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EU Cloud-Edge-IoT: Event “Giving Energy an Edge” 10/11/2023

Use Case: Energy

Phoenix Systems Tomasz Korniluk

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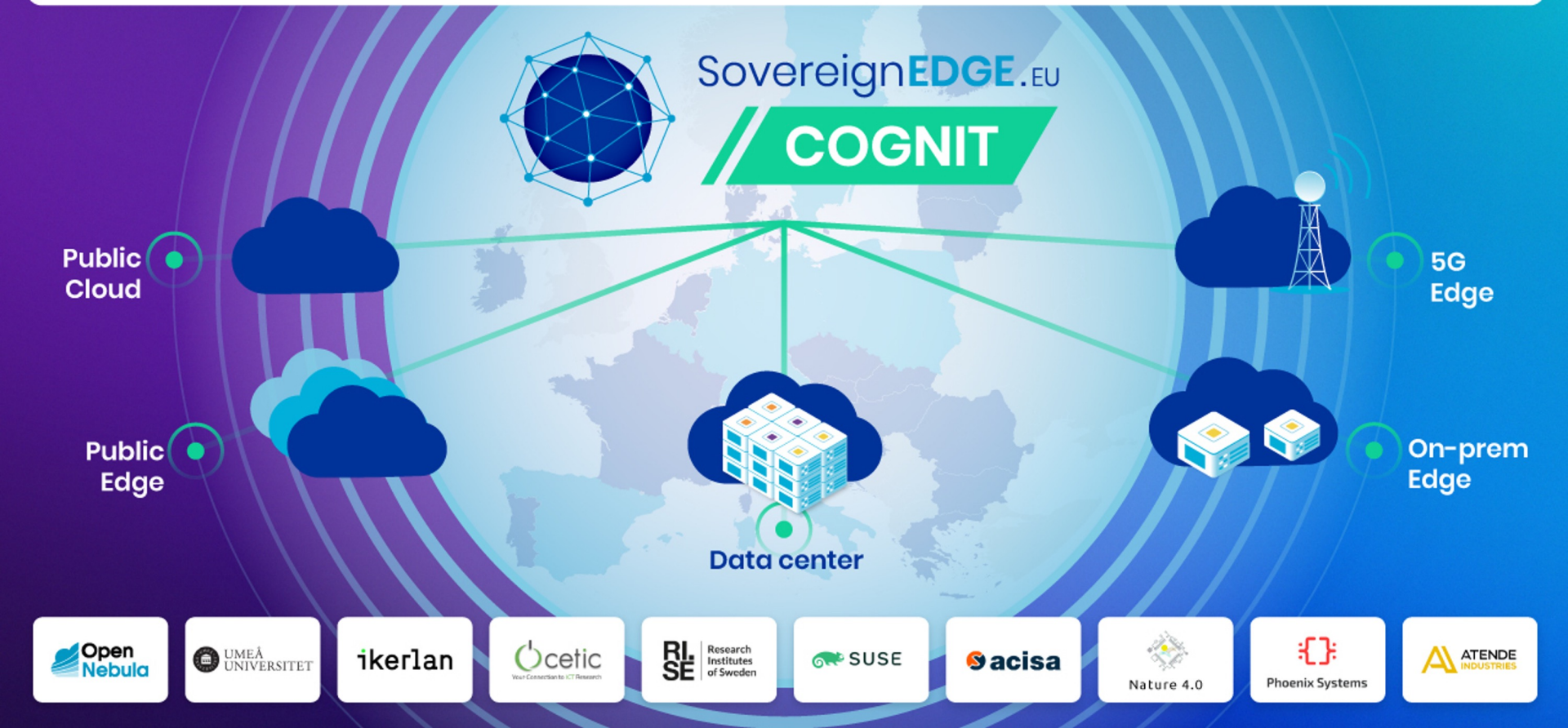
A Cognitive Serverless Framework for the Cloud-Edge Continuum

