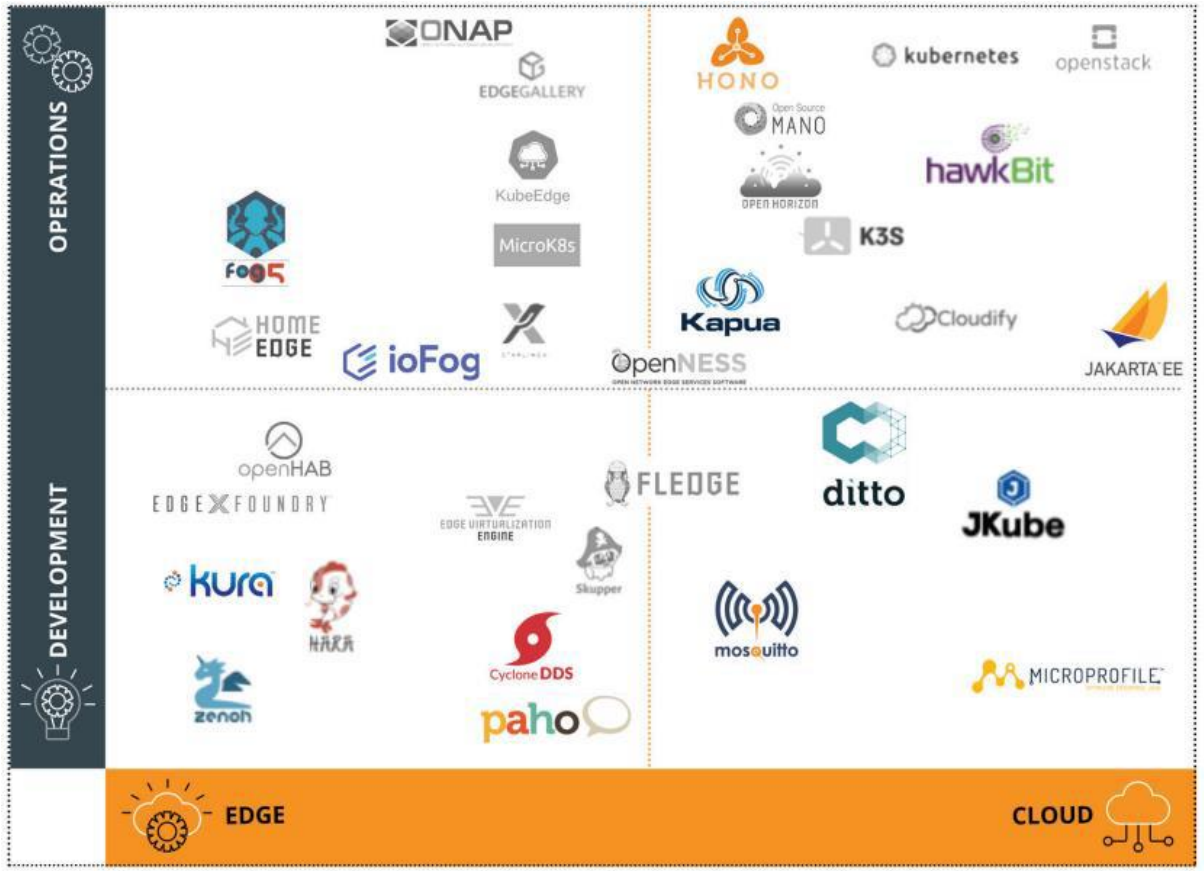
A lightweight software stack and synergetic meta-orchestration framework for the next generation compute continuum

26ο Συνέδριο InfoCom World
Athens, 12/11/2024

Dr. Anastasios Zafeiropoulos
National Technical University of Athens
tzafeir@cn.ntua.gr

Main 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



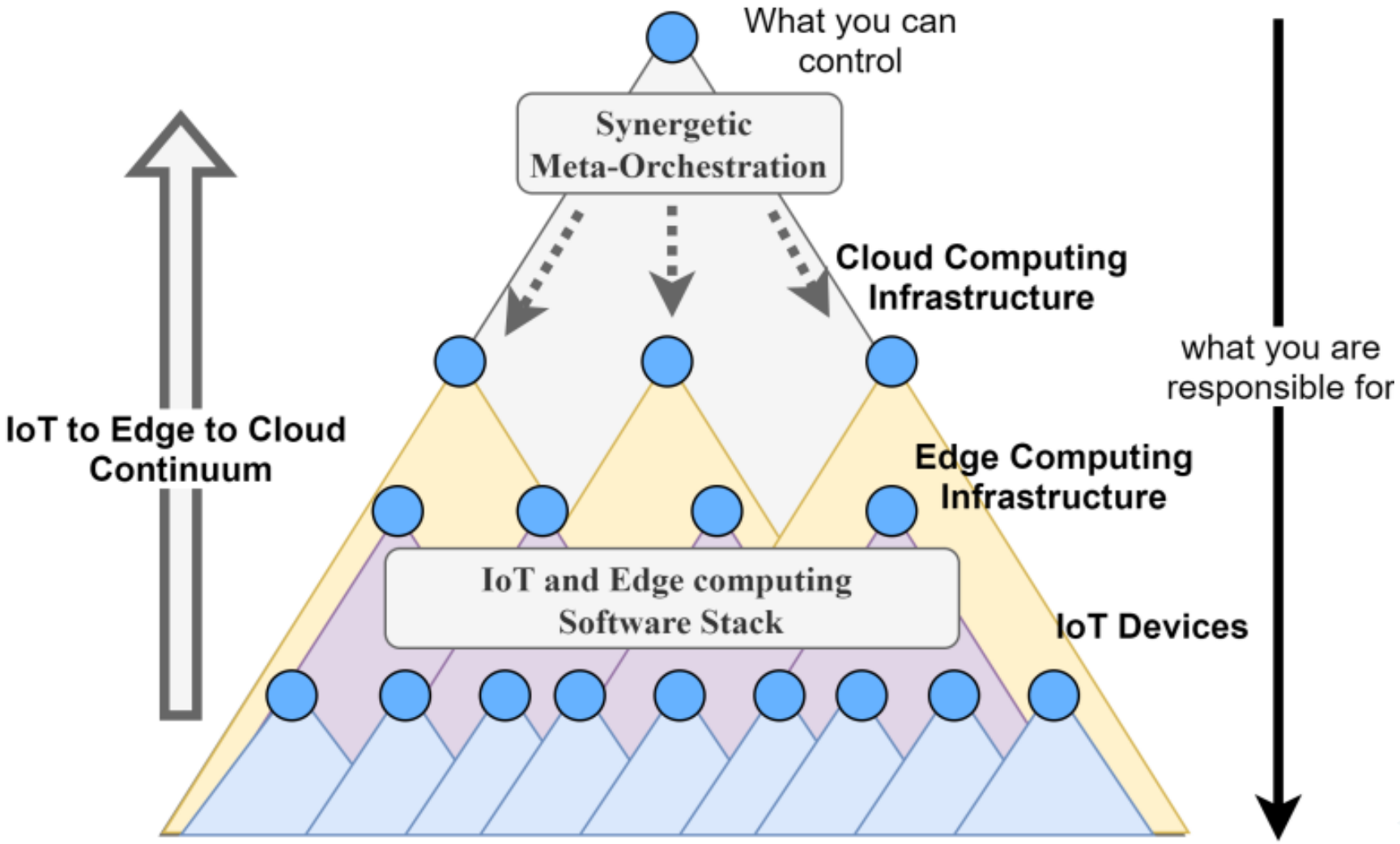
Eclipse Foundation, From DevOps to EdgeOps: A Vision for Edge Computing, White paper, 2021

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.

