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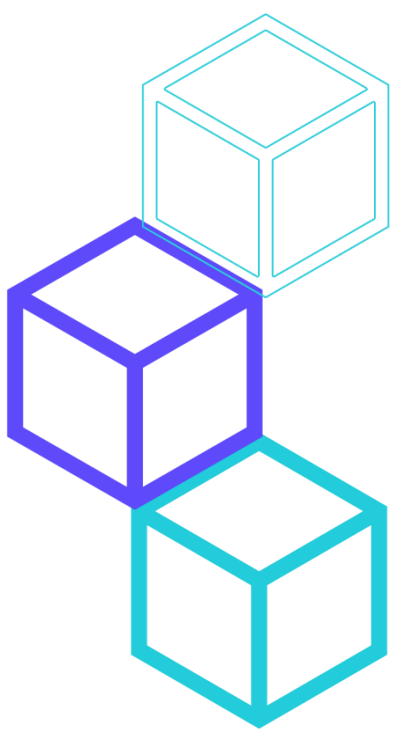
WEBINAR:
**2030.5 ENHANCED TOOLS FOR
DER INTEGRATION & TESTING**
The InterSTORE Project

THURSDAY MARCH 5TH
9AM PST/12PM EST

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Agenda



- Opening remarks about the InterSTORE project: Antonello Monti presenting
- IEEE2030.5 LPC and client/server library with configuration tool: Matjaz
- Testing procedures with short UI demo: Nithin & Alessandra
- Architectures and environments tested, lessons learned and main KPIs reached: Daniele Carta
- Practical example of the IEEE 2030.5 (client/server library) and LPC implementation on EMS and REC sides: Nikolaj





interstore

Interoperable open-source Tools to Enable hybridisation, utilisation, and monetisation of storage flexibility

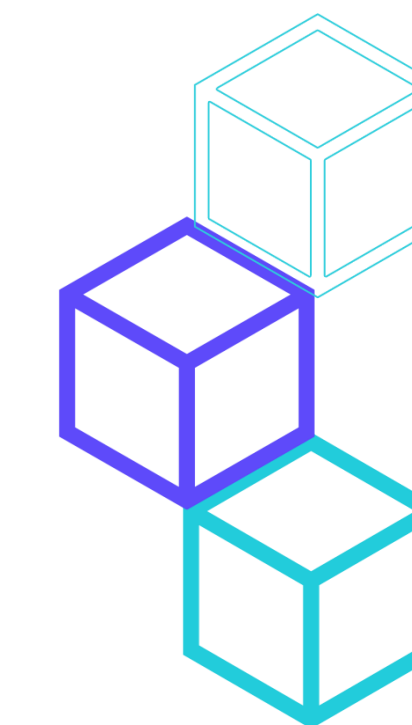
Key Facts

Antonello Monti



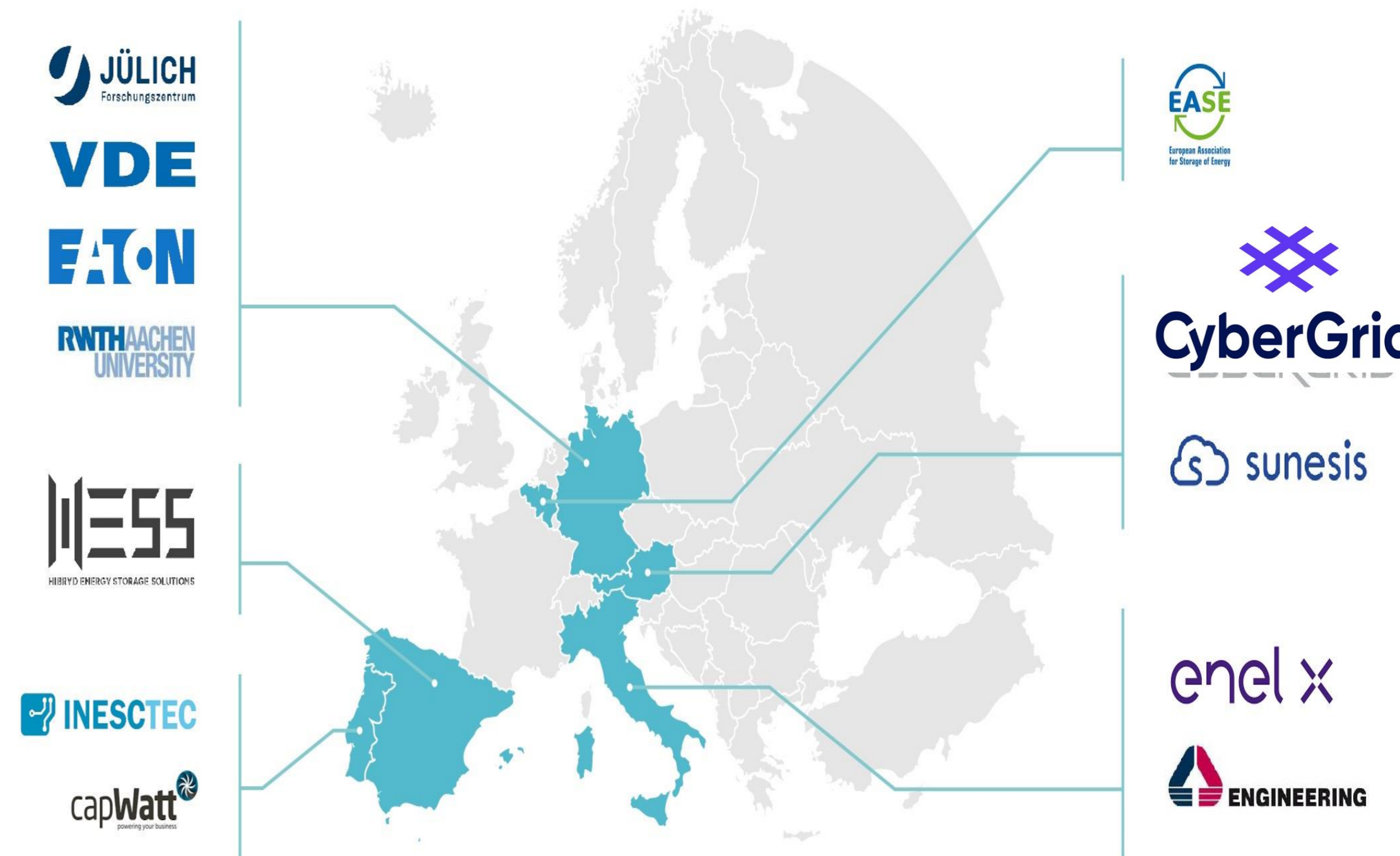
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Opening remarks about the InterSTORE project



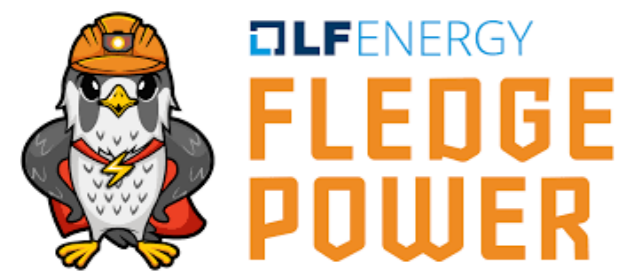
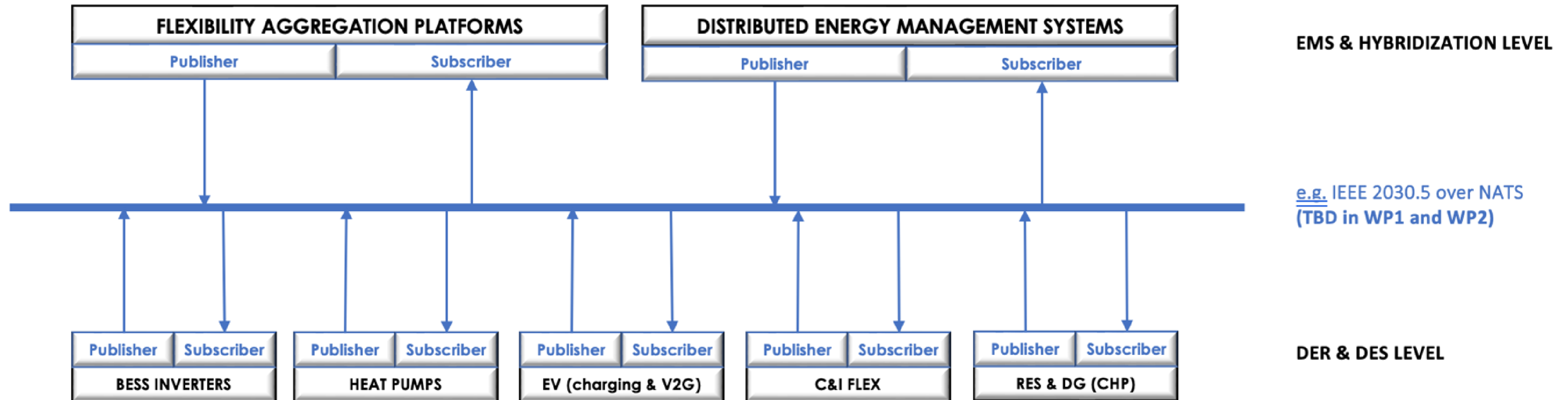
Project acronym: InterSTORE – Interoperable open-source Tools to Enable hybridisation, utilisation, and monetisation of storage flexibility

- **Type of Action:** IA
- **GA N°:** 101096511
- **Call & Topic:** HORIZON-CL5-2022-D3-01-10: 24 proposals submitted: 3 funded (us, PARMENIDES (AIT), FlexCHESS (UNIVERSITE D'AIX MARSEILLE))
- **Starting date:** 01.01.2023
- **Duration:** 36 M
- **Budget:** 4,355,197.5 €
- **EU contribution:** 3,498,630.75 €
- **Project Coordination:** Prof. Antonello Monti (RWTH)
- **Project manager/Technical coordinator:** Alexandre Lukas (INESC)