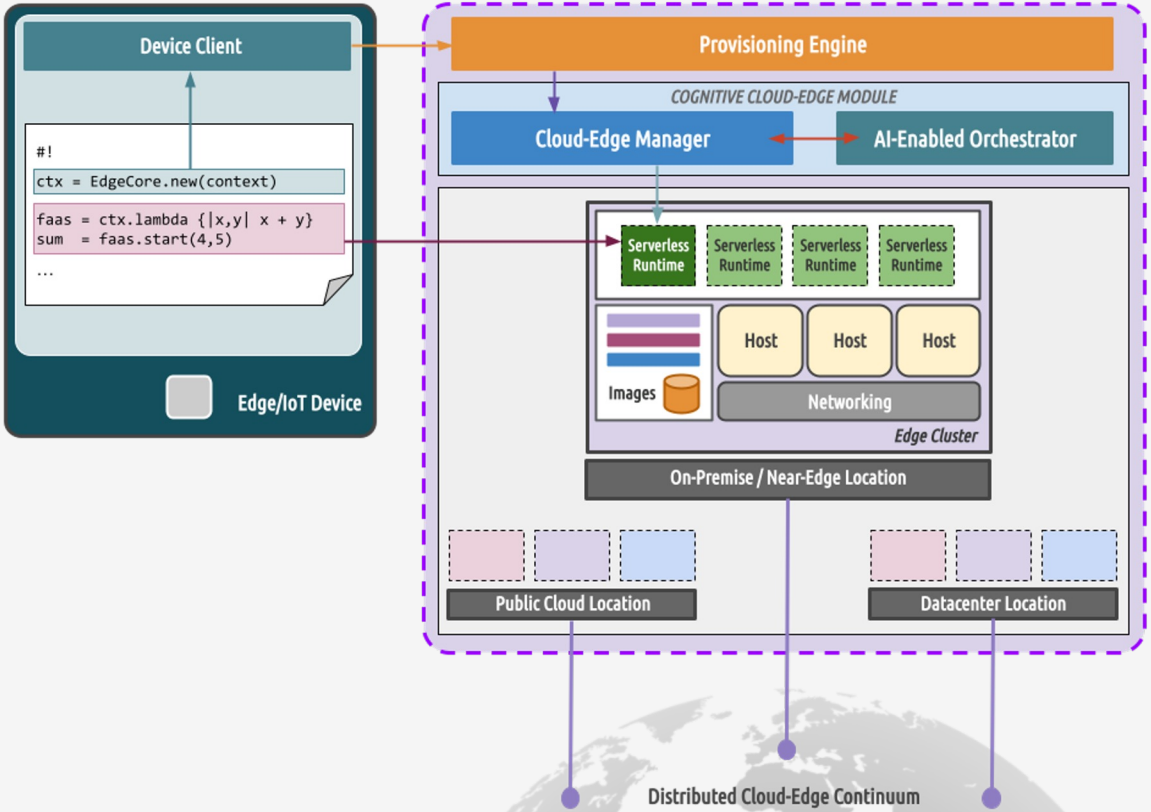
Topic: **HORIZON-CL4-2022-DATA-01-02** (Cognitive Cloud) · Execution Dates: **2023 - 2025**



Open Nebula · Umeå Universitet · ikerlan · cetic · RISE Research Institutes of Sweden · SUSE · acisa · Nature 4.0 · Phoenix Systems · Atende Industries

COGNIT Architecture

COGNIT introduction



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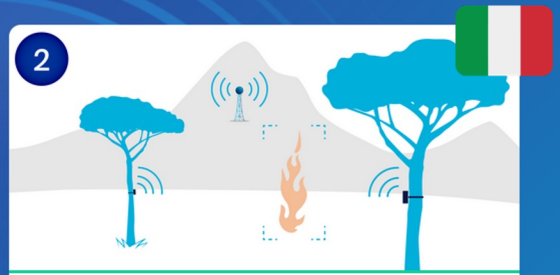
Four Validation Use Case

COGNIT introduction

Smart Cities

Coordinated by ACISA



Wildfire Detection

Coordinated by Nature 4.0

Energy

Coordinated by Phoenix Systems & Atende Industries

Cybersecurity

Coordinated by CETIC and SUSE

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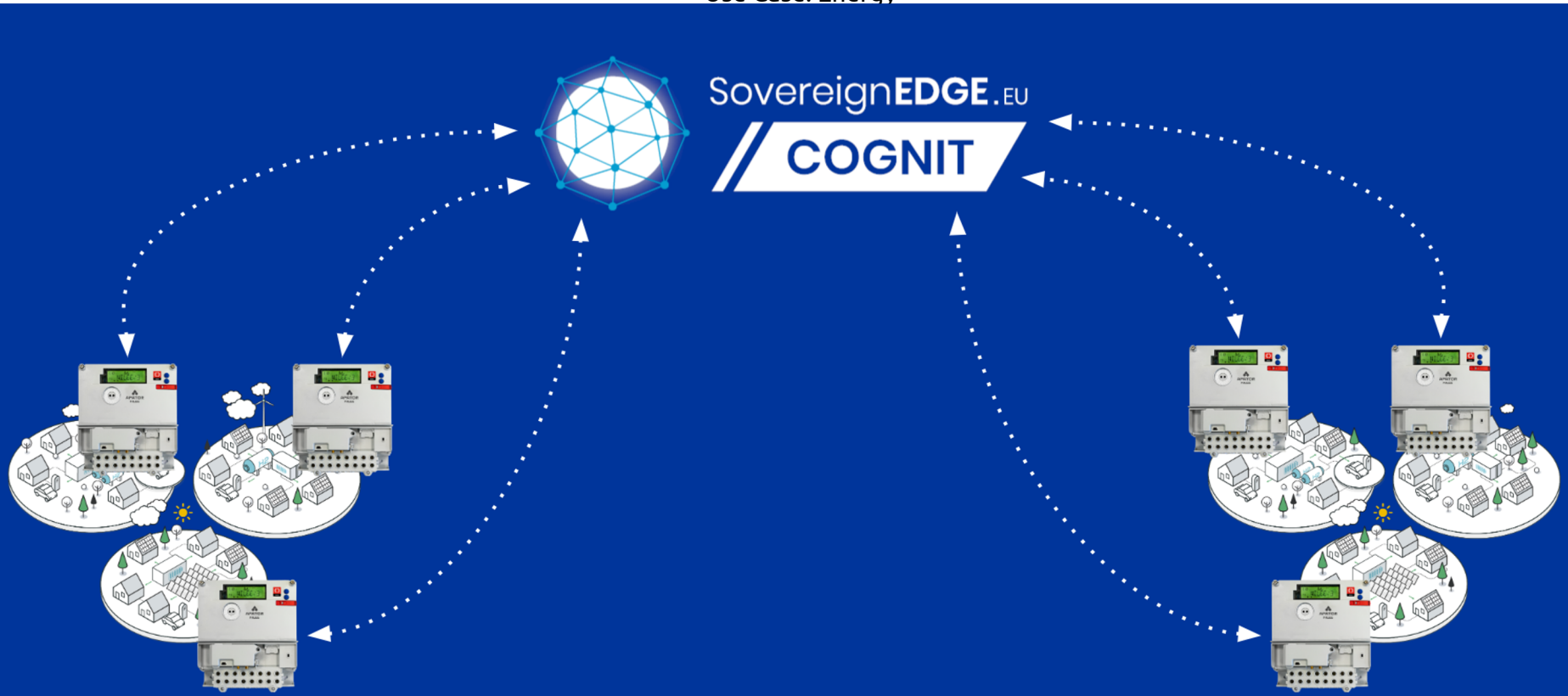
Reference Scenario