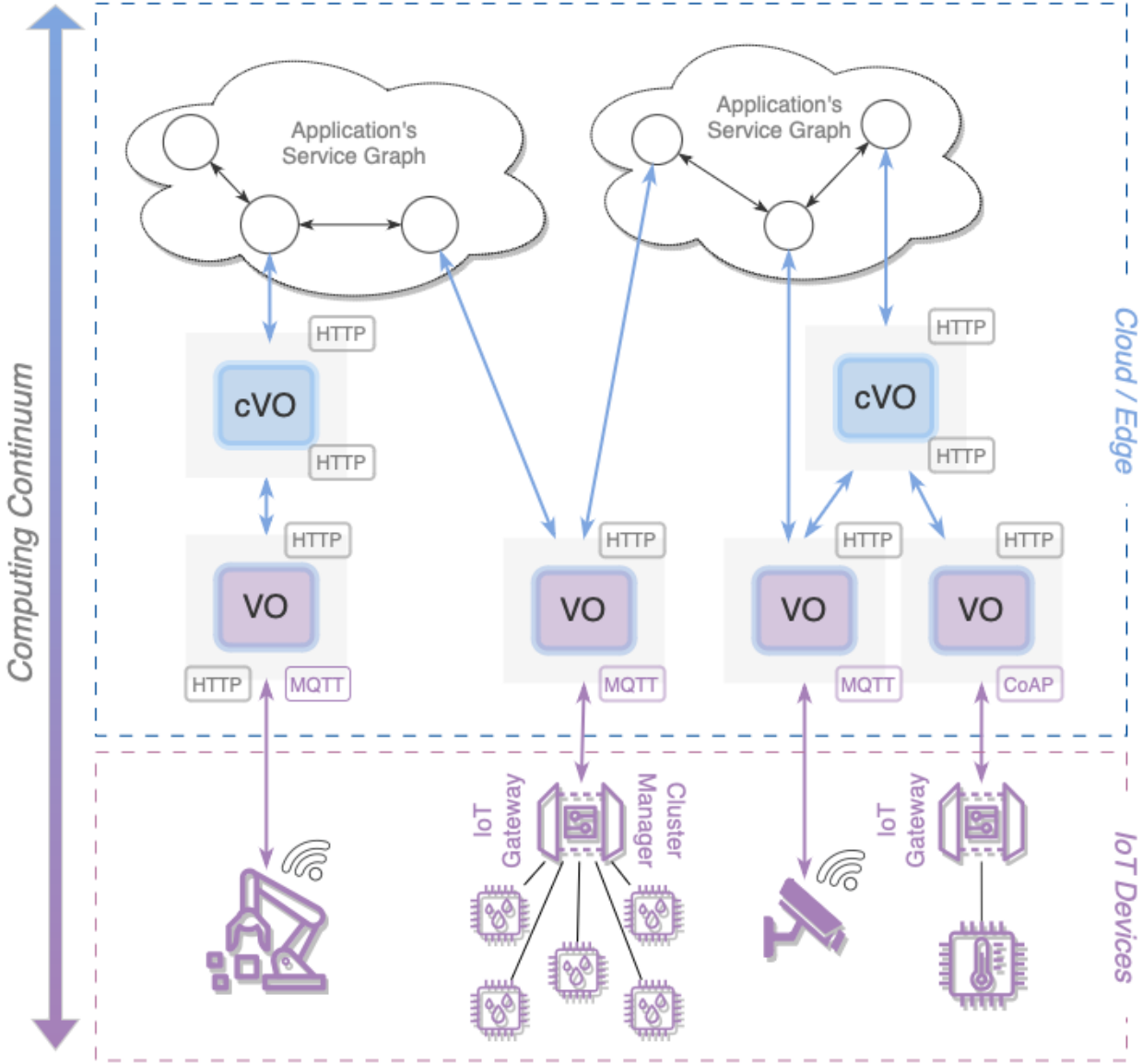
System of Systems Approach

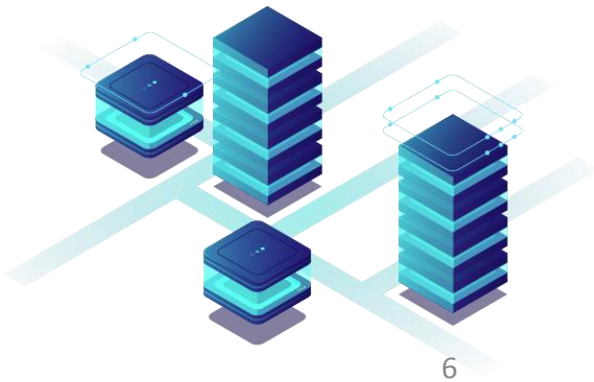


Virtual Object (VO) Definitions

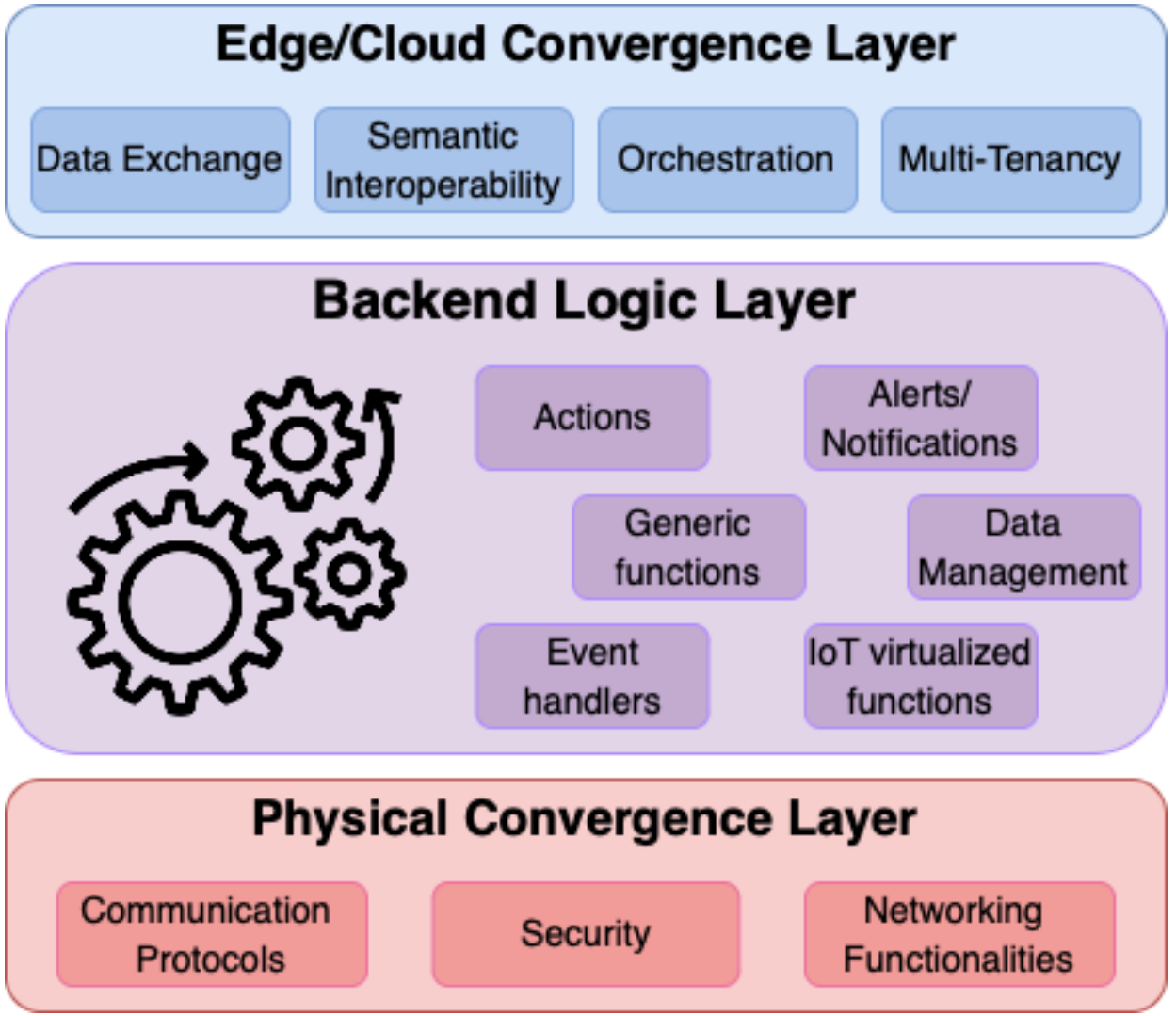
- A Virtual Object (VO) is considered as a virtual counterpart of a physical device on the Internet of Things domain
  - set of abstractions for managing any type of IoT device through a virtualized instance;
  - augments the supported functionalities through the development of a multilayer software stack, called **Virtual Object Stack (VOStack)**.
- A Composite Virtual Object (cVO) is a software entity that can manage the information coming from one or multiple VOs and provide advanced functionalities.
  - a cVO is connected with multiple VOs that manage IoT devices of several types;
  - a cVO enhances the capabilities of the VO through the provision of application-oriented functionalities.

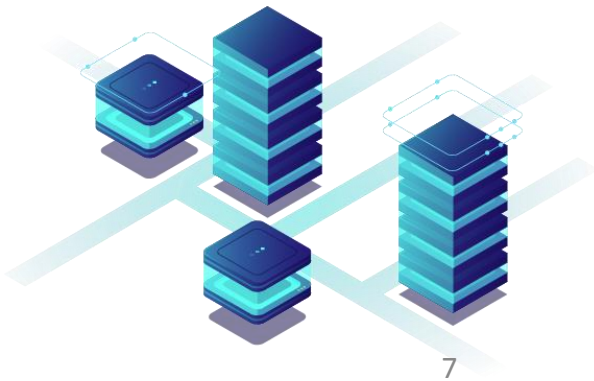
VOs, Composite VOs and Application Graph



