ETSI The Standards People

IoT Conference 2023

Development of a Virtual Object (VO) and an Associated Lightweight Software Stack (VOStack) for IoT Interoperability within the Computing Continuum

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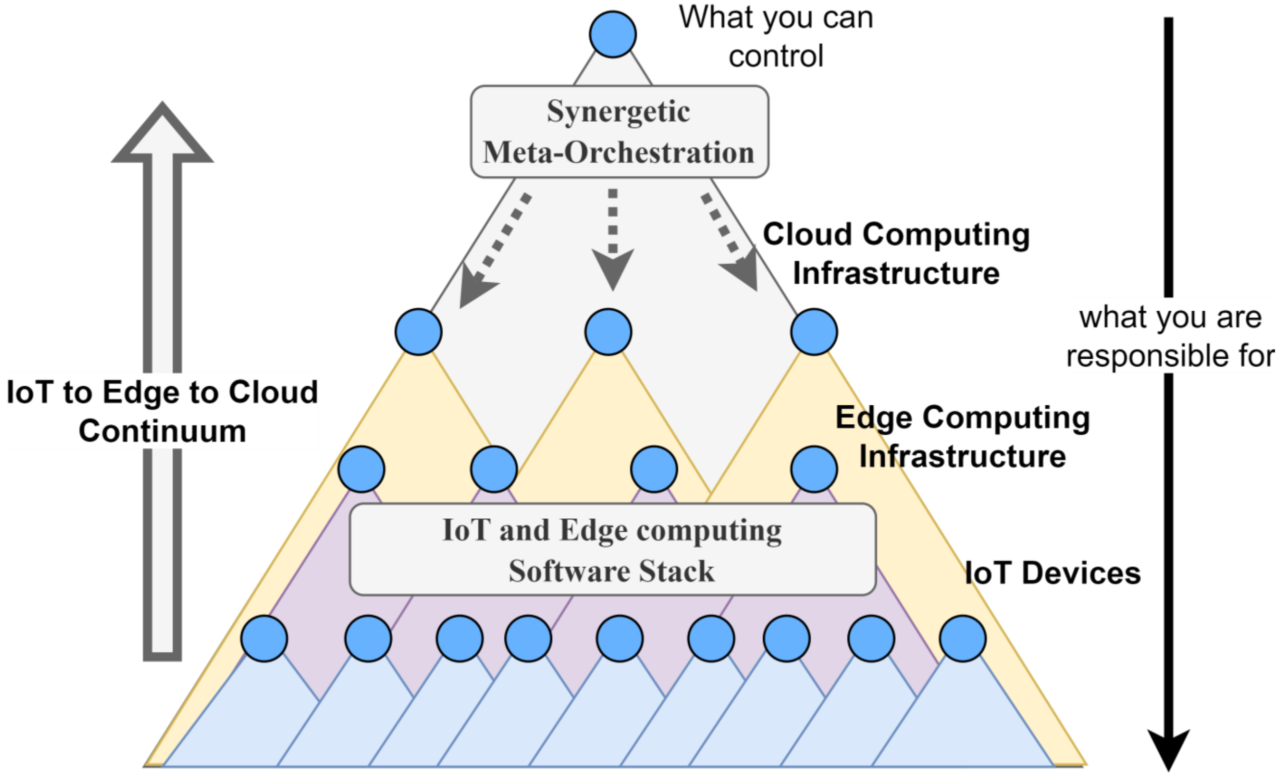
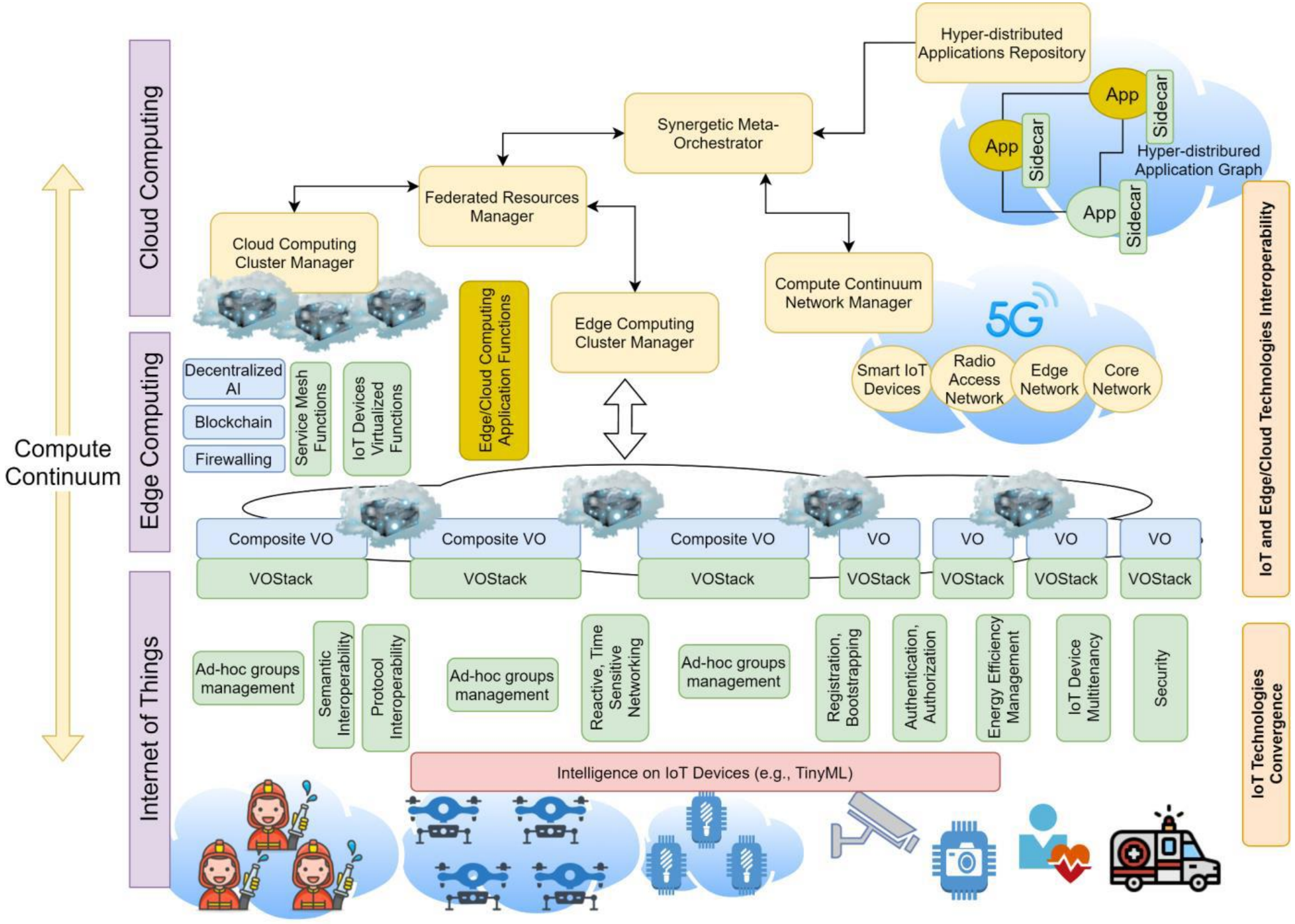
NEPHELE Ecosystem