Use Case: Energy

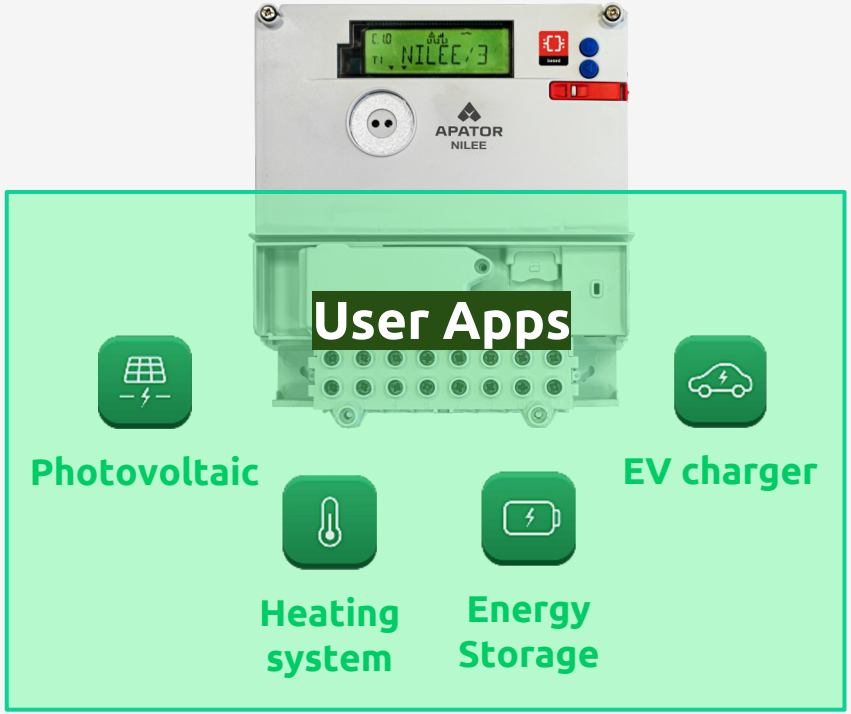


Brief Concept

Reference Scenario

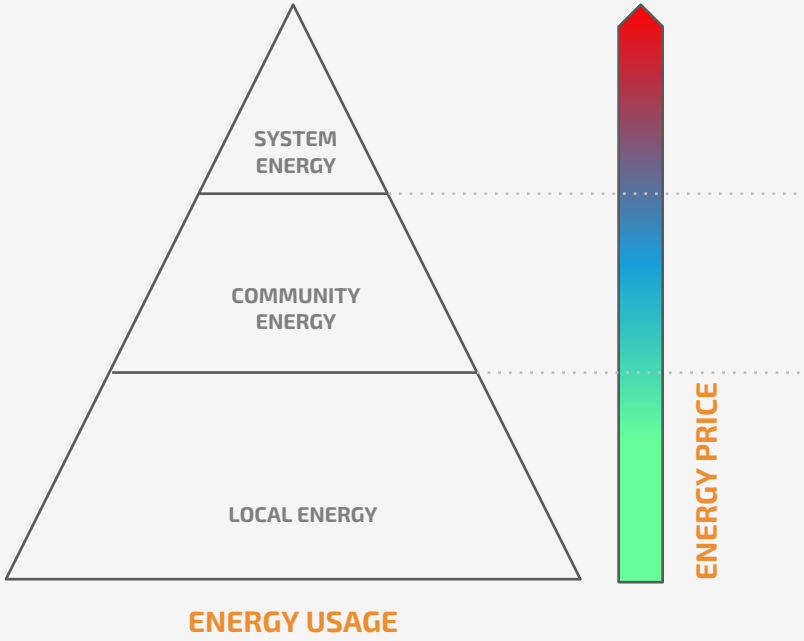
The main goal is to turn electricity meter into **Energy Assistant**. It should manage energetically important appliances in accordance to user preferences.