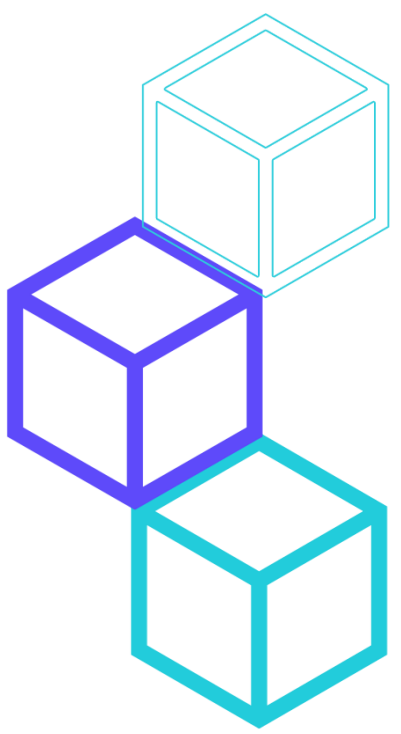


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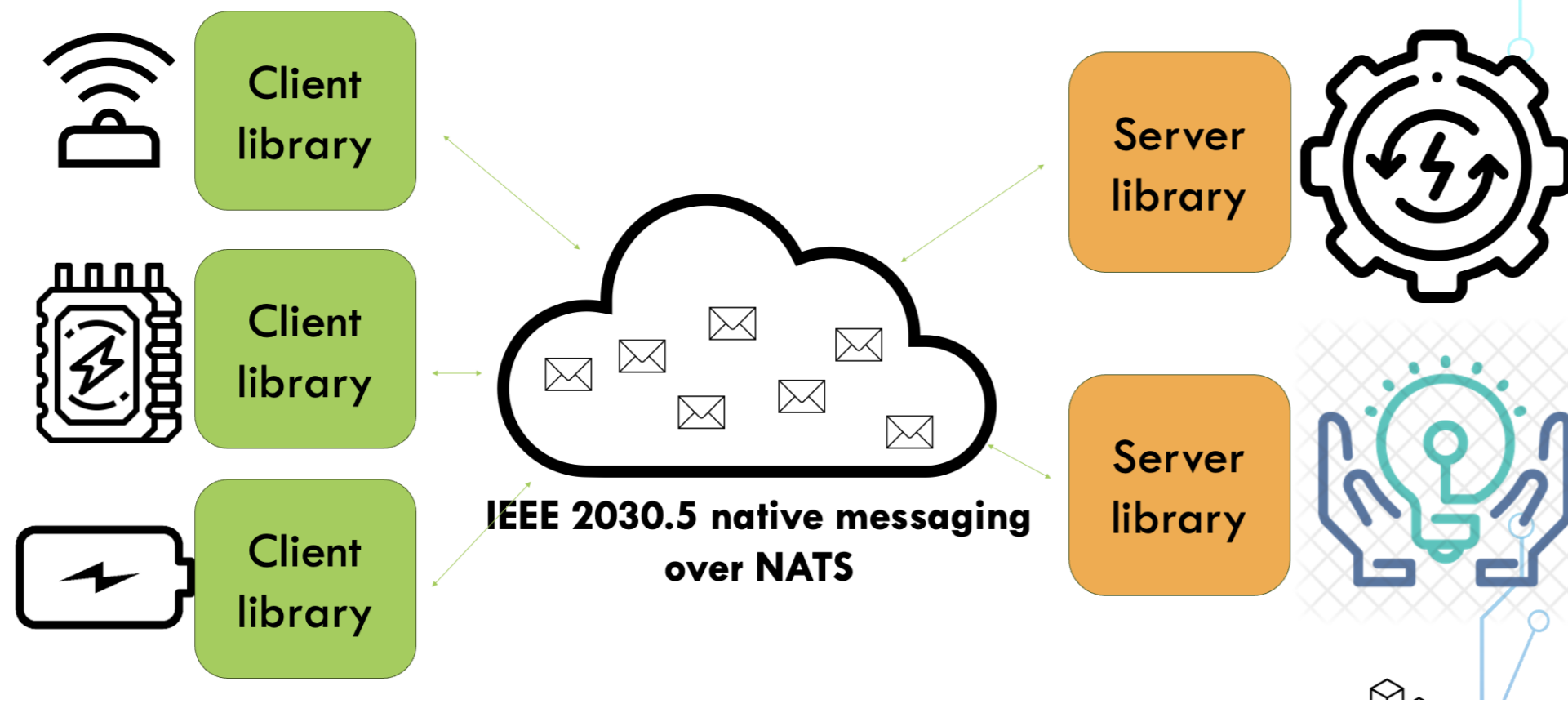
A Middleware allowing Interoperability data exchange



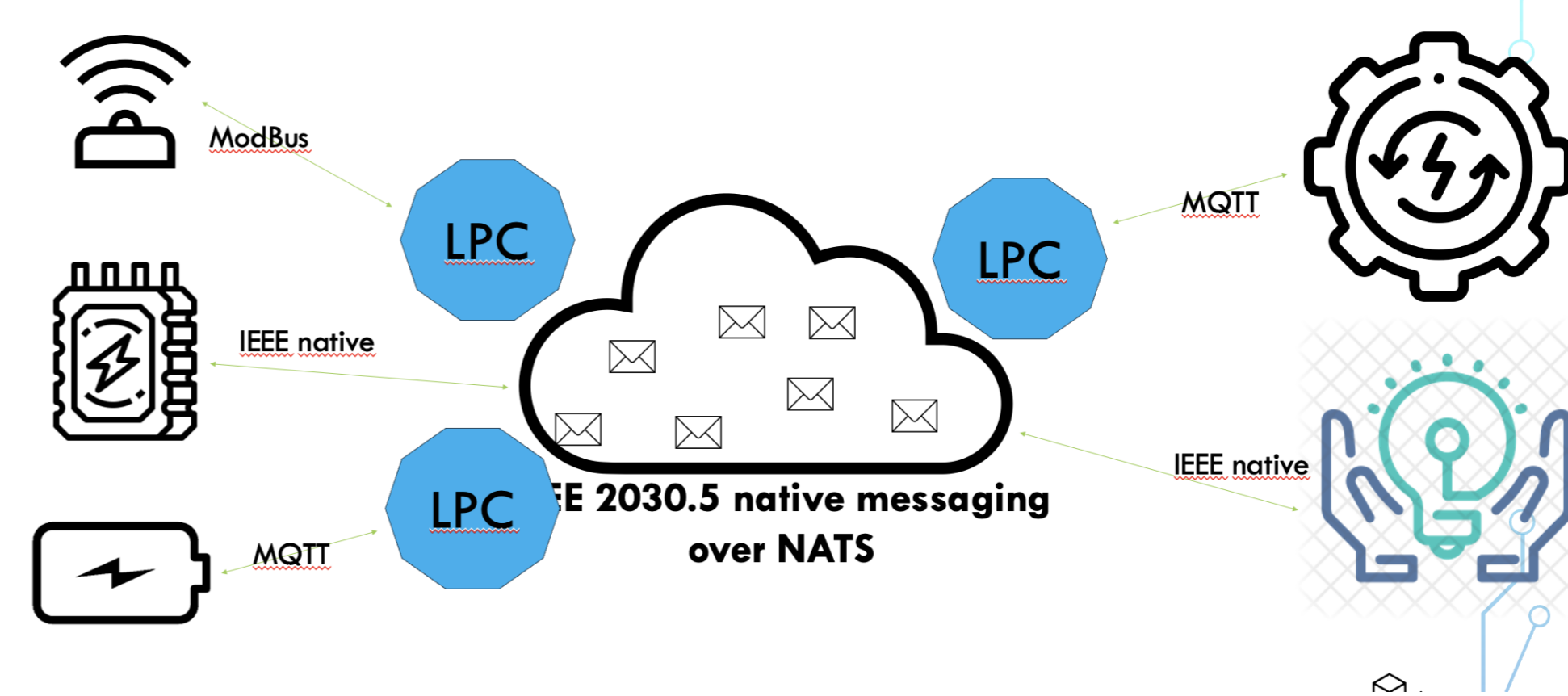
A fully interoperable solution based on IEEE2030.5