https://nephele-project.eu/

- 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



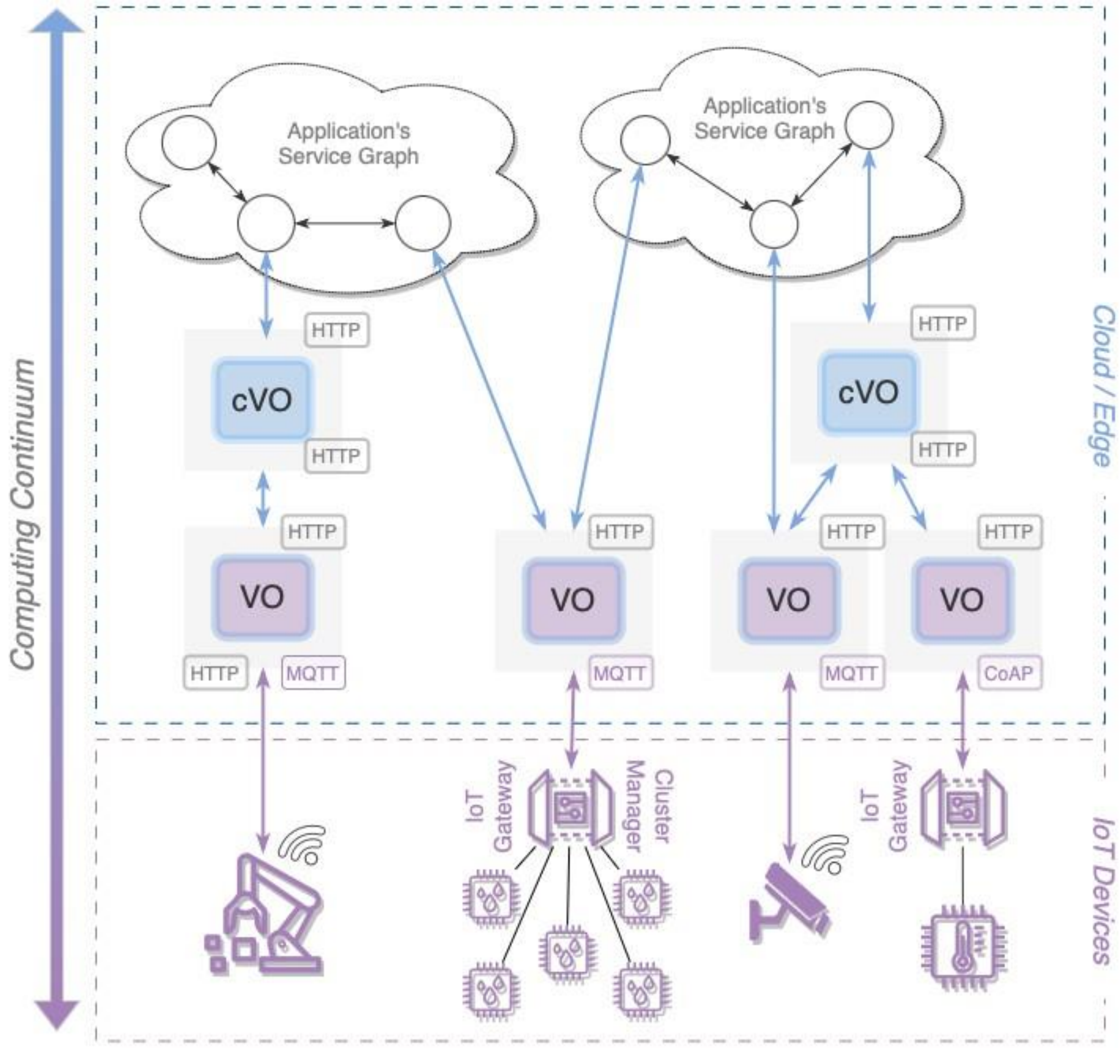
Synergetic Orchestration Mechanisms



Virtual Object Definition

A **Virtual Object (VO)** is the virtual counterpart of a physical device on the Internet of Things domain. It provides a set of abstractions for managing any type of IoT device through a virtualized instance while augmenting the supported functionalities through a software stack (VOStack).