To achieve that there is a need for the meter to be powered by AI capabilities. It allows for developing solution which is highly flexible, that could react to dynamic needs of end-user.



Business Case

Reference Scenario



Distributed model of the energy system assumes that there are many energy producers. Thanks to renewable energy solutions, nowadays consumers tend to produce their own energy and become prosumers. From financial and ecological point of view, prosumers should **consume produced energy locally**.

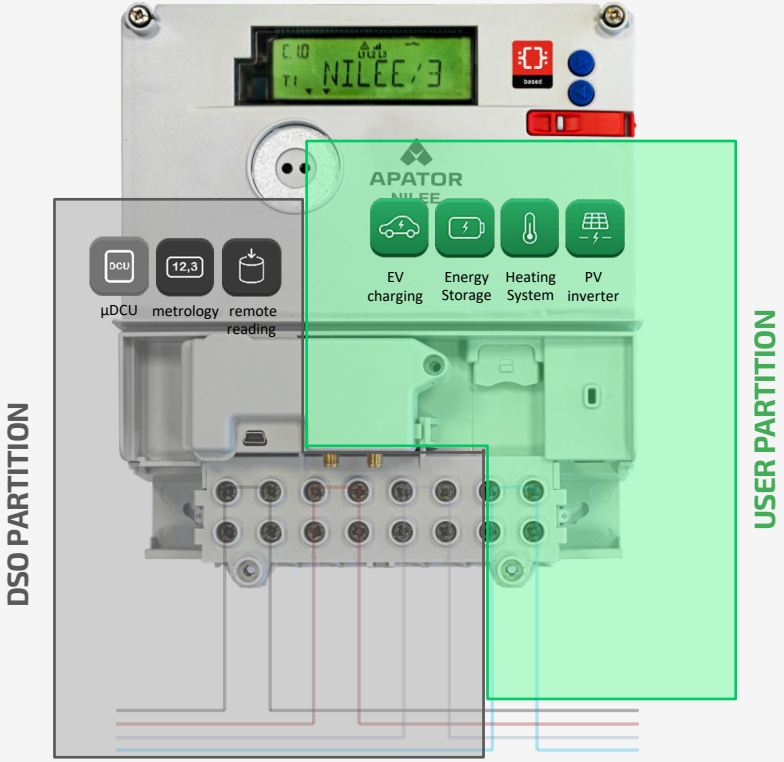
By using AI-powered decision algorithm self-consumption of locally produced energy could be optimized, respecting of user preferences.

Limitations

Reference Scenario

Electricity meters are devices with severely constrained resources. They must execute DSO applications and only very little computational resources are left for user apps.

This is why powering electricity meter with AI models is difficult. According to the paradigm that assumes offloading intense computing task execution outside of the device, it is possible to equip meters with new features.



Actors

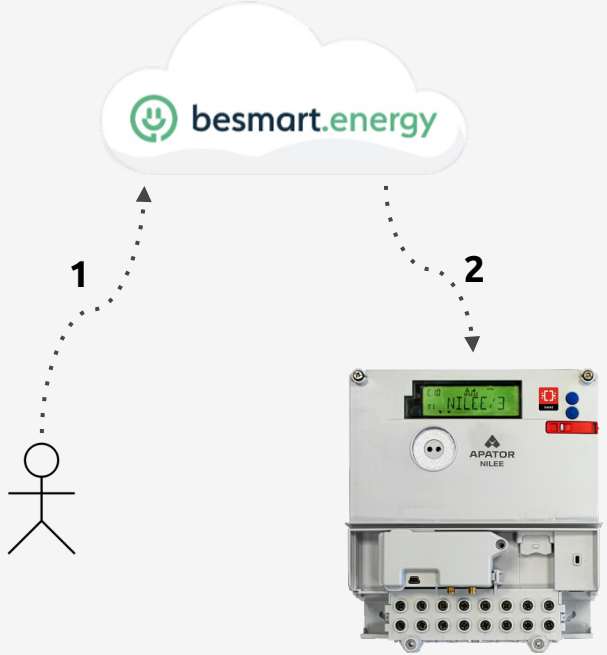
Reference Scenario

- **User** - stakeholder.
- **Serverless Runtime** - consists of a FaaS Runtime which is a computation environment and a Data Service providing data storage for FaaS Runtime usage.
- **Provisioning Engine** - Serverless Runtime manager.
- **Besmart Energy** - cloud platform for managing smart energy systems.
- **Electricity Meter** - current data provisioner, manager of actuators, integrated COGNIT Device Client.
- **Device Controllers** - actuating devices.