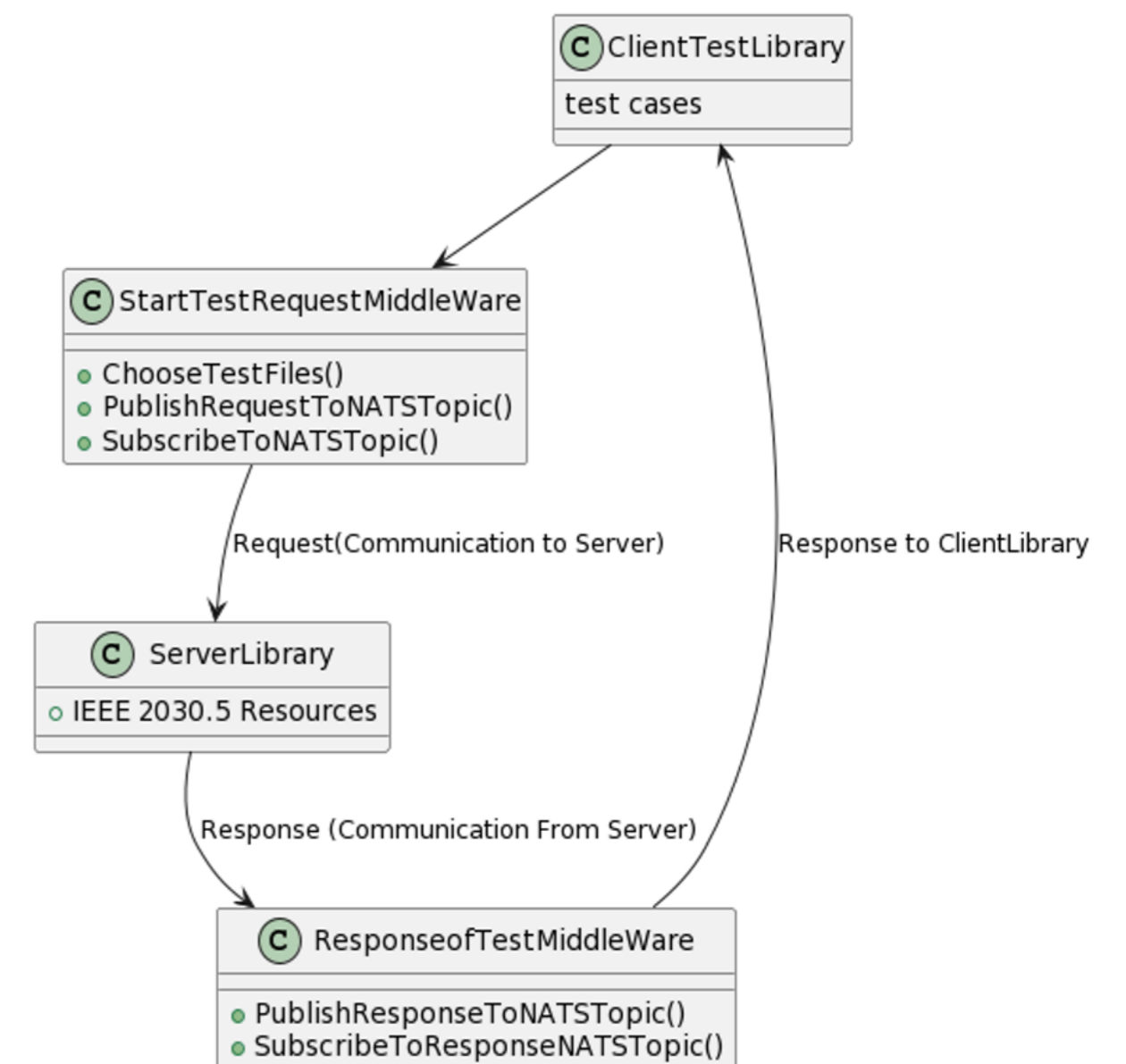
TOOL 1: INTEROPERABLE CLIENT/SERVER FOR DISTRIBUTED ENERGY STORAGE



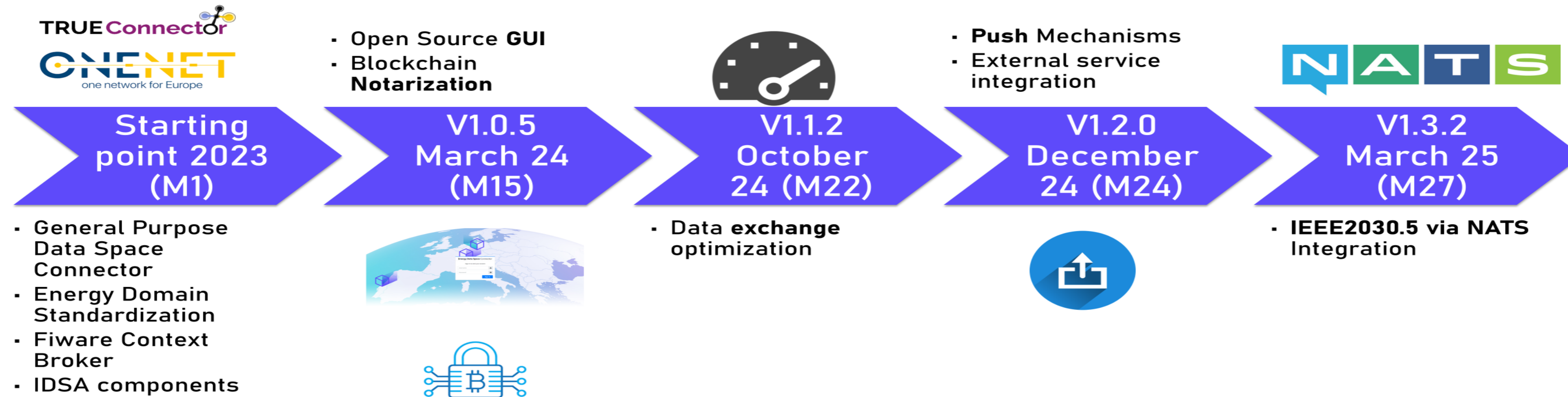
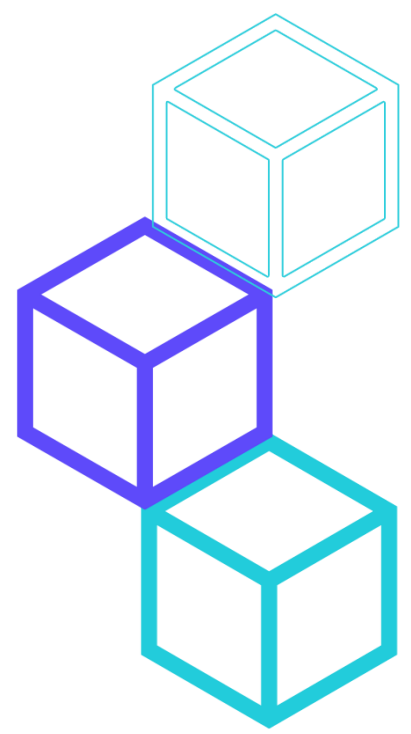
TOOL 2: LEGACY SYSTEMS PROTOCOL CONVERTER



- Extended capabilities of IEEE2030.5 by mapping to NATS opening to multi-multi communication
- Interoperability with legacy devices thanks to a Legacy Protocol Converter supporting all typical alternative used in industry
- Testing procedures

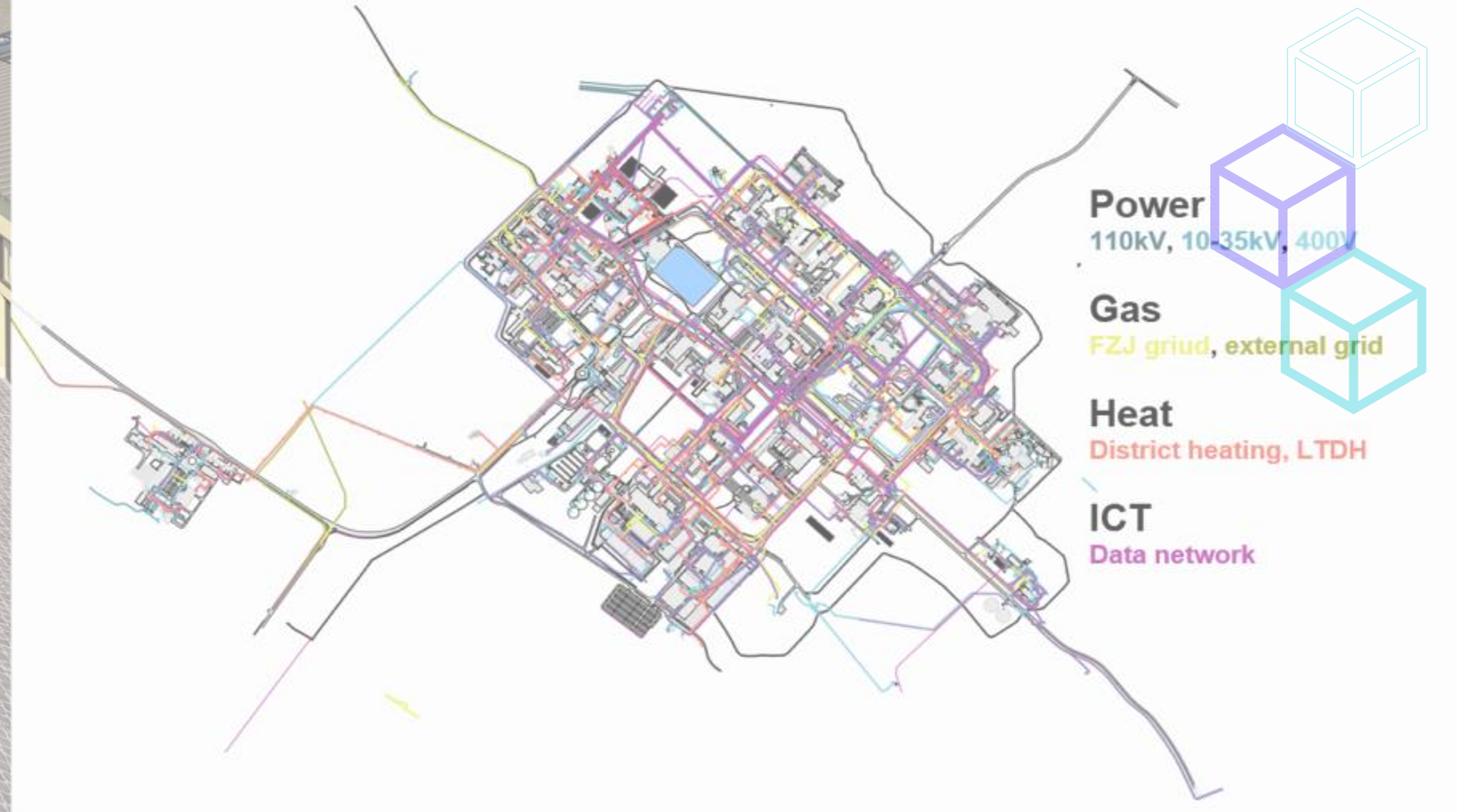


Interoperable Data Spaces Framework



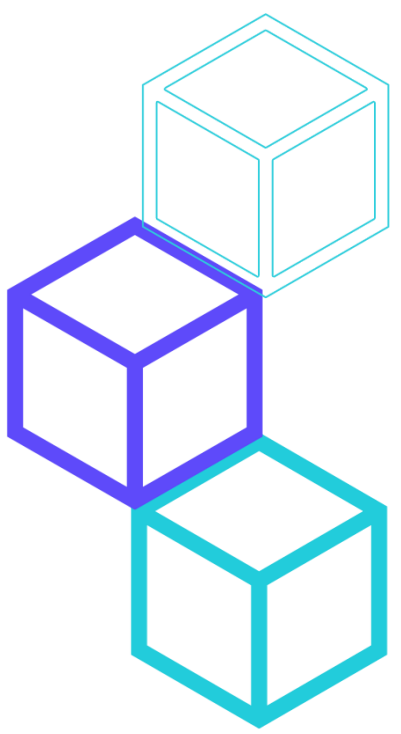
- Fully Open-Source advanced GUI
- Data Exchange Blockchain Notarization and Verification
- Push mechanisms and External Service integration
- IEEE2030.5 integration
- Scalability and performance optimization (up to 90%)





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Project Legacy: CUPID in LF Energy (Linux Foundation Europe)



- Linux Foundation Energy under the name CUPID, which has been disseminated in different events for communities to engage and contribute as this will be the future stage for the InterSTORE project developments.