A **Composite Virtual Object (cVO)** is a software entity that is able to manage the information coming from one or multiple VOs (aggregation point) and provide advanced functionalities.



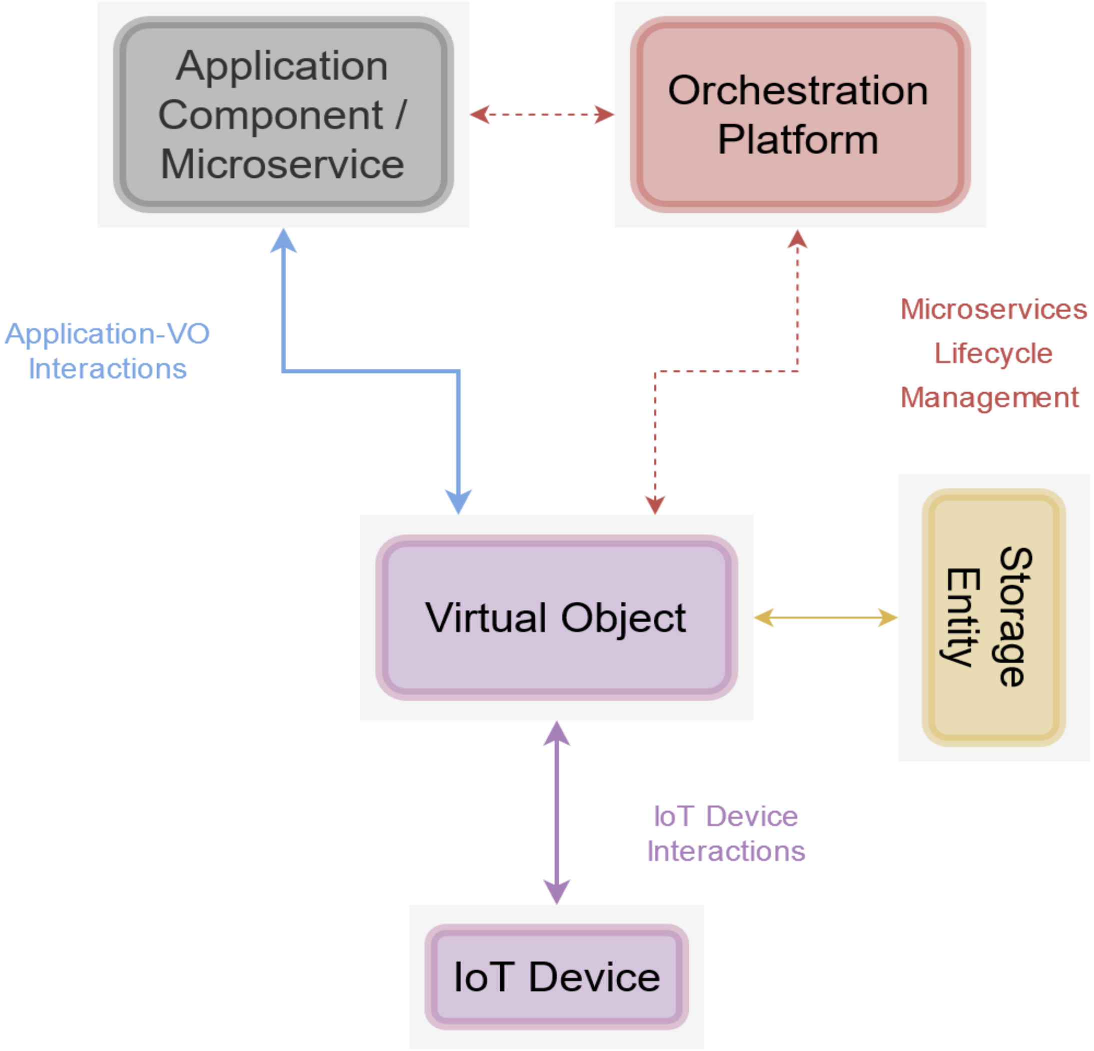
(c)VO Interactions

VO-to-IoT-Device Interaction: solve interoperability and convergence challenges with the IoT ecosystem.

VO-to-Application Interaction: enable the interaction between the VO and cVOs application components