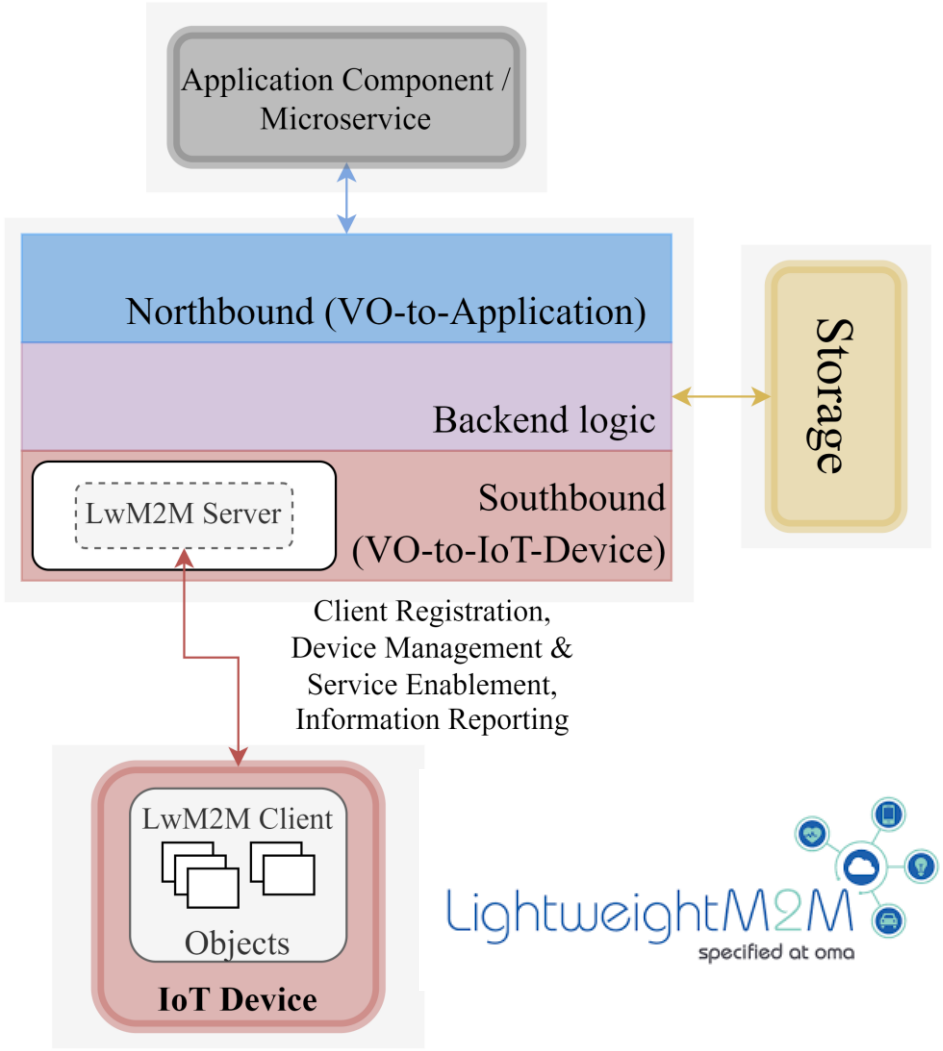


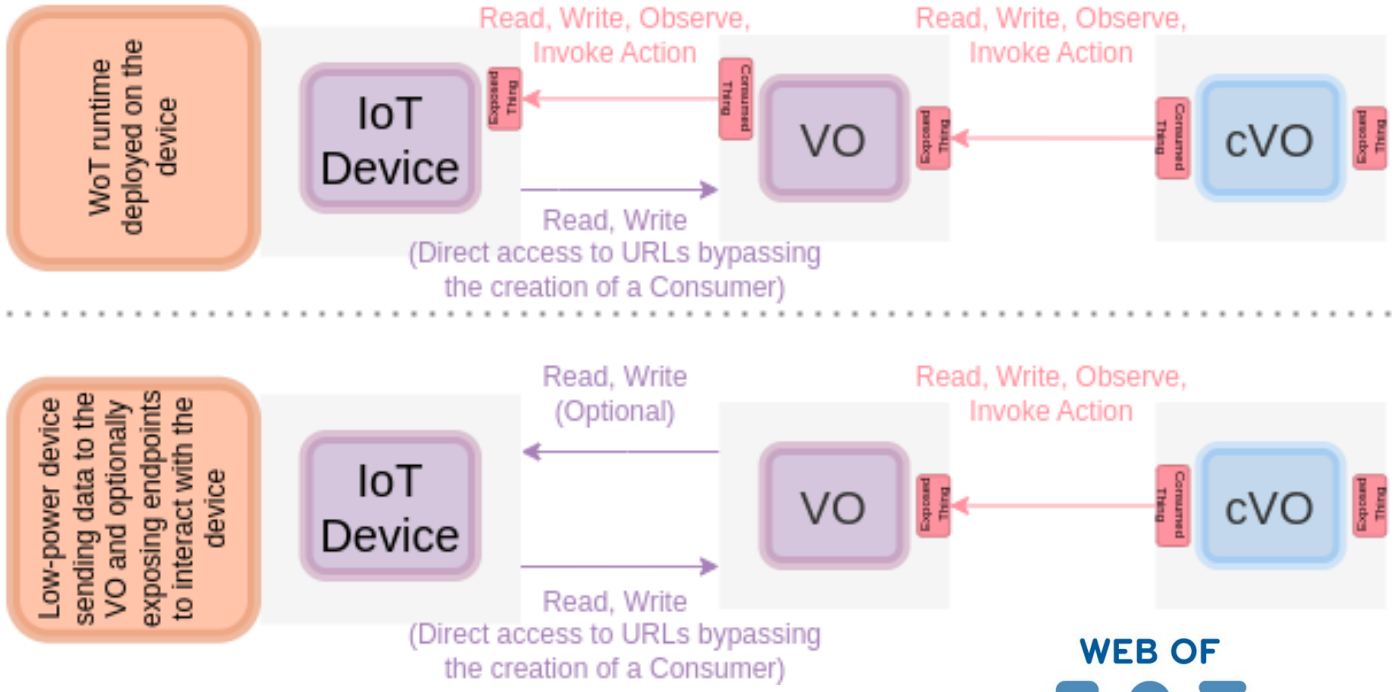
Virtual Object Stack (VOStack) Layers



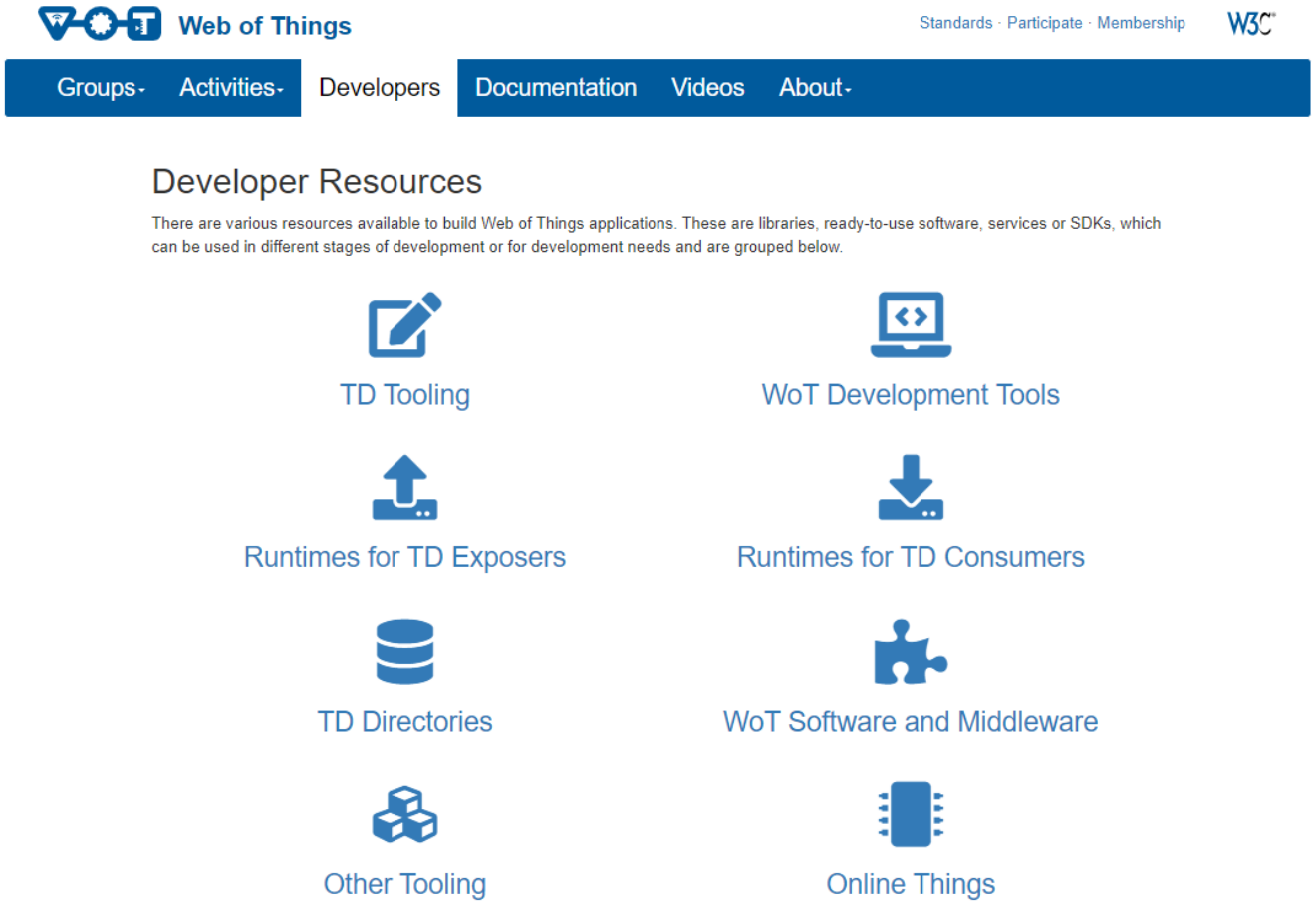


VOStack implementation





VOStack implementation in W3C WoT Developer Resources



WoT Software and Middleware

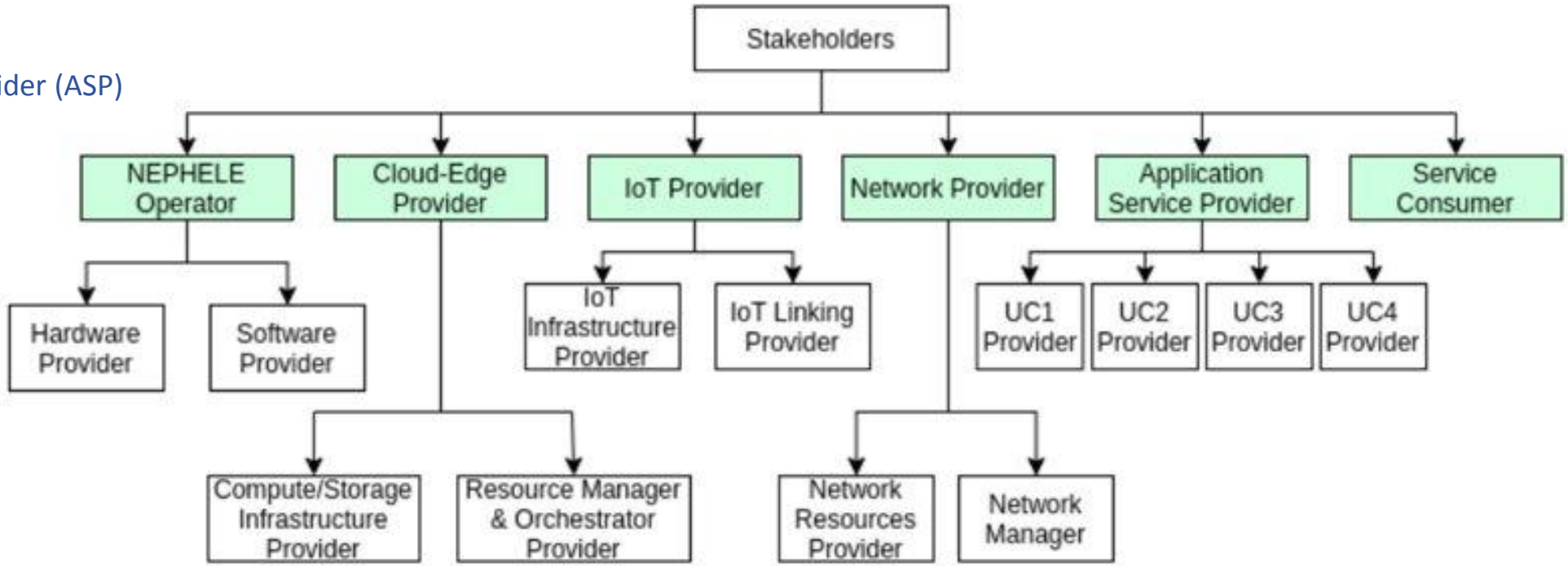
Ready to use software applications that can be deployed in order to provide a certain functionality in a system, such as gateway and proxying, simulation, testing services.