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

The screenshot shows the GitHub organization page for 'cupid-project'. At the top, there is a navigation bar with a search box and icons for repository management. Below the navigation bar, the organization name 'cupid-project' is displayed with a purple and white logo and an 'Unfollow' button. The main content area is divided into two columns. The left column, titled 'Popular repositories', lists three repositories: 'Legacy-Protocol-Converter', 'interoperability-common', and 'Client-Server', all of which are public and use Java. The right column, titled 'People', states that the organization has no public members. Below this, there is a 'Top languages' section showing Java as the primary language. At the bottom of the page, there is a 'Report abuse' link.



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interstore

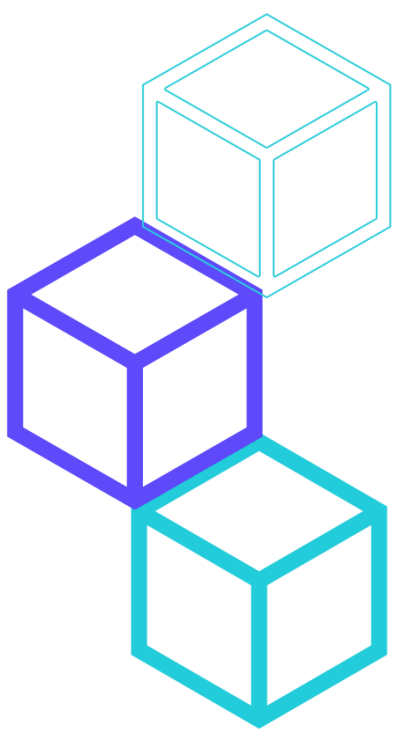
Open-source Interoperability Toolkit Legacy System Protocol Converter

Matjaz Juric



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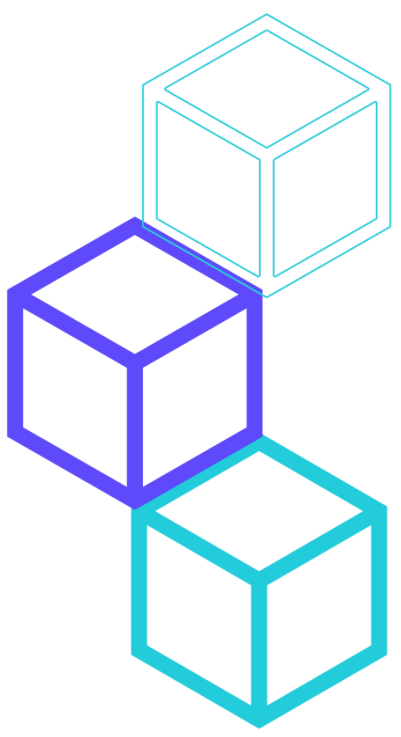
Open-source Interoperability Toolkit



Completed design, implementation and validation of the toolkit. All software tools reached operational readiness and were delivered for pilot deployment.

- **Legacy Protocol Converter (LPC)**
- **Interoperable Client/Server**
- **Testing Procedures**
- **Data Spaces Framework**





Legacy Systems Protocol Converter

Legacy Systems Protocol Converter (LPC)

- Provides simple and configurable transformation between legacy protocols and IEEE 2030.5

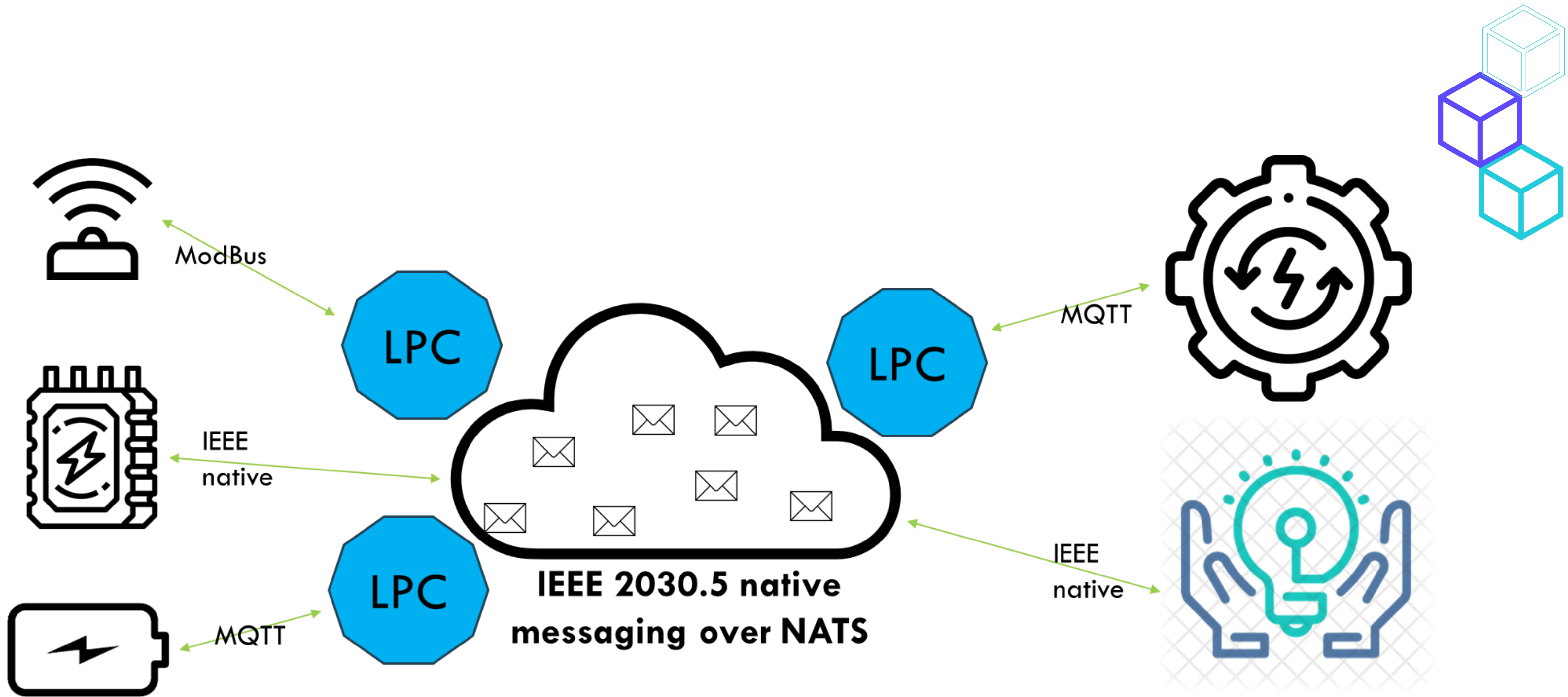
Supported protocols:

- ModBus (serial and TCP)
- MQTT
- NATS (for IEEE 2030.5)

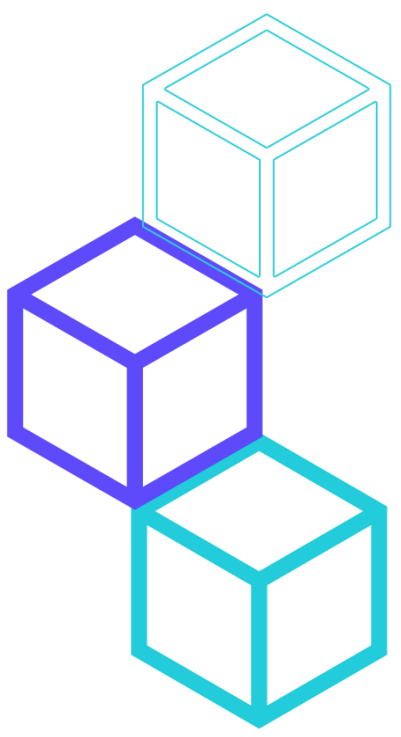
Supported IEEE 2030.5 formats

- XML
- JSON
- All 321 IEEE 2030.5 elements are supported





LPC Key Features



Built-in Transformation Framework

- Users can define mappings and transformations for converting messages between different formats and structures.

Configuration File

- LPC utilizes a configuration file to specify connection details for NATS, MQTT, and Modbus devices
- Simple setup and management.