Simplified Scenario

Reference Scenario

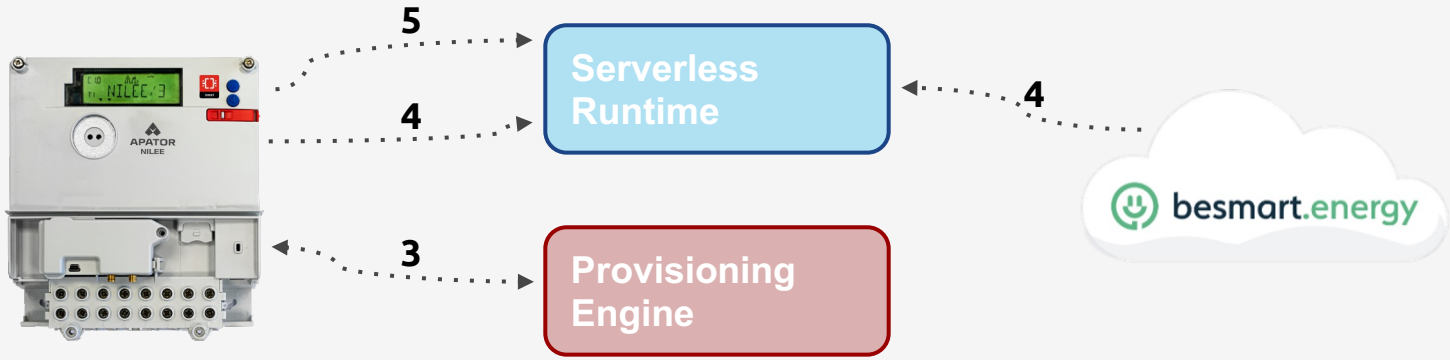
1. **User** sets preferences in **Besmart Energy** platform.
2. **Besmart Energy** platform starts supervising process on **Electricity Meter**.



Simplified Scenario

Reference Scenario

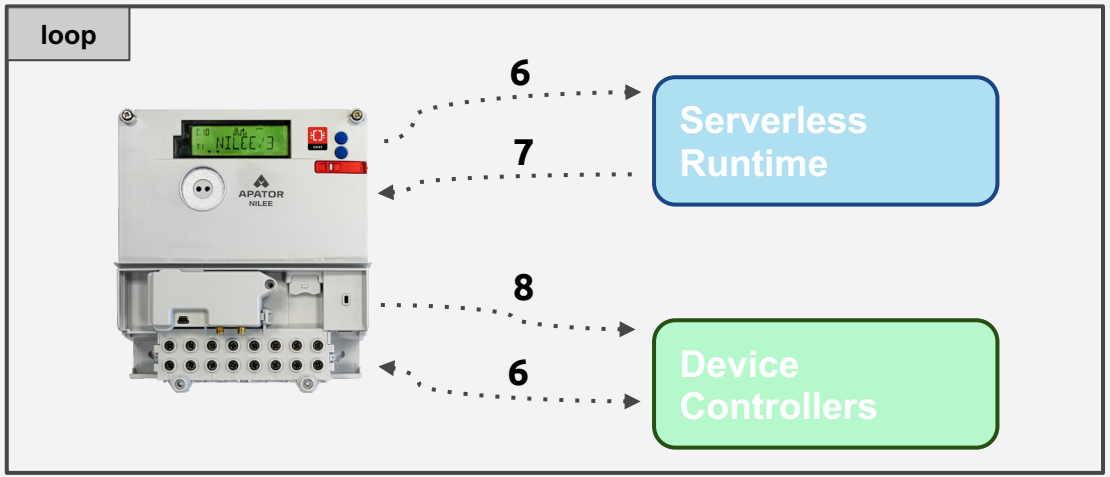
3. **Electricity Meter** requests **Provisioning Engine** for **Serverless Runtime**.
4. **Electricity Meter** requests **Serverless Runtime** to download weather forecast from **Besmart Energy** platform.
5. **Electricity Meter** offloads energy assistant AI model to **Serverless Runtime**.