- sayWoT! - Industrial-grade implementation that allows integration of devices into Siemens software products.
- Web of Things Test Bench - CLI based tool that tests a WoT Thing by executing interactions automatically, based on its TD.
- WebThings Gateway - An open source Web of Things gateway for smart buildings, which bridges a wide range of IoT protocols to the Web of Things.
- UA Edge Translator - An industrial connectivity edge reference application translating from proprietary protocols to OPC UA leveraging the W3C Web of Things (WoT) Thing Descriptions.
- VO-WoT - A Python-based stack that allows developing WoT Things with additional functionalities, called Virtual Objects (VOs). A documentation website is available here.
- Shadow Thing - CLI based tool for creating and deploying a Thing based on its TD for simulation, proxy or protocol translation purposes.

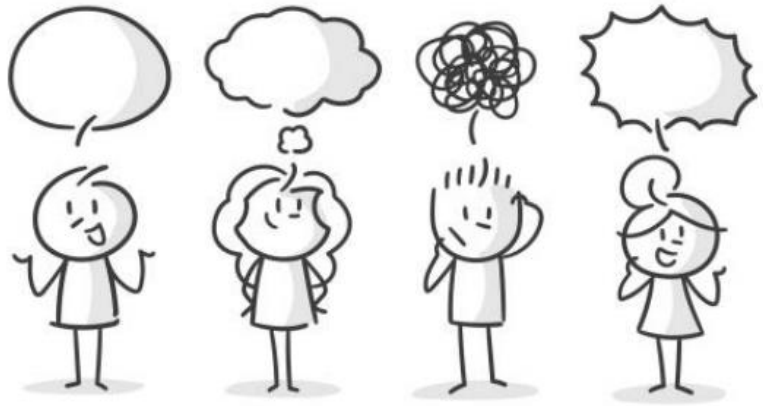
Stakeholders

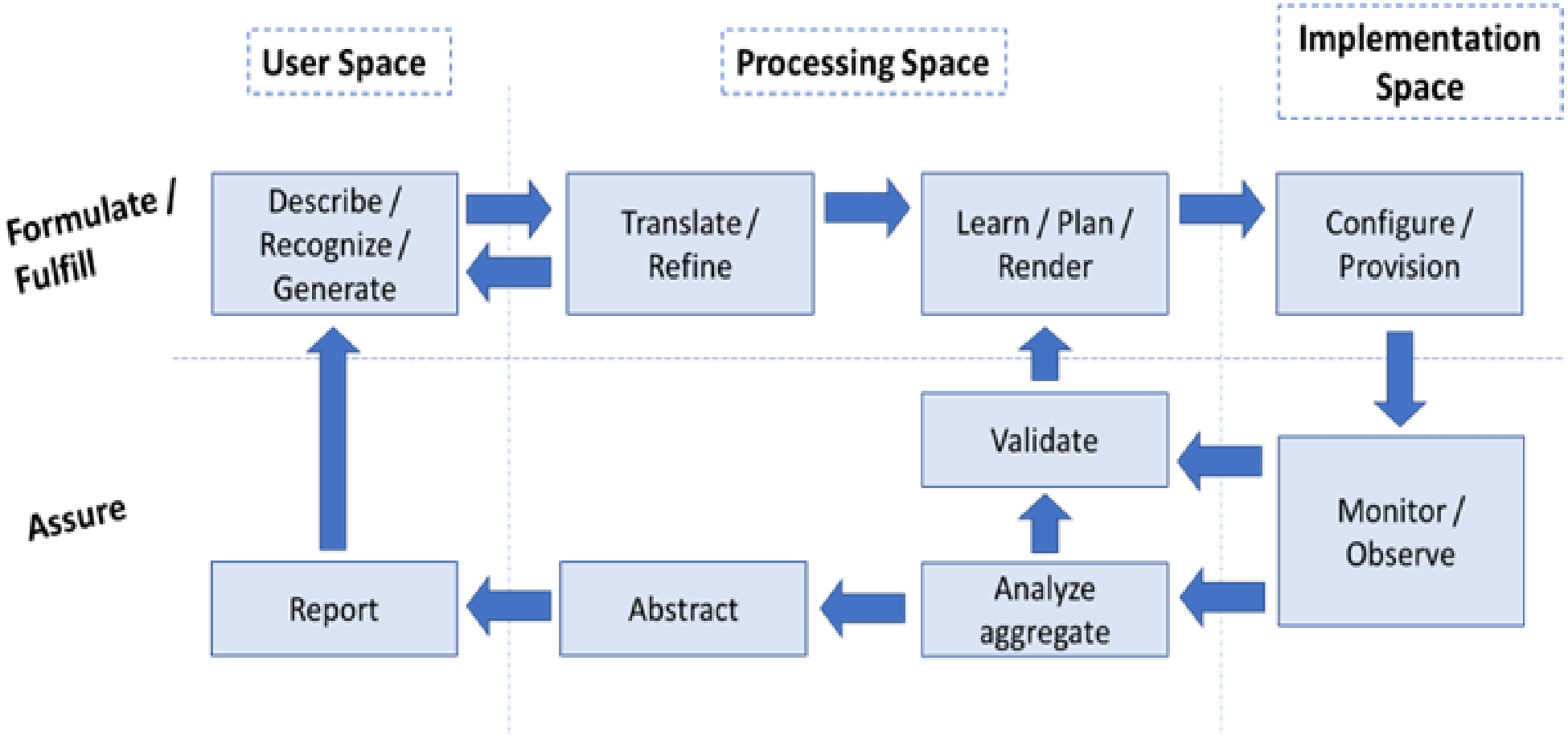
Stakeholders include individual or groups within the system