Flexibility

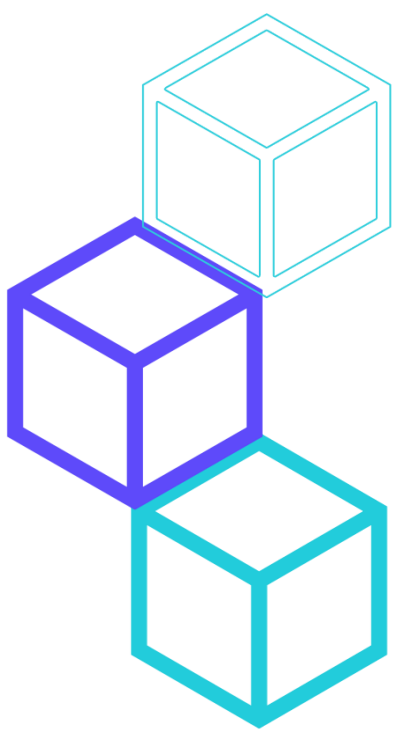
- LPC supports multiple transformations
- Each with distinct incoming and outgoing connections, message formats, and structures
- Diverse integration scenarios

Deployment Options

- LPC can be deployed in various ways, including Docker containers, Raspberry Pi, IoT devices, servers, Kubernetes, etc.



NATS – Cloud-native Communication Backbone



NATS as the foundation

- Shift from the traditional REST API-based communication to NATS messaging.
- Asynchronous communication improves real-time data exchange and makes it more resilient.

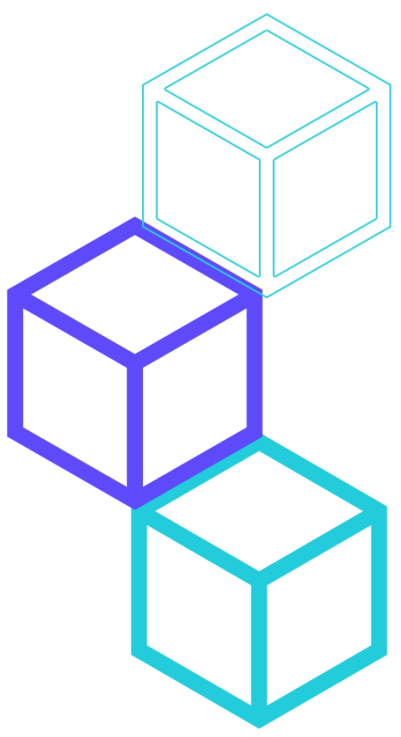
Flexibility in Message Exchange

- The LPC's architecture enables support for various message exchange patterns:
 - one-to-one, one-to-many, and many-to-many communication.
- Versatility for diverse integration scenarios within the smart grid.

Example of Many-to-Many Communication

- LPC can subscribe to messages from multiple incoming connections (e.g., devices using Modbus and MQTT) and then publish transformed messages to multiple outgoing connections (e.g., EMS systems using IEEE 2030.5 over NATS).





Hardware Requirements

LPC can run on any computer, embedded device or virtual machine

- Docker – pre-build image available in docker Hub
- Virtual machine
- Execute Java JAR (requires OpenJDK JRE)
- Custom build from source code

Any OS that can run Java

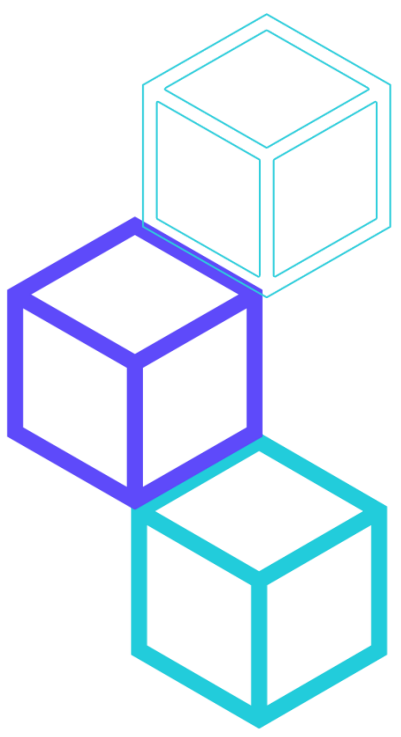
- Linux, Windows, MacOS, etc.

Low Requirements

- Low memory (256 MB or more) and processor (can be run on Raspberry PI).
- Optimized for Docker
- Optimized for Kubernetes for high available, resilient, high throughput scenarios.



Legacy Systems Protocol Converter



```
{
  "datetime": "28-08-2023 12:00:35",
  "status": "active",
  "start": "28-08-2023",
  "duration": 900
}
```



```
<Event>
  <creationTime>1702909917932</creationTime>
  <EventStatus>
    <currentStatus>1</currentStatus>
    <dateTime>1693216835000</dateTime>
    <potentiallySuperseded>>false</potentiallySuperseded>
  </EventStatus>
  <interval>
    <duration>900</duration>
    <start>1693216835000</start>
  </interval>
</Event>
```

transformations:

- name: JSON IncomingEvent to XML IEEE2030.5 Event

description: Example showing transformation of messages from JSON to XML

connections:

incoming-connection:

- MQTT-connection

incoming-topic: topic1

incoming-format: JSON

outgoing-connection:

- NATS-connection

outgoing-topic: event/myevent

outgoing-format: XML

to-outgoing:

'<Event>

<creationTime>\${timestamp}</creationTime>

<EventStatus>

<currentStatus>

<lpc:mapping>

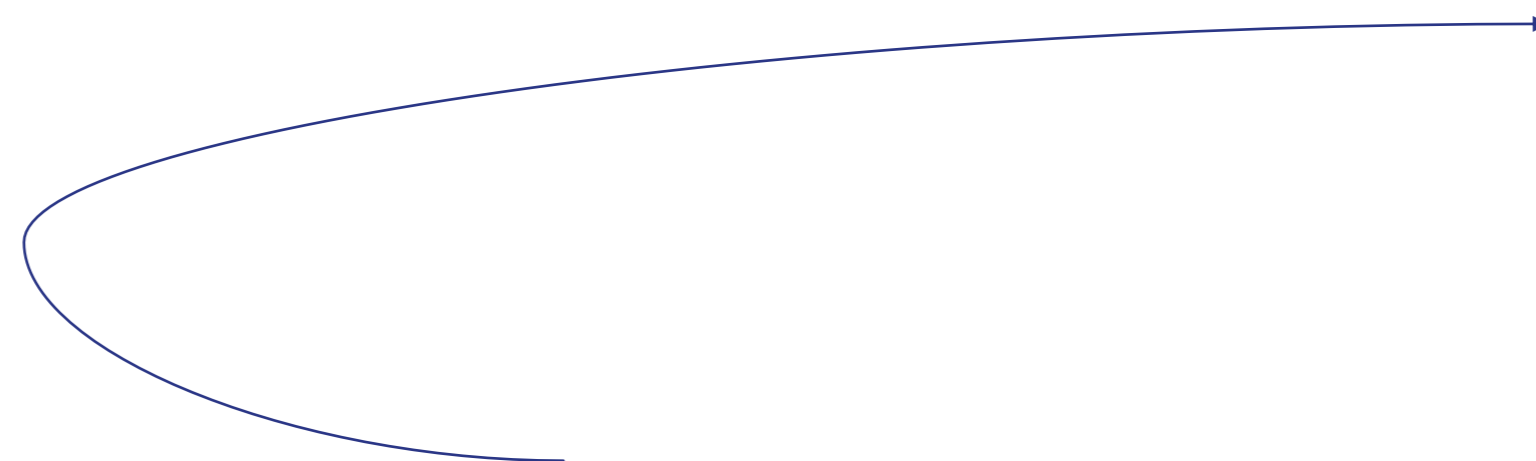
<path type="integer">/status</path>

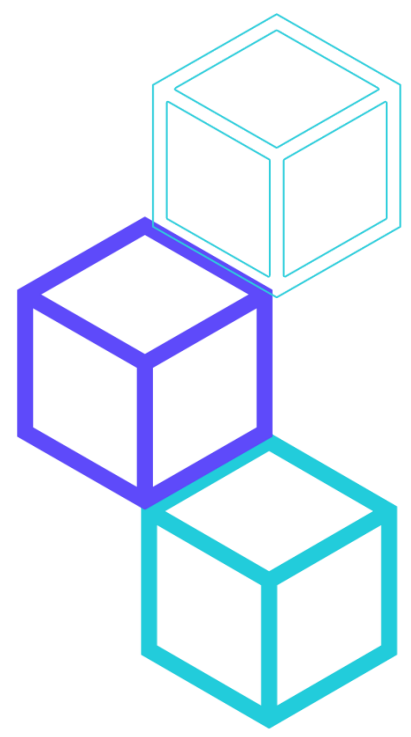
<values>["scheduled", "active", "cancelled", "cancelled_with_r", "superseded"]</values>

</lpc:mapping>

</currentStatus>

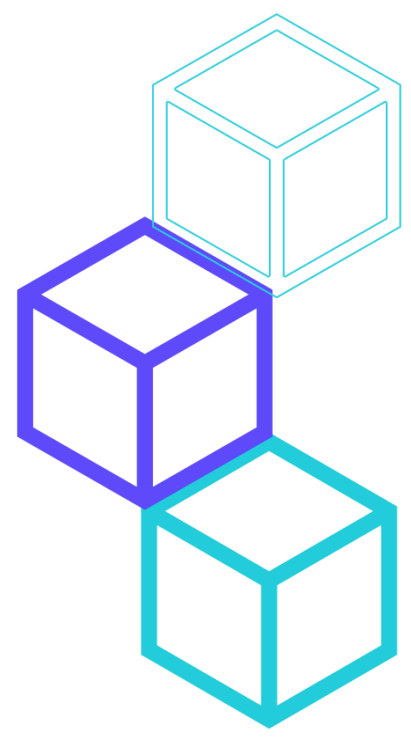
<dateTime>





```
1 connections:
2   - name: NATS-Server
3     type: NATS
4     host: localhost
5     port: 4222
6   - name: MQTT-broker
7     type: MQTT
8     host: 10.0.1.123 # IP of the MQTT broker on the ICT platform.
9     port: 8086
10    reconnect: true
11   - name: batteryName-invNum-boardName
12     type: Modbus
13     host: 10.0.2.123 # IP of the batteryName-invNum-boardName
14     port: 502
```