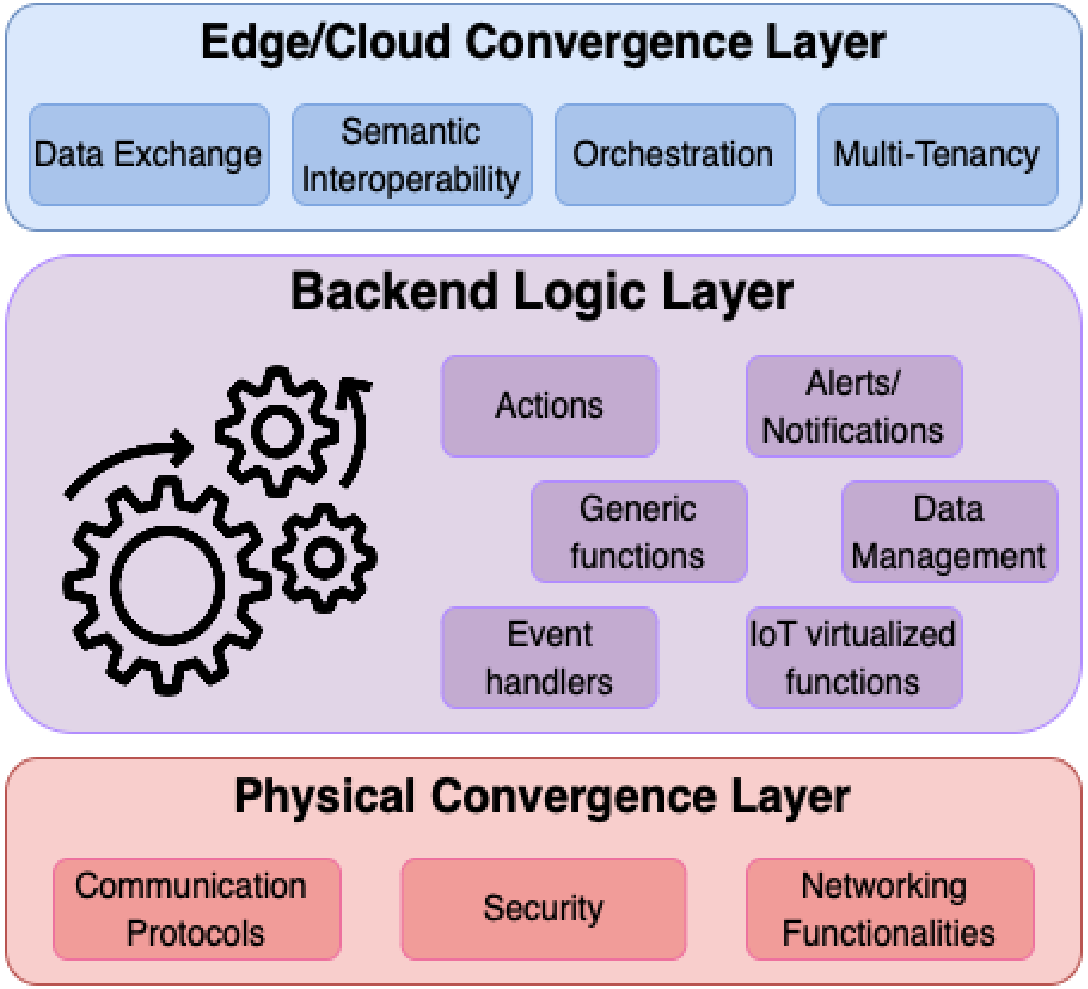
VO-to-Orchestration Interaction: enable the development of edge/cloud computing distributed applications, where the (c)VO is an integral part of a distributed application graph and, thus, manageable by cloud/edge computing orchestration mechanisms.

VO-to-Storage Entity Interaction: the objective is to keep track of device metadata, status, data management and messages exchanged with other devices and applications.



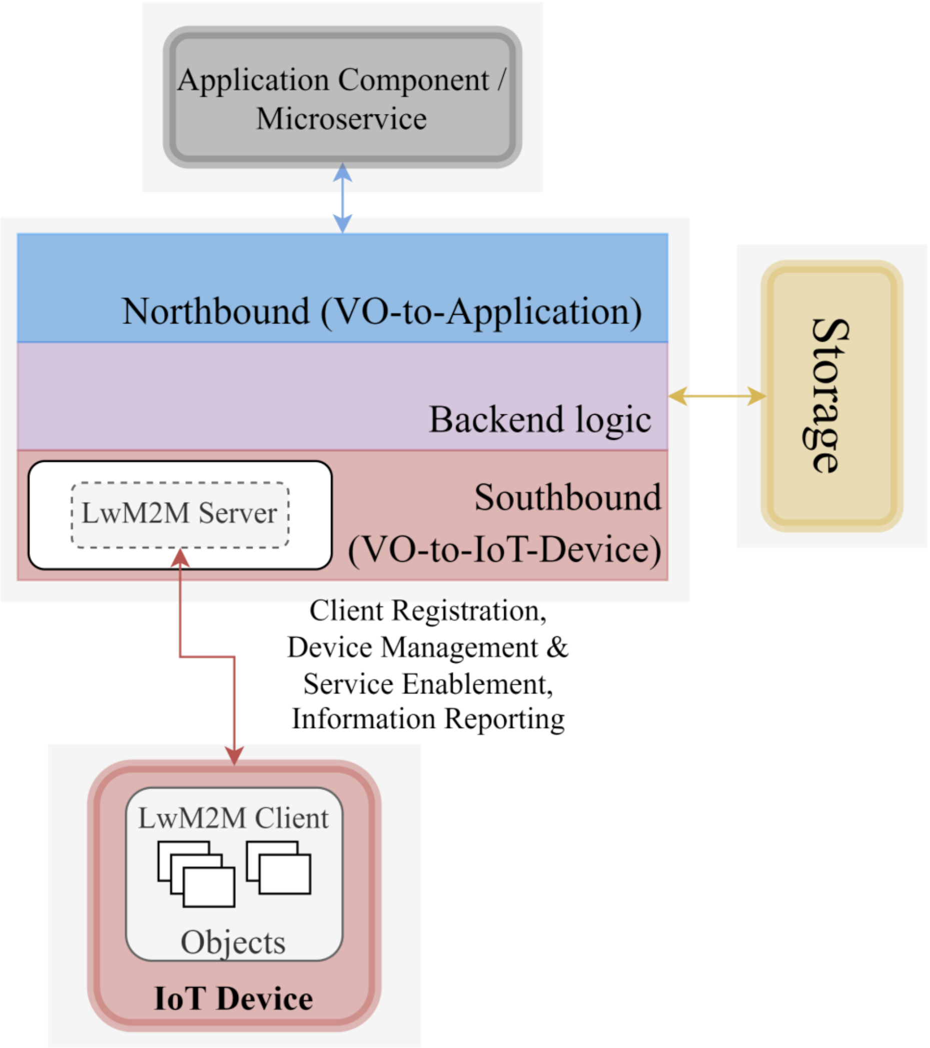
Virtual Object Stack (VOStack)