- NEPHELE Operator:
- Cloud-Edge Provider (CEP)
- IoT Provider
- Network Provider
- Application Service Provider (ASP)
- Servive Consumer

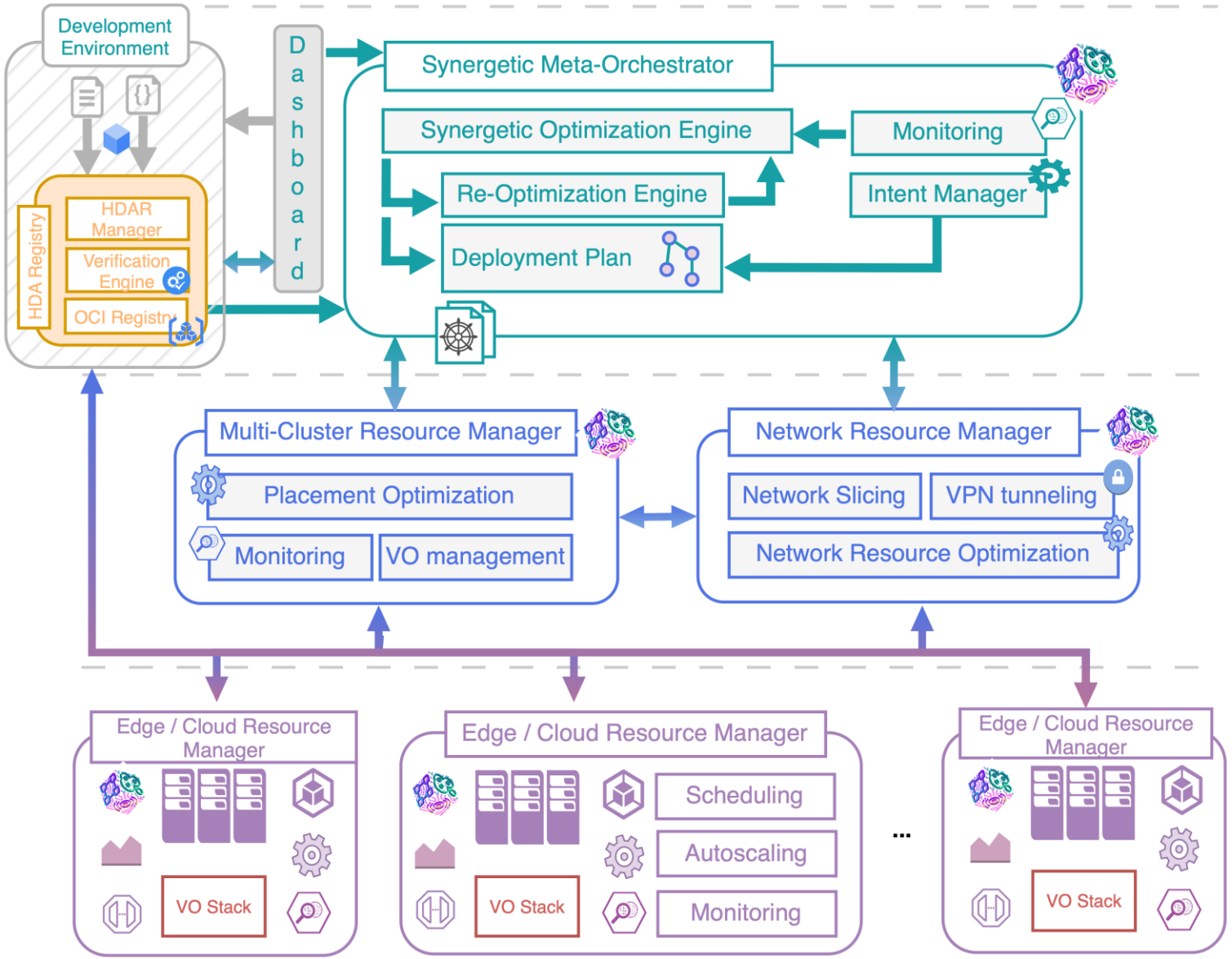


Intent-based Orchestration

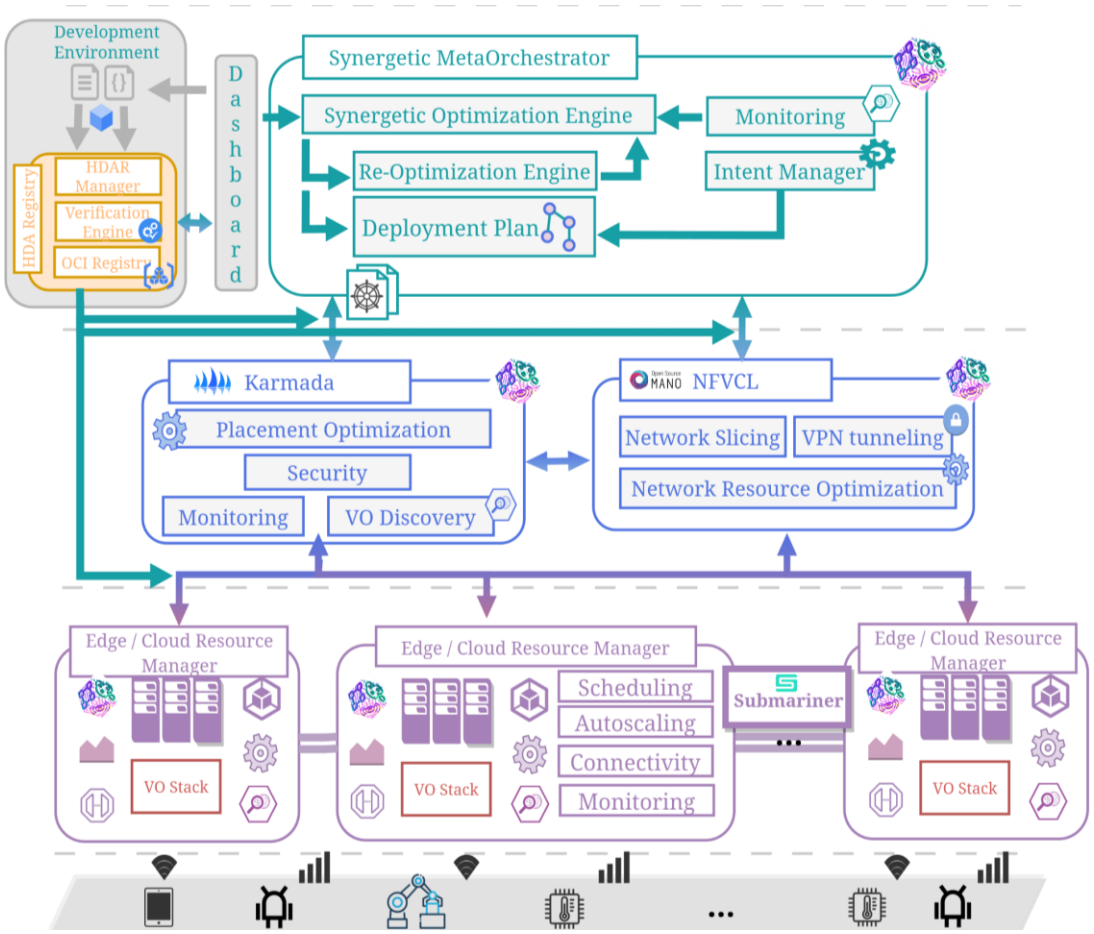


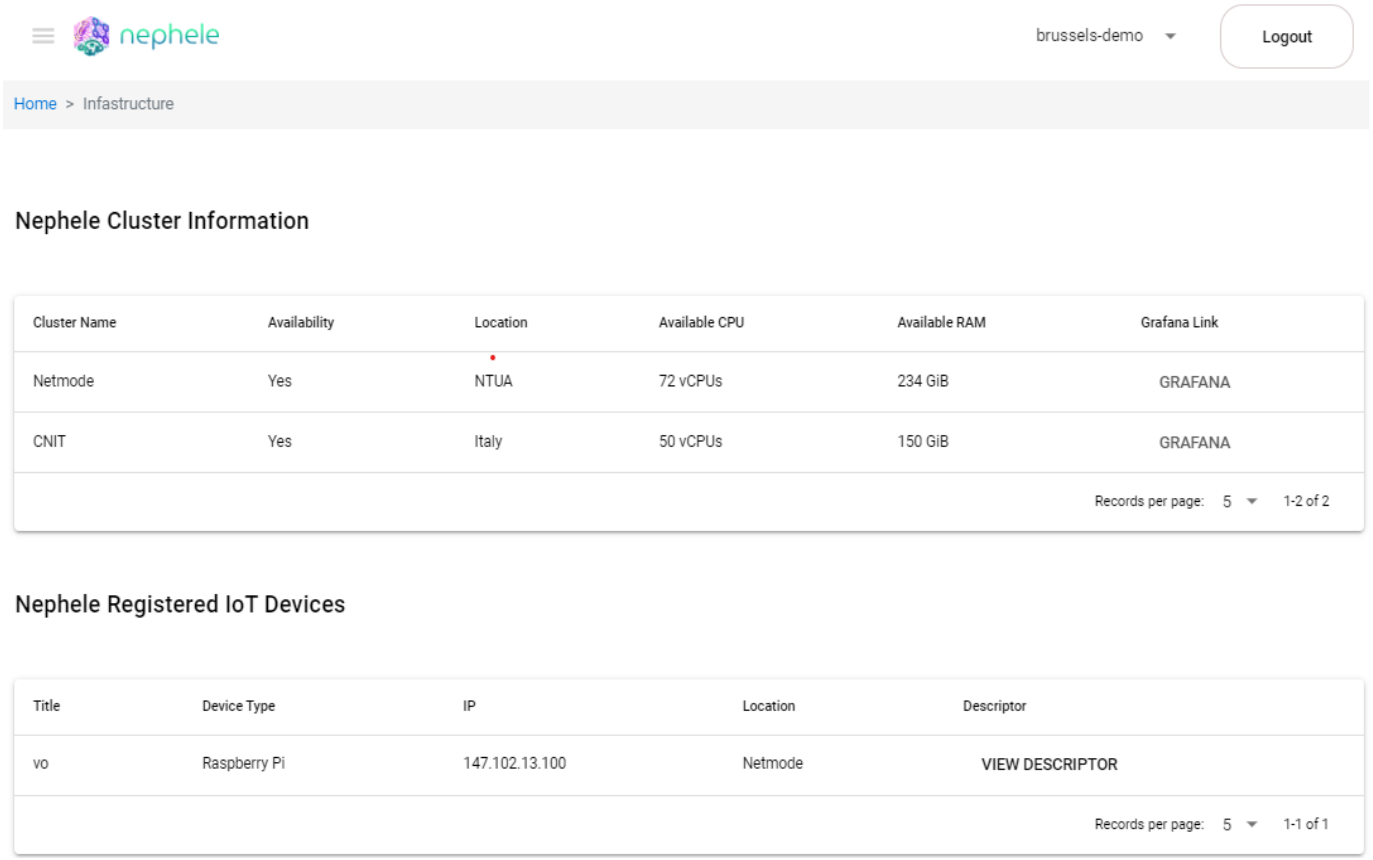


Reference Architecture