Simplified Scenario

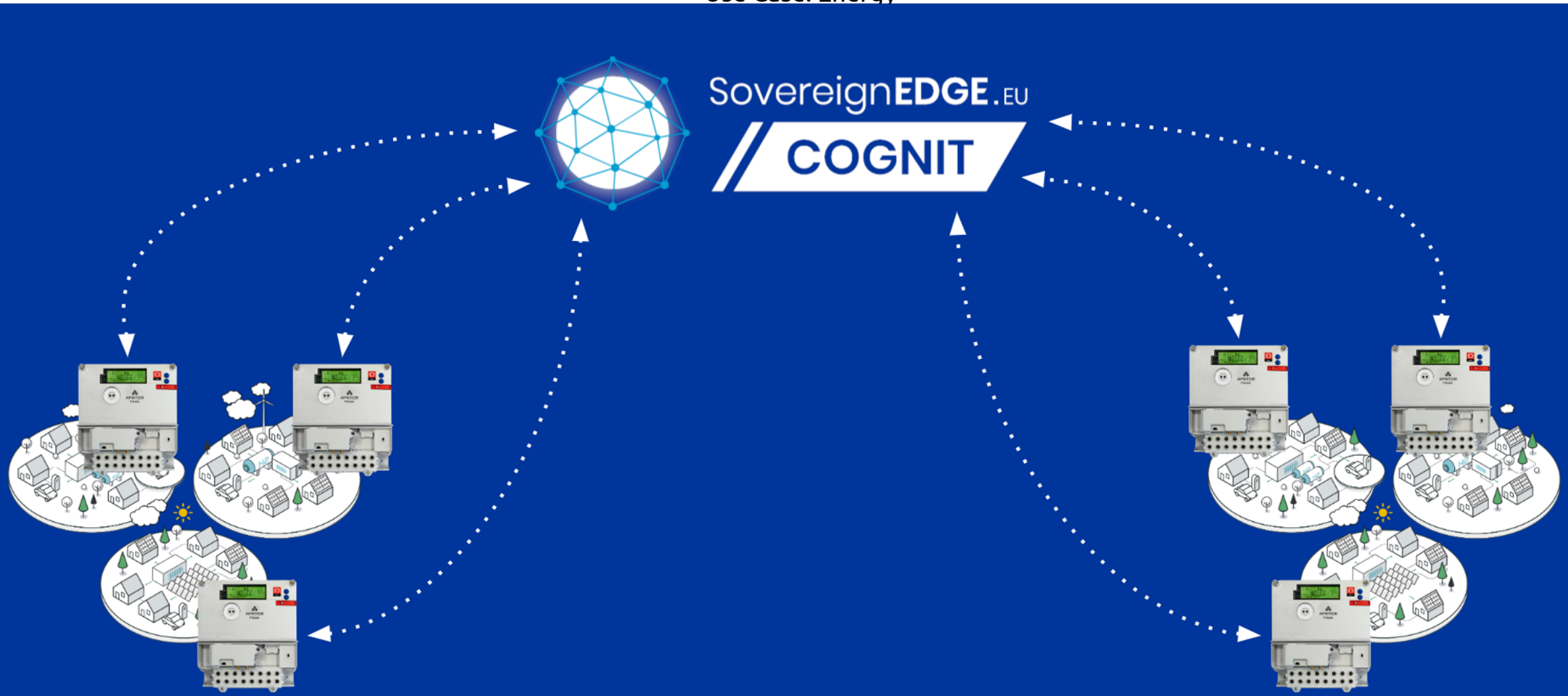
Reference Scenario

6. **Electricity Meter** starts essential supervising phase - periodically sends actual data from **Device Controllers** and initiate computations on **Serverless Runtime**.
7. **Serverless Runtime** sends back results of computations to Electricity Meter.
8. **Electricity Meter** sets parameters of **Device Controllers** for supervised process.



Global KPIs perspective

Use Case: Energy



Unique Challenges

Global KPIs perspective

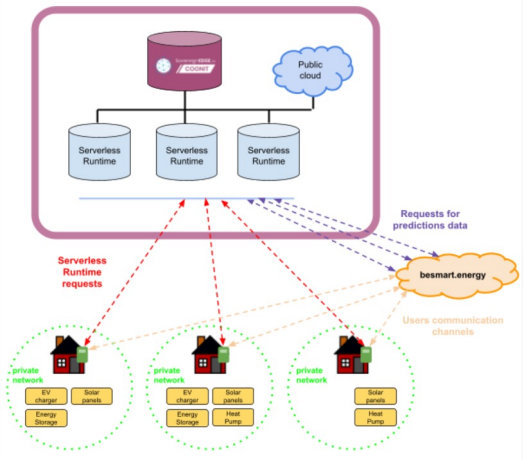
- Electricity meters have limited computational resources, e.g., only 500 kB of memory available for the entire user partition.
- Highly dynamic and varying processing require relatively frequent offloading (every few minutes, depending on user preferences).
- Scaling the number of Serverless Runtime instances, since there will be many smart meters making concurrent requests.
- Development of AI/ML algorithms for decision making to manage energetically important appliances.
- Maximisation of energy self-consumption.

Objectives

Global KPIs perspective

The main goal of the demonstration and validation is to test performance of the COGNIT Framework:

- in case when there are large amounts of concurrent requests in the area of the same local edge node;
- in the case of dynamic changes in Serverless Runtime performance requirements due to changes in user preferences.



Global KPIs

Global KPIs perspective

This specific Use Case is expected to provide a unique contribution towards the validation and achievement of the following global KPIs of the COGNIT Project:

- Meet experience level agreements dynamic needs without intervention of the user.
- Automatic scale up/down of the microVM running the Serverless Runtime.

Reference Scenario context

Global KPIs perspective

User preferences are dynamic and could change towards supervising process. Few examples of dynamic user preferences:

- Resolution of executing computations.
- Preferences to the costs of the computations.
- Preferences connected with the supervised process e.g. EV charging current.
- Preferences due to strategy for consuming/selling produced energy