- **Communication Protocols:** HTTP, HTTPS CoAP, MQTT, WebSocket
- **Security**: Basic Security (User-Pass), Token, oAuth (HTTP)
- **Semantic Interoperability:** W3C WoT, oneM2M, OMA LwM2M, NGSI-LD
- **Storage**: Data Management (Timeseries DB) and Telemetry
- **Orchestration** Elasticity of Containers, exposure of DBs, Alerting Notifications
- **Discovery Server**: Things Directory enhanced with Authentication Mechanism

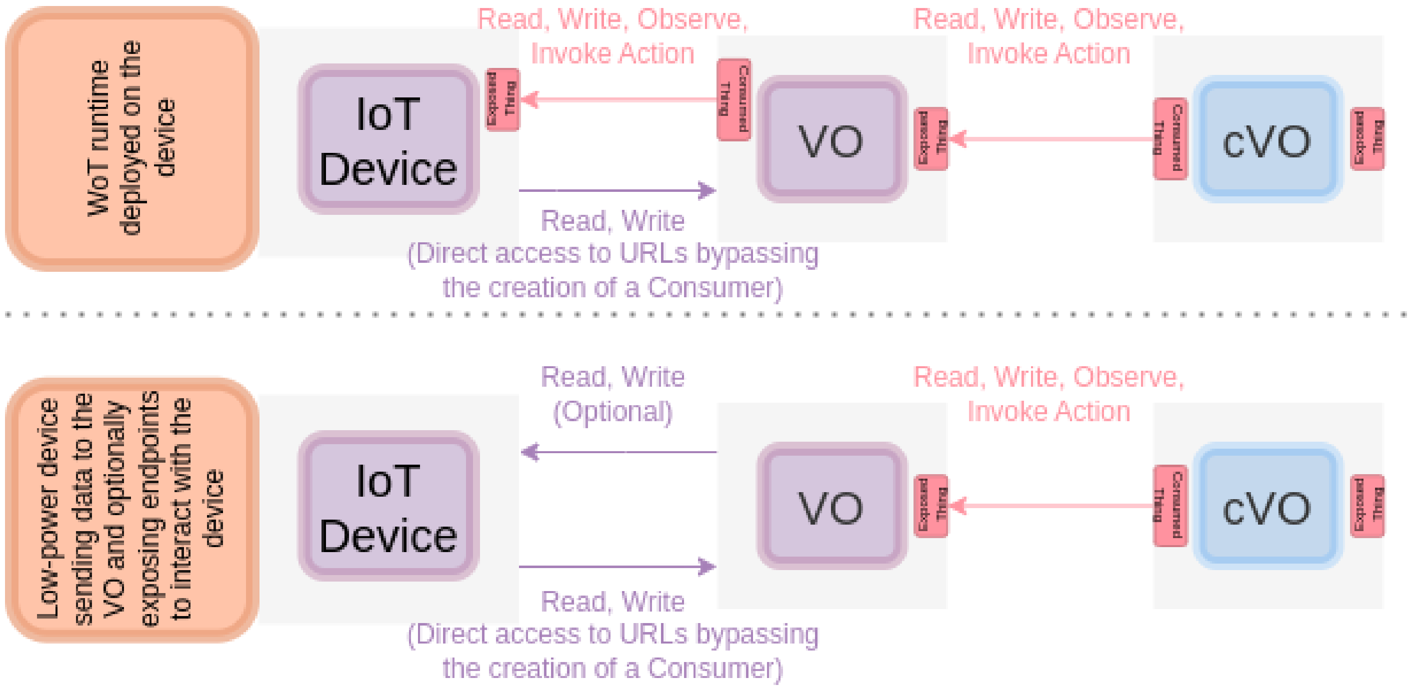


VOStack Implementations

OMA LwM2M



W3C WoT



Deployment types in accordance with W3C WoT

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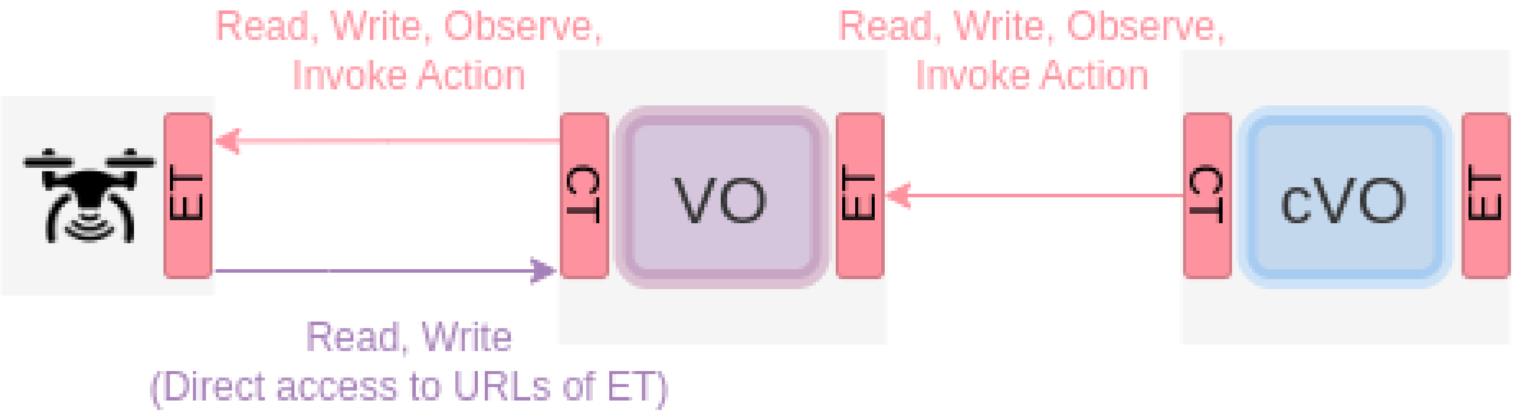
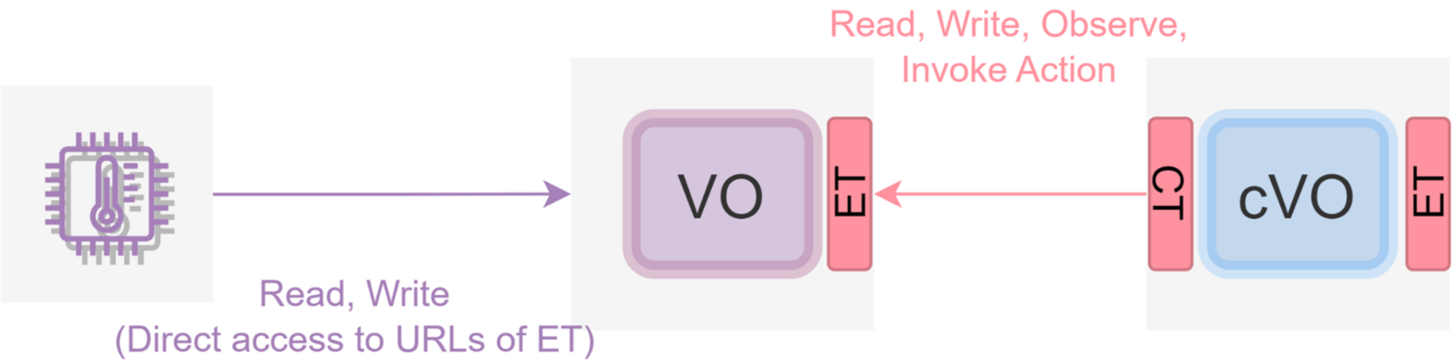
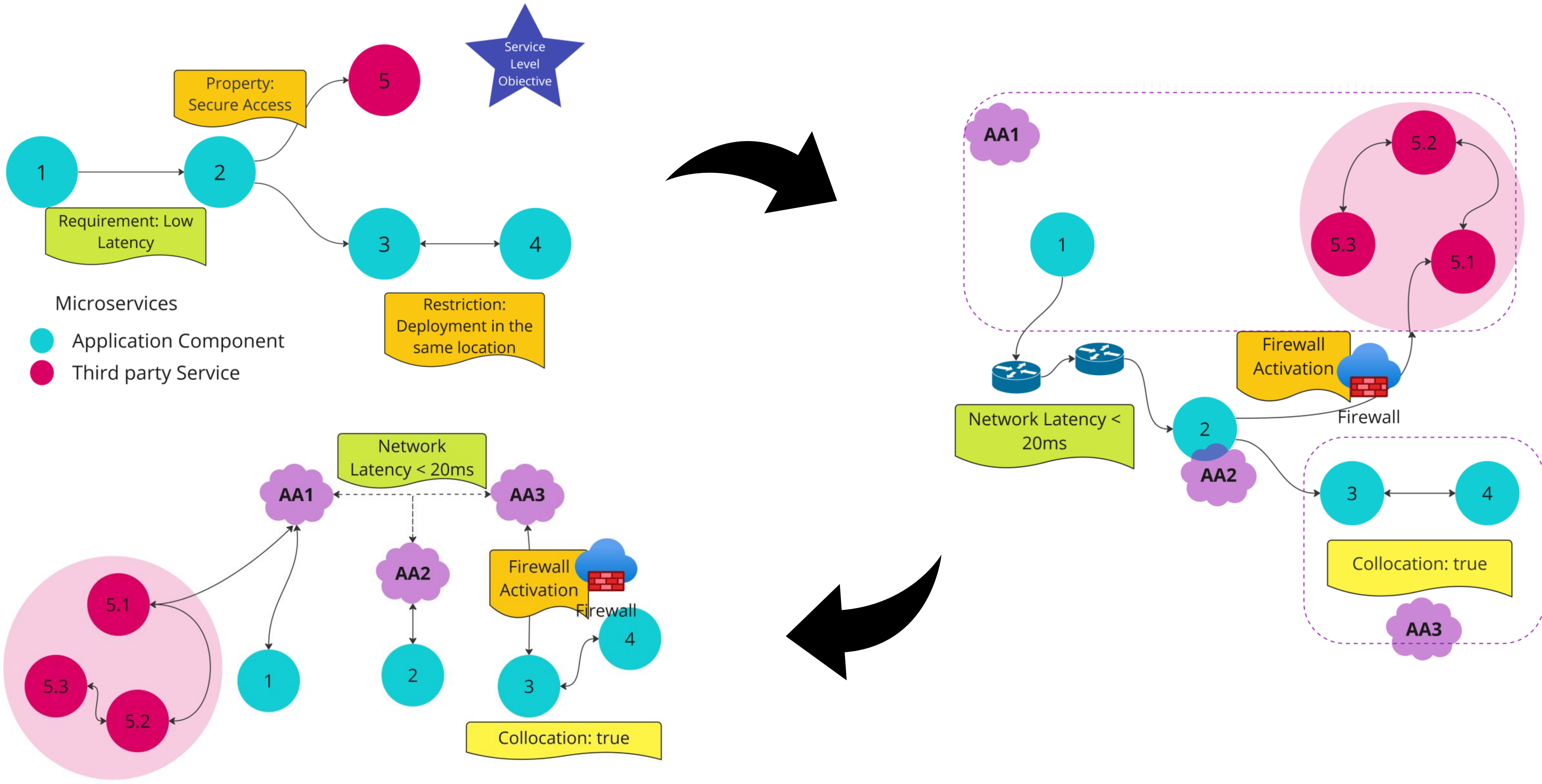
Type A:
Device with computing capabilities e.g., Drone, Pi