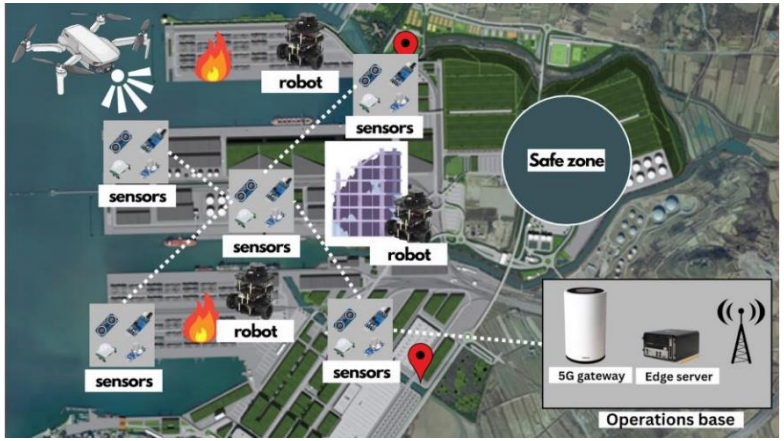
NEPHELE Platform Development



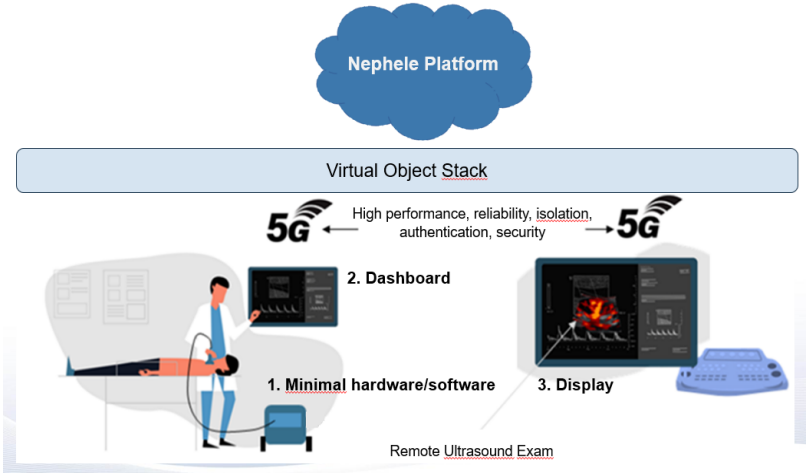


NEPHELE Use cases

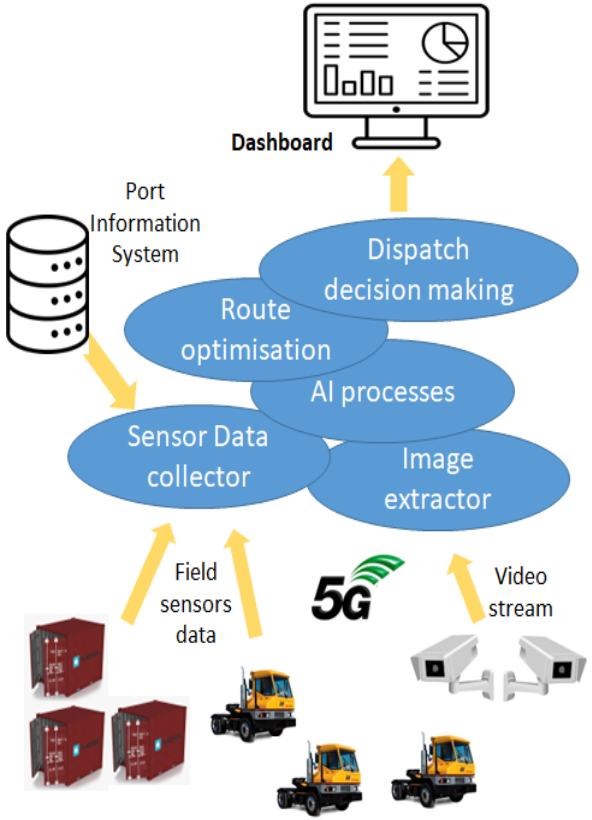
Emergency/Disaster Recovery



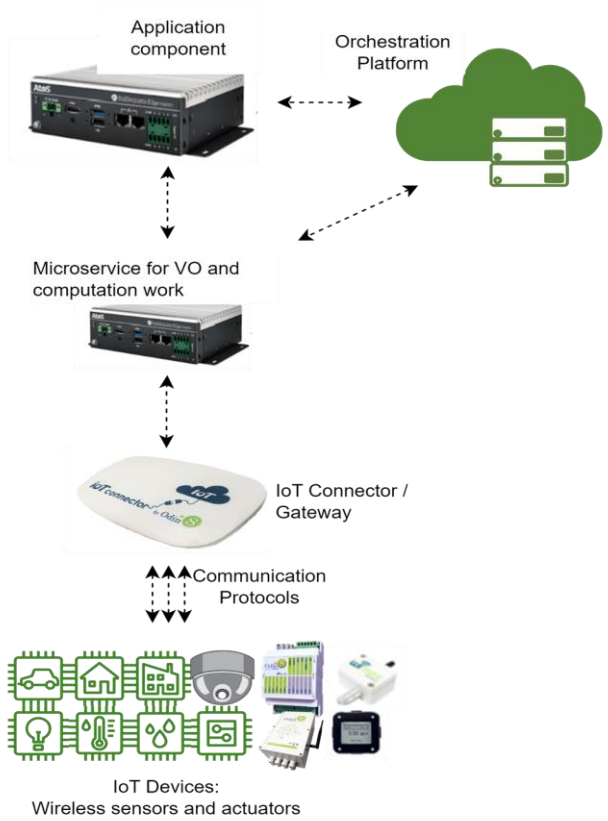
Remote Healthcare



Smart Port



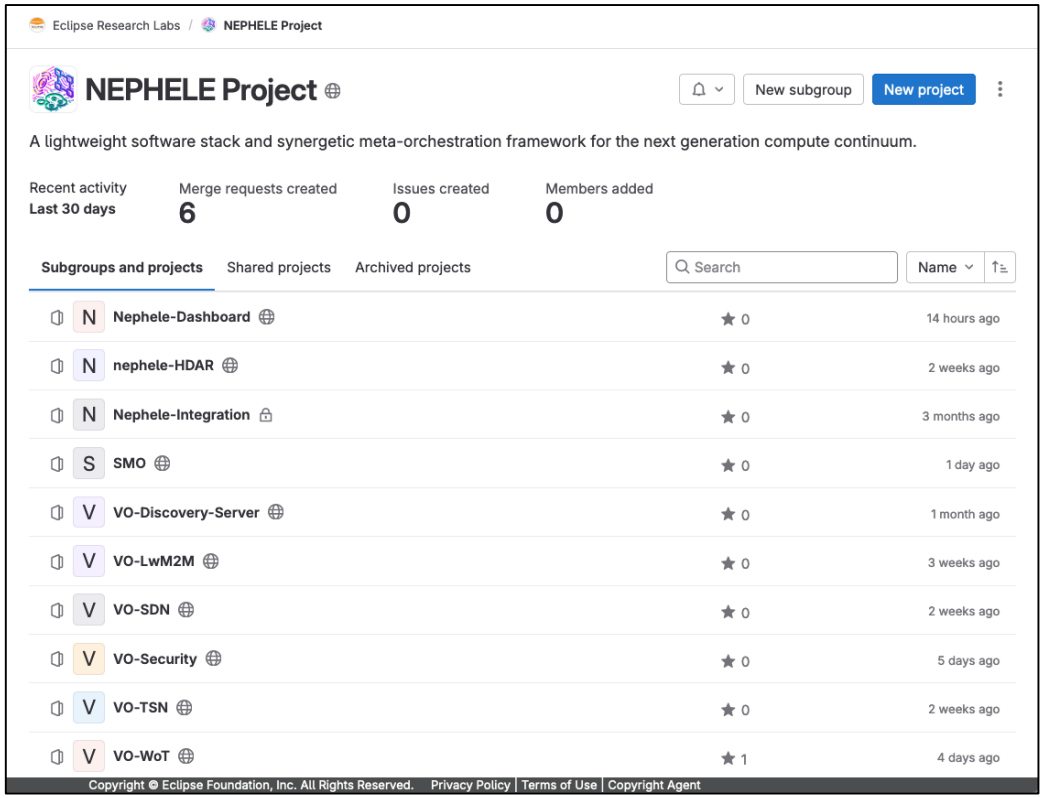
Energy Management in Smart Buildings



NEPHELE Open Source Ecosystem

Goal: Prepare NEPHELE open-source results for up-take by developers (open calls, OS communities, Meta-OS cluster, etc.) by implementing open-source best practices.

Eclipse ResearchLabs GitLab



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

nephele

Thank you!