Reference Scenario context

Global KPIs perspective

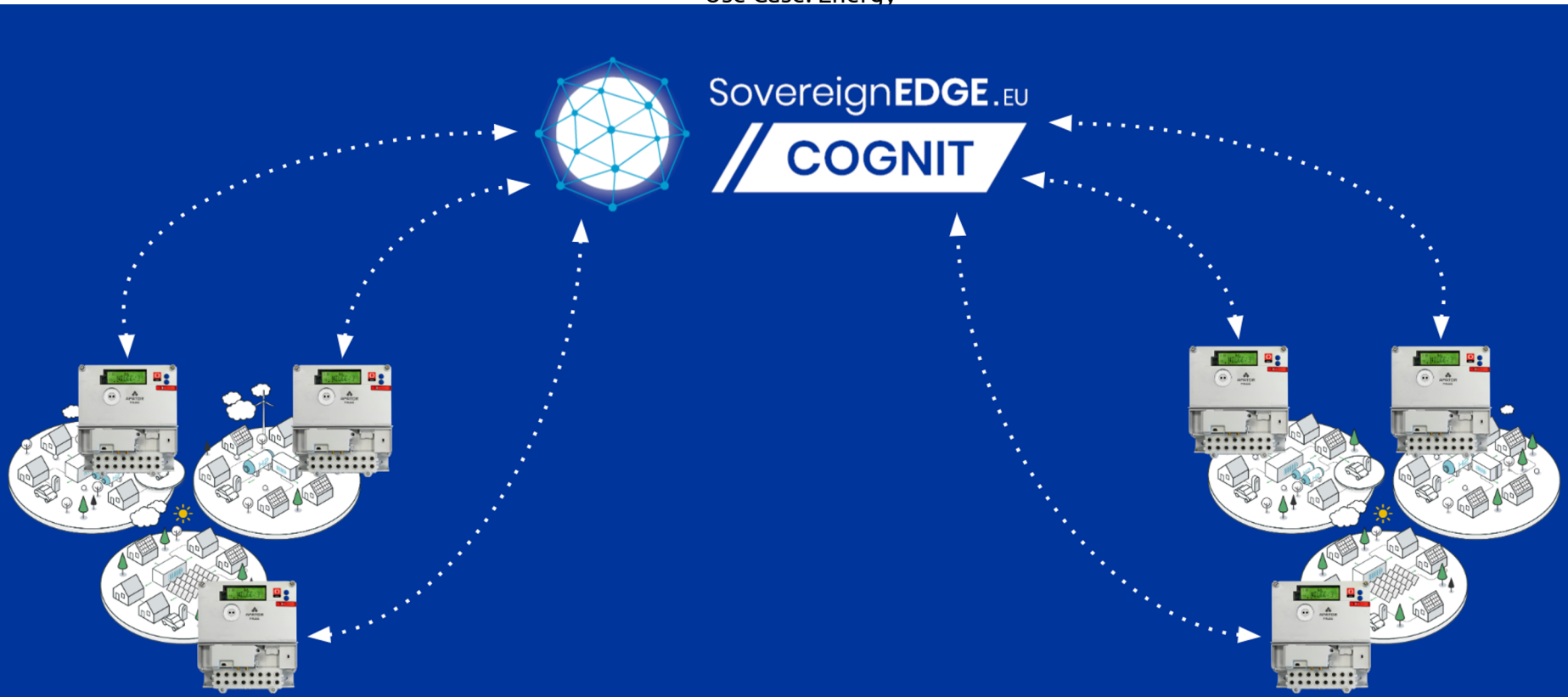
Its common situation that there are many devices in the same geographical area so there is a need for handling many concurrent requests in the range of a single edge node.

There is possibility to get situation when there are too many requests with preferences to specific same computation location. This kind of corner case would be useful to test performance of COGNIT Framework.

Also, important factor in this context are dynamic user preferences which could request for more resources, so on demand for scaling VM up.

Status of work

Use Case: Energy



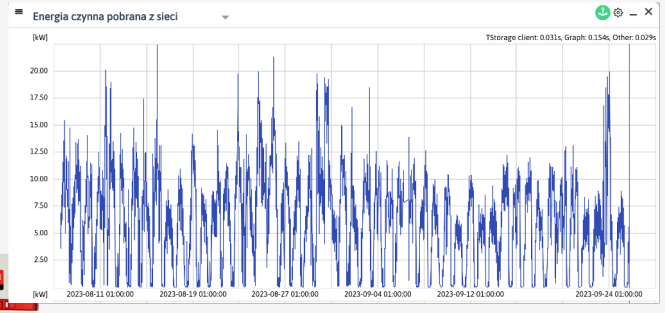
Infrastructure

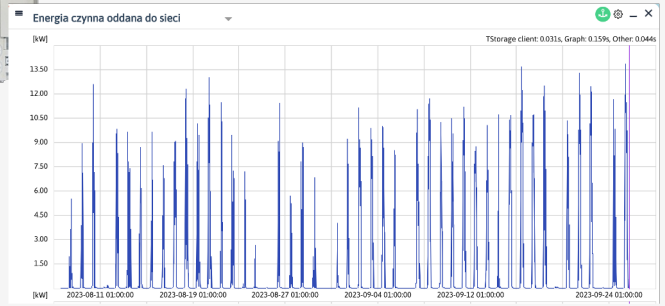
Status of work

Electricity Meter equipped with Phoenix-RTOS is installed on the testground.

It was connected to the internet by GSM modem but in this geographical area connection was unstable.

Currently the Electricity Meter has stable LAN connection.