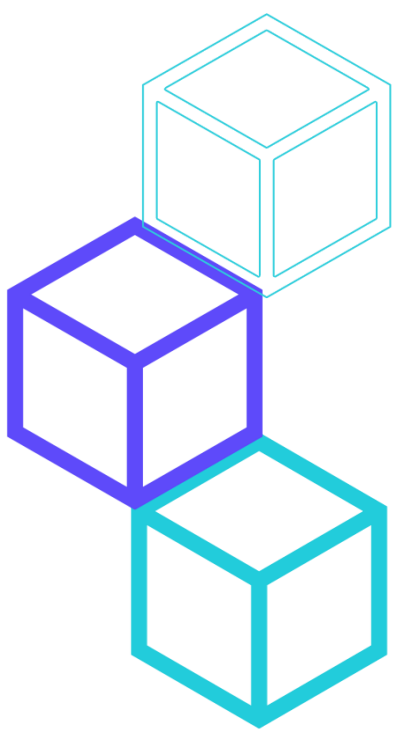


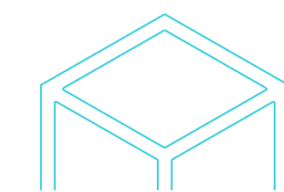
```
15  transformations:
16    - name: batteryName-invNum-boardName - Modbus to NATS
17      description: Transformation of messages from Modbus to JSON for batteryName battery, inverter invNum, boardName board
18      validate-ieee2030-5: both
19      connections:
20        incoming-connection:
21          - batteryName-invNum-boardName
22        outgoing-connection:
23          - NATS-Server
24        outgoing-topic: batteryName.invNum.boardName
25        outgoing-format: JSON
```



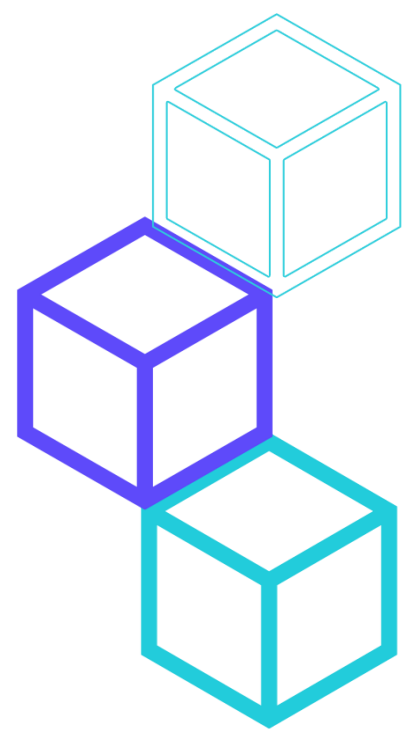
```
26 to-outgoing:
27   to-topic: batteryName.invNum.boardName
28   message: |
29     {
30     "DER": [
31     {
32       "description": "BESS",
33       "DERCapability": { # 10.10.4.4.2 in the standard
34         "DERType": { # from DERType object
35           "value": 80 # "Other storage system"
36         },
37         "modesSupported": { # look for the valued in table 54 (Modes and attributes for storage type DERs)
38           "dERControlType": {
39             "value": [
40               0, # Charge mode
41               1 # Discharge mode
42             ]
43           }
44         },
45         "rtgMaxW": { # Maximum continuous active power output capability in watts
46           "value": {
47             "lpc:mapping": {
48               "path": "79",
49               "type": "int16"
50             }

```





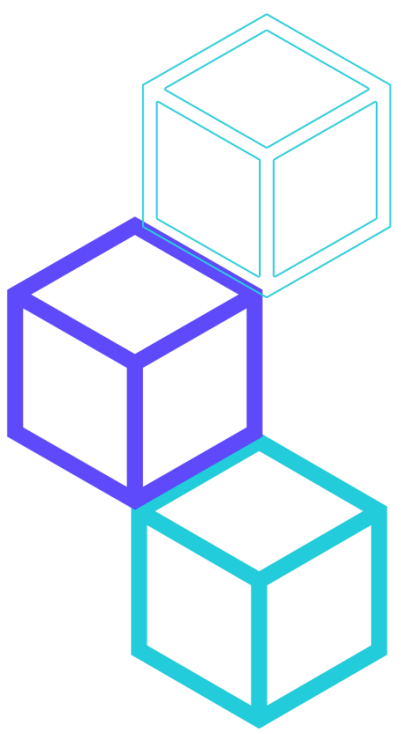
```
213 - name: batteryName-invNum-boardName - NATS to MQTT
214 description: Transformation of messages from JSON to MQTT for batteryName battery, inverter invNum, boardName board
215 connections:
216   incoming-connection:
217     - NATS-Server
218   incoming-topic: batteryName.invNum.boardName # Origin topic in the NATS server (same as outgoing in the Modbus to NATS transformation)
219   outgoing-connection:
220     - MQTT-broker
221   outgoing-format: JSON
222 to-outgoing:
223   to-topic: batteryName/invNum/boardName # Destination topic in the MQTT message "batteryName" bucket is specified on Telegraf
224   message: |
225     {
226       "voltage": {
227         "average": {
228           "value": {
229             "lpc:mapping": {
230               "path": "mirrorMeterReadingList/mirrorMeterReading/0/reading/value",
231               "type": "int32"
232             }
233           },
234           "multiplier": {
235             "lpc:mapping": {
236               "path": "mirrorMeterReadingList/mirrorMeterReading/0/readingType/powerOfTenMultiplier/value",
237               "type": "int32"
```



```
199     interval-request:
200         interval: 1000 # Interval in milliseconds
201         request:
202             modbus-function-code: 3 # Function code for reading holding registers
203             modbus-device-id: 1 # Device ID
204             endianness: big # Modbus register endianness
205             modbus-registers:
206                 - register-address: 11 # e.g.,: "Input mains star voltage V1"
207                   type: "int16"
208                 - register-address: 79 # e.g.,: "Maximum continuous active power output capability in watts"
209                   type: "int16"
210                 - register-address: 300 # e.g.,: "Total active power"
211                   type: "int32"
```



LPC UI for Simplifying Configuration



- <https://sunesis.si/interstore/lpc/>

The screenshot shows a web browser window at <https://sunesis.si/interstore/lpc/transformations>. The interface is divided into several sections:

- Quick nav:** A sidebar with buttons for "Connections", "Transformations", and "Registration".
- Modbus TCP configuration:** A dropdown menu for "Incoming connections" is set to "modbus1". Below it, "Outgoing connection type" is set to "NATS" and "Outgoing connections" is set to "nats1".
- Define mapping from modbus1 to nats1:** A dialog box with a close button. It contains:
 - "Outgoing format": A dropdown menu set to "JSON".
 - "Retry count": An empty input field.
 - "To topic": A text input field containing "enel2".
 - "Message": A text area containing a JSON snippet:

```
{
  "dERSettings": {
    "modesEnabled": {
      "value": [
        {
          "lpc:mapping": {
            "path": "/IncomingEvent/duration",
            "type": "integer",
            "pattern": "date-pattern",
            "values": []
          }
        }
      ]
    }
  }
}
```
 - Buttons for "Insert LPC mapping" and "Format JSON".
- Second mapping dialog:** A second "Define mapping from modbus1 to nats1" dialog box is partially visible at the bottom, with "Incoming format" set to "JSON".
- Right sidebar:** A "Find element..." search box is present. Below it is a list of "IEEE2030.5 Elements" including: AbstractDevice, AccountBalance, AccountBalanceLink, AccountingUnit, AccumulationBehaviourType, ActiveBillingPeriodListLink, ActiveCreditRegisterListLink, ActiveDERControlListLink, and ActiveEndDeviceControlListLink. At the bottom of the sidebar are "Download" and "Continue" buttons.



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- Quick nav
- Connections
- Logging
- Transformations
- Registration

MQTT-broker

Define mapping from NATS-Server to MQTT-broker

Outgoing format: | Retry count:

From topic *:

To topic *:

Message *

```
{  "voltage": {    "average": {      "value": {        "lpc:mapping": {          "path": "mirrorMeterReadingList/mirrorMeterReading/0/reading/value",          "type": "int32"        }      }    },    "multiplier": {      "lpc:mapping": {        "path": "mirrorMeterReadingList/mirrorMeterReading/0/readingType"      }    }  }
```

Define mapping from MQTT-broker to NATS-Server +

Define Interval Request for NATS-Server +

Back

Download

Continue

- Quick nav
- Connections
 - Logging
 - Transformations
 - Registration

MQTT-broker

Define mapping from NATS-Server to MQTT-broker

Outgoing format: | Retry count:

From topic *:

To topic *:

Message *

```
{
  "voltage": {"activeDERControlListLink": {
    "all": 5,
    "href": "http://www.your.gov/imponet/acuto"
  }
  "average": {
    "value": {
      "lpc:mapping": {
        "path": "mirrorMeterReadingList/mirrorMeterReading/0/reading/value",
        "type": "int32"
      }
    }
  }
}
```

Define mapping from MQTT-broker to NATS-Server +

Define Interval Request for NATS-Server +

DER

IEEE2030.5 Elements

Click element to insert

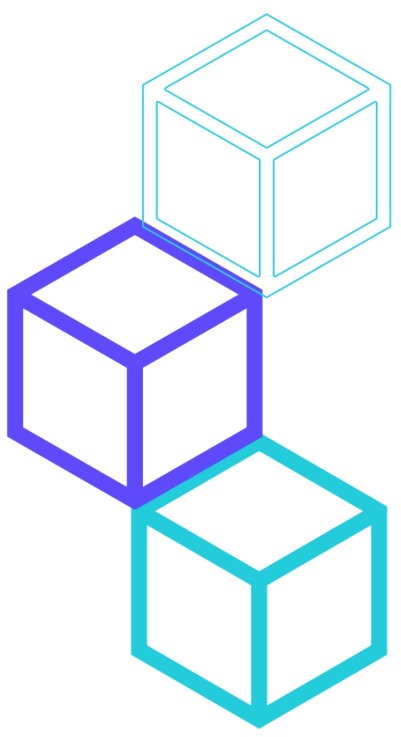
- ActiveDERControlListLink
- AssociatedDERProgramListLink
- CurrentDERProgramLink**
- DefaultDERControl
- DefaultDERControlLink
- DER
- DERAvailability
- DERAvailabilityLink