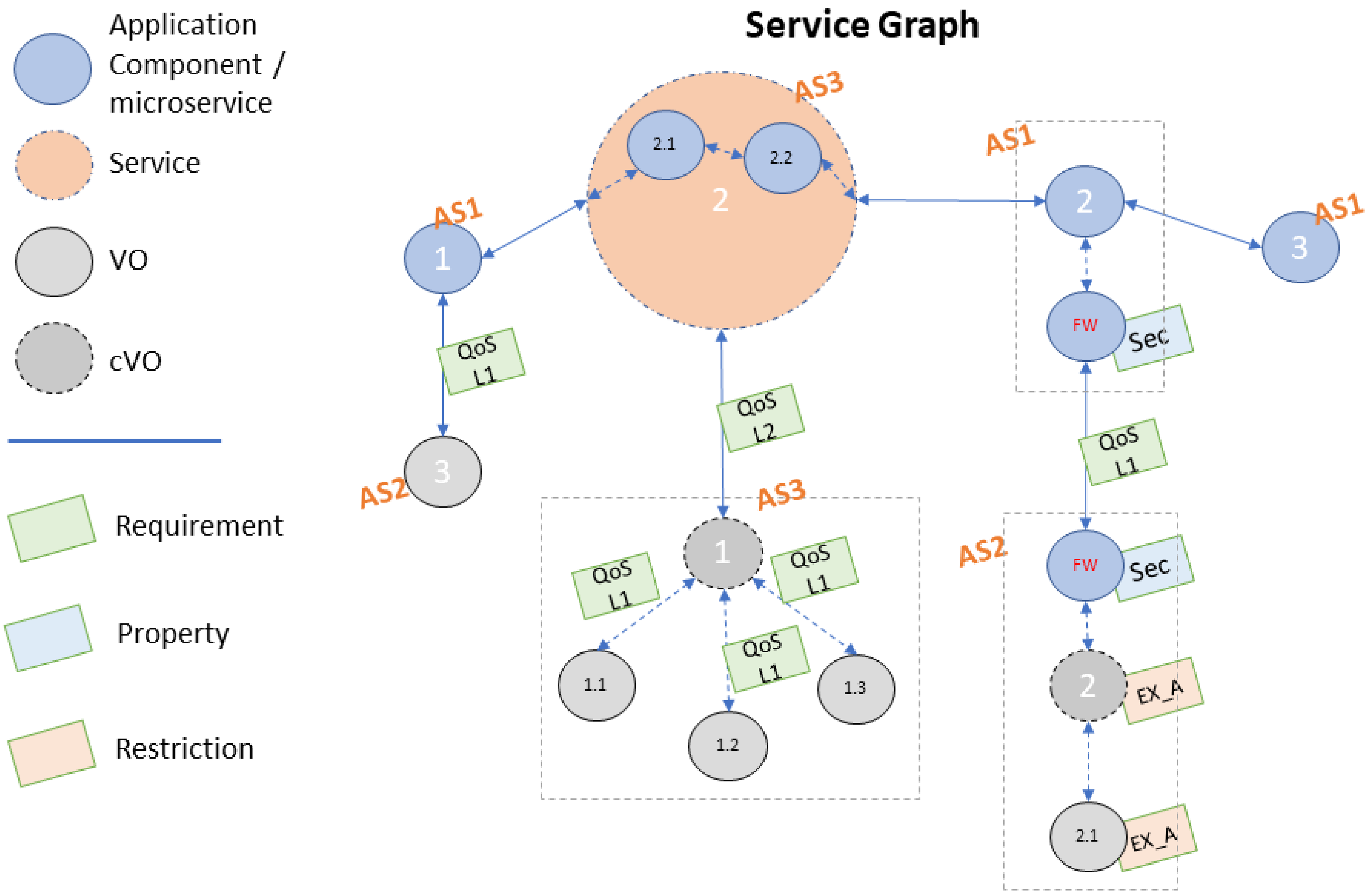
Type B:
Device with no computing capabilities e.g., Sensor