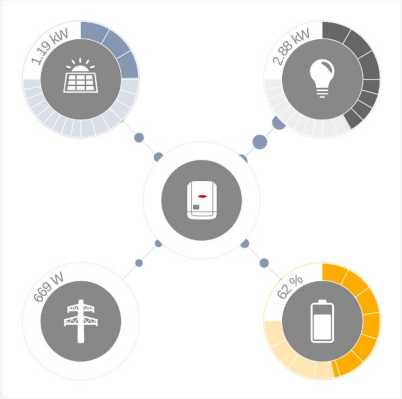


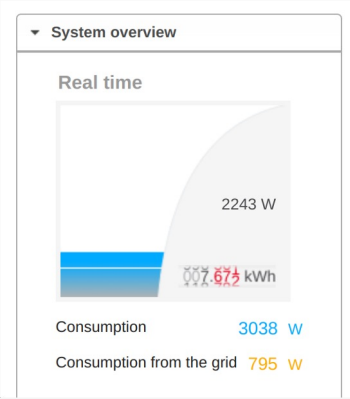
Integration of the Testground Environment

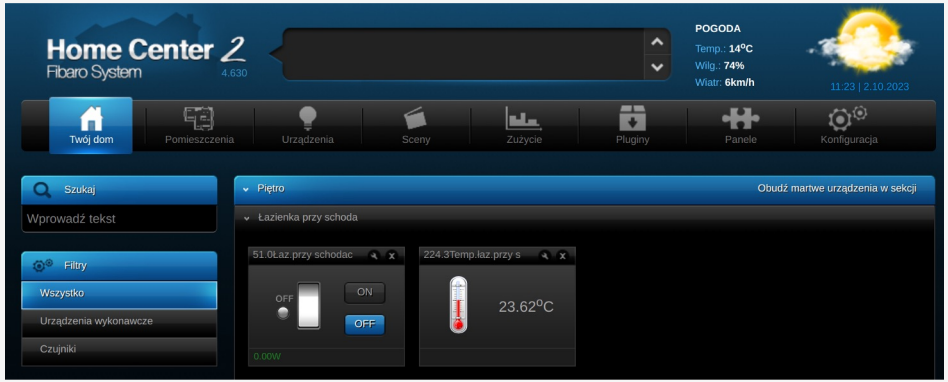
Status of work

Two Photovoltaic inverters are connected to the LAN. Via Modbus TCP protocol it allows to supervise producing energy process from PV panels installation as well as energy storage charging.

Heating system consists of Smart Home HUB and wireless network (868MHz) with actuating devices controllers as well as temperature sensors. Controlling of system is available throught REST API provided by Smart Home HUB connected to the LAN.





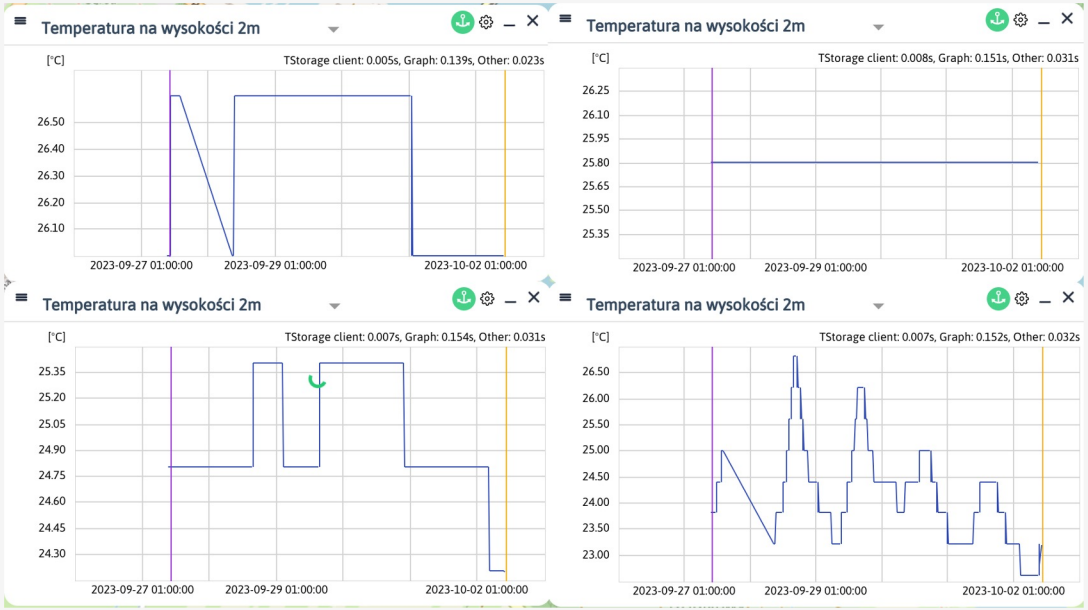


Data collection

Status of work

Data about temperature in the household is collected from 25 temperature sensors placed in house every 5 minutes.

It is necessary to collect data useful for future training of AI models for decision making in terms of managing energetically important appliances.



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A Cognitive Serverless Framework for the Cloud-Edge Continuum

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