Back

Download

Continue

Latest Version and New Features in LPC



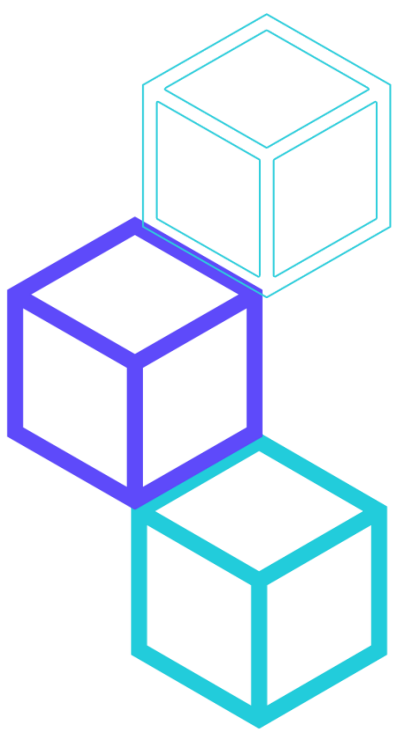
Latest version is **Version 1.5.2** (Oct 2, 2025)

Selected new features:

- Cron based interval request scheduling
- Synchronization with NTP server supported for interval requests
- Option to use pymodbus or Java Modbus TCP libraries
- Support for unsigned and signed integers when using Modbus connections
- Configuration of logs inside the configuration of LPC
- Option of message validation for compliance with IEEE2030.5 schema
- Validation flag for IEEE2030.5 inbound and outbound messages
- Several performance and scalability improvements

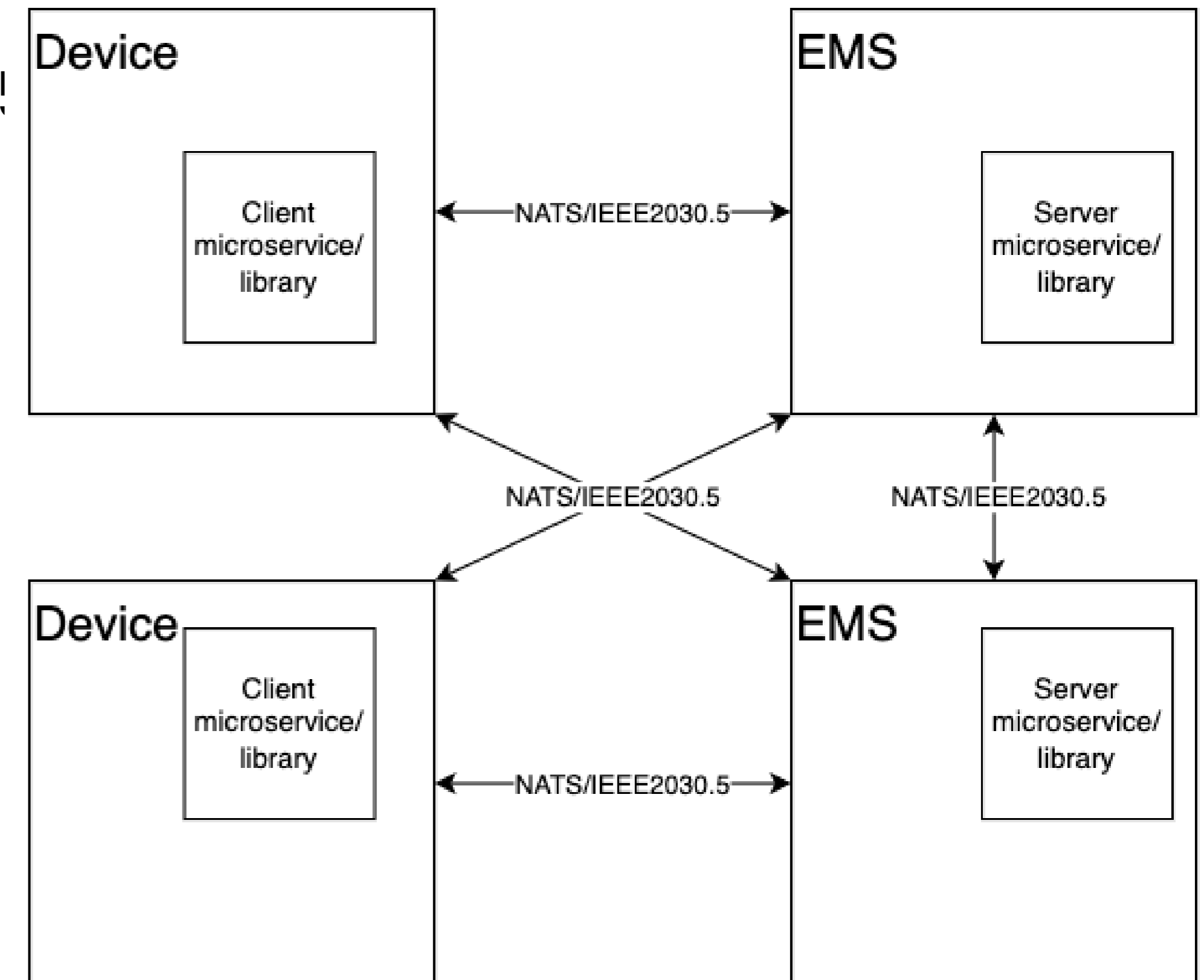


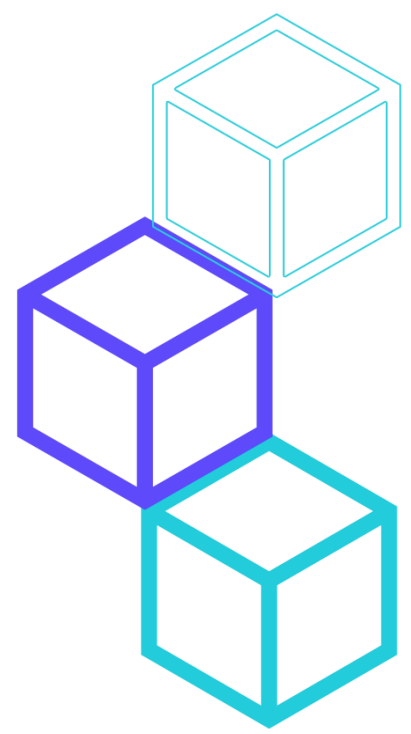
Interoperable client/server for Distributed Energy Storage



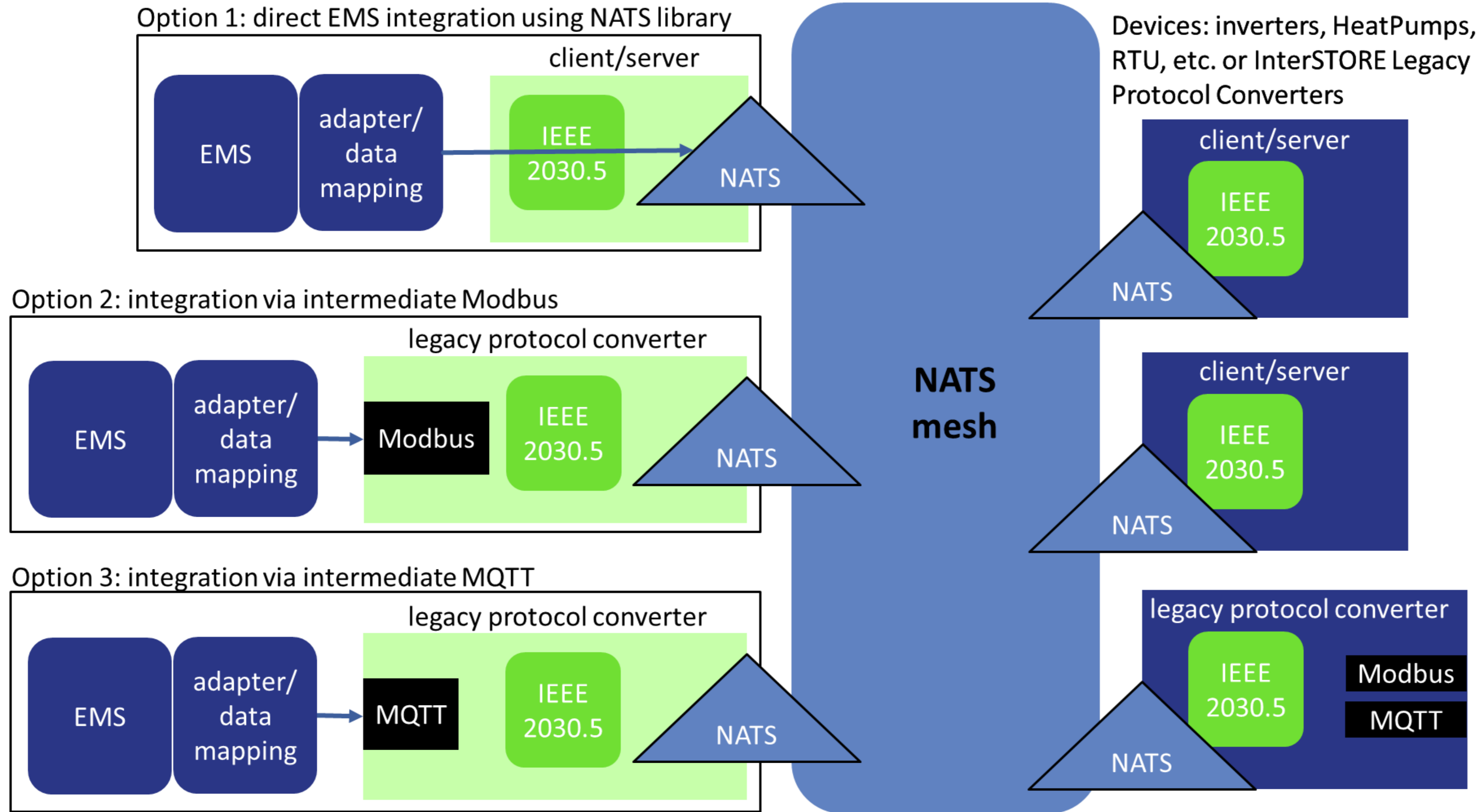
Objectives:

- Open source, out-of-the-box support for IEEE2030.5 communication standard
- Next generation NATS messaging, superseding other communication mechanisms (such as REST over HTTP) and enabling message-driven, loosely coupled and scalable communication platform
- Reference implementation as an open-source project, available on [GitHub](#)

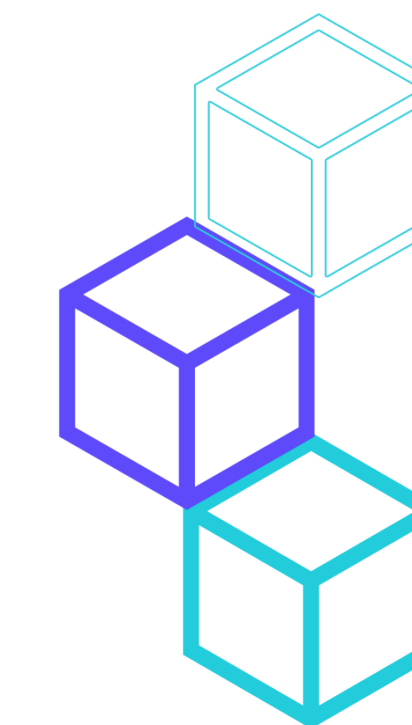




InterSTORE IEEE 2030.5 over NATS architecture



Linux Foundation Energy



LPC has been adopted by Linux Foundation for Energy.

LPC can now be found in Linux Foundation hosted repo on GitHub - CUPID:

<https://github.com/cupid-project/Legacy-Protocol-Converter>

CUPID code is currently mirrored with original Interstore repository

<https://github.com/Horizont-Europe-Interstore/Legacy-Protocol-Converter>

CUPID will move to the Linux Foundation Energy GitHub org by the end of the year.

The screenshot shows the GitHub repository page for `cupid-project/Legacy-Protocol-Converter`. The repository is public and has 42 commits, 1 branch, and 5 tags. The main content area displays a list of files and folders with their commit dates:

File/Folder	Description	Commit Date
<code>config-examples</code>	Updated Readme.md and sample configuration file	5 months ago
<code>docs</code>	Add files via upload	4 months ago
<code>log-config</code>	Logging supported in configuration. Modbus supports uint ...	7 months ago
<code>transformation-framework</code>	Added NTP server synchronization and cron based start of in...	3 months ago
<code>.gitignore</code>	Added dynamic reloading of configuration files.	last year
<code>Dockerfile</code>	Code refactoring, adding comments and pymodbus library o...	5 months ago
<code>LICENSE</code>	Create LICENSE	last year
<code>Readme.md</code>	Merge pull request #6 from Horizont-Europe-Interstore/feat...	3 months ago
<code>legacy-protocol-converter.jar</code>	Code refactoring, adding comments and pymodbus library o...	5 months ago
<code>pom.xml</code>	Added NTP server synchronization and cron based start of in...	3 months ago
<code>pymodbus_script.py</code>	Code refactoring, adding comments and pymodbus library o...	5 months ago

The right sidebar shows repository statistics: 0 stars, 1 watching, 0 forks. The README section is partially visible, titled "Legacy Systems Protocol Converter for IEEE2030.5".



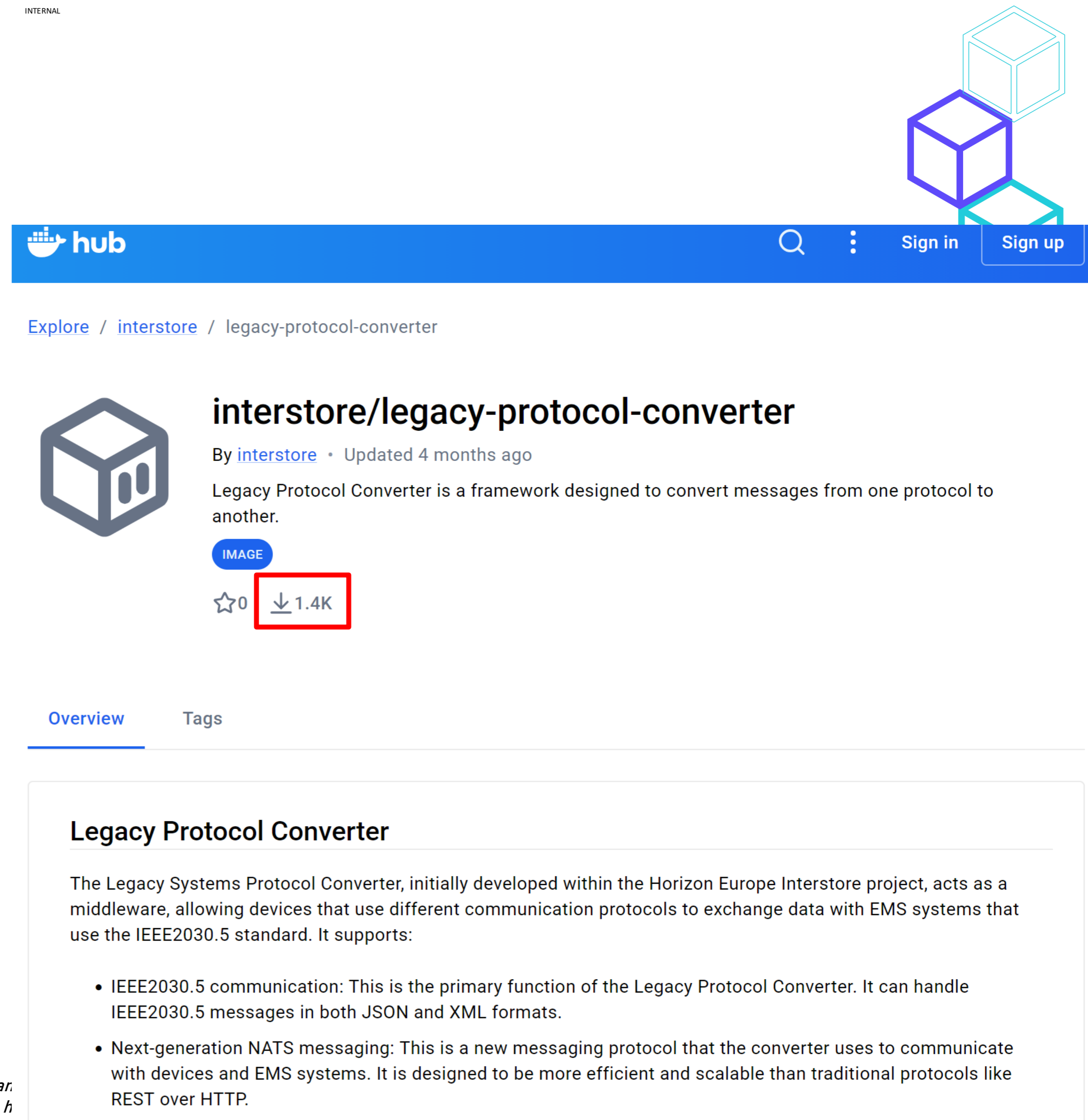
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Docker Hub

LPC has pre-build images on Docker Hub:
<https://hub.docker.com/u/interstore>

Using Docker Hub images is the fastest way to start using LPC. It only requires one command:
`docker pull interstore/legacy-protocol-converter`

Note: you also need to define the mapping, as shown before.




The screenshot shows the Docker Hub interface for the repository `interstore/legacy-protocol-converter`. The page includes a navigation bar with the Docker Hub logo, a search icon, and links for "Sign in" and "Sign up". Below the navigation bar, the breadcrumb path is "Explore / interstore / legacy-protocol-converter". The repository name is displayed prominently, along with the author "interstore" and the update date "Updated 4 months ago". A description states: "Legacy Protocol Converter is a framework designed to convert messages from one protocol to another." Below the description, there is a blue "IMAGE" badge, a star icon with "0", and a download icon with "1.4K" (highlighted with a red box). The page has two tabs: "Overview" (selected) and "Tags". The "Overview" tab contains the title "Legacy Protocol Converter" and a detailed description: "The Legacy Systems Protocol Converter, initially developed within the Horizon Europe Interstore project, acts as a middleware, allowing devices that use different communication protocols to exchange data with EMS systems that use the IEEE2030.5 standard. It supports:" followed by a bulleted list of supported protocols.

INTERNAL

hub

Explore / interstore / legacy-protocol-converter

 **interstore/legacy-protocol-converter**

By [interstore](#) • Updated 4 months ago

Legacy Protocol Converter is a framework designed to convert messages from one protocol to another.

IMAGE

☆ 0 ↓ 1.4K

Overview Tags

Legacy Protocol Converter

The Legacy Systems Protocol Converter, initially developed within the Horizon Europe Interstore project, acts as a middleware, allowing devices that use different communication protocols to exchange data with EMS systems that use the IEEE2030.5 standard. It supports:

- IEEE2030.5 communication: This is the primary function of the Legacy Protocol Converter. It can handle IEEE2030.5 messages in both JSON and XML formats.
- Next-generation NATS messaging: This is a new messaging protocol that the converter uses to communicate with devices and EMS systems. It is designed to be more efficient and scalable than traditional protocols like REST over HTTP.



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interstore

Open-source IEEE 2030.5 Testing Software based on SunSpec Testing Procedures