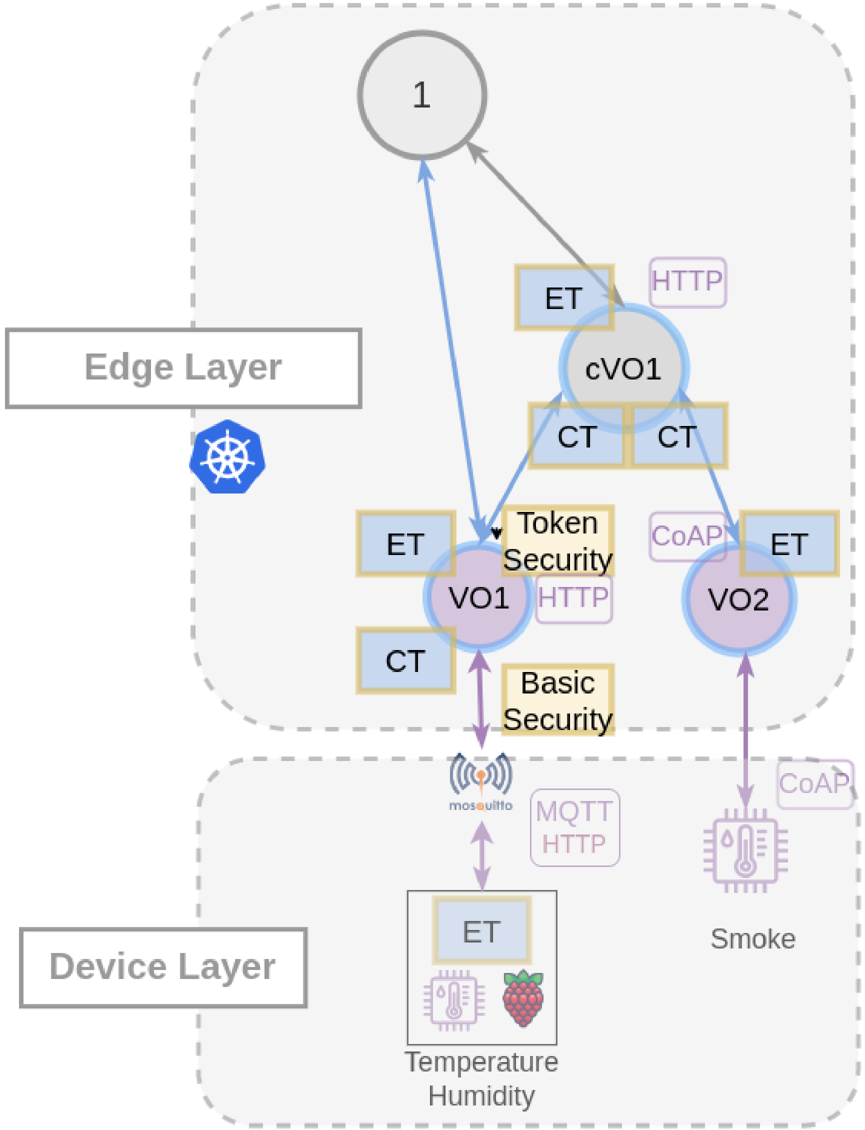
Distributed Application Graphs



Application Graph



Application Graph Instance



App Component 1:
/fire : Endpoint that observes (without WoT) a fire event (CVO)
Trigger Average_values(VO1) (with WoT)
Trigger Forecast Temperature (cVO) (with WoT)

cVO Description:
- Properties: Humidity, Temperature, Fire
- Observe: When Smoke Existence (VO2) Trigger Current_Values (VO1).
- Events: If Current temperature is above threshold then emit fire_event
- Forecast temperature value (ARIMA).
- Functionalities: InFluxDB, Sqlite
- Specific_Function: ARIMA forecasting

VO1 Description:
- Properties: Humidity, Temperature, Average_data (list)
- Action1: Current Values of Device
- Action2: Calculate average values
- Functionalities: InFluxDB, Sqlite
- Generic_Functions: avg_value_10

VO2 Description:
- Properties: Smoke
- Events: Smoke existence
- Functionalities: Sqlite

Overview of NEPHELE Use Cases

Energy Management in Smart Buildings/Cities

Methodology: Integration of Cloud-Edge processing with building monitoring and control continuums, harmonisation between existing sensors and smart devices, deployment of management automation processes.

Objective: Performance optimisation through latency decrease and computational power increase; Decreased energy consumption through flexible self-management; Increased reliability and well-being of the offered services through continuum self-healing and stabilisation.

Smart Port

Methodology: Integration of Cloud-Edge processing with port logistics tools, deployment of sensors for container and vehicle movements, implementation of machine-learning processes for problem-solving and risk avoidance.

Objective: Resource optimisation through decentralised decision-making; Increase in system flexibility, stability, and portability through continuum harmonisation; Increased coordination capabilities with different networks (road, railway) through predictive decision-making.

Emergency/Disaster Recovery

Methodology: Establishment of a Cloud-Edge continuum for emergency initiatives, integration of sensor-carrying robots and smart devices in the continuum, deployment of edge computing for low-reception scenarios.

Objective: Increased victim-locating capabilities through the processing of data from the sensors in the continuum; Optimisation of injury assessment and treatment through data gathered by the smart devices; Predictive emergency operations through system-wide analytics.

Remote Healthcare

Methodology: Integration of Cloud-Edge processing with ultrasound medical imaging systems.

Objective: Connect, decompose and virtualize ultrasound medical imaging systems into the cloud-edge continuum to lose any barriers due to the hardware capabilities and localization of current physical systems.

Thank you for your attention!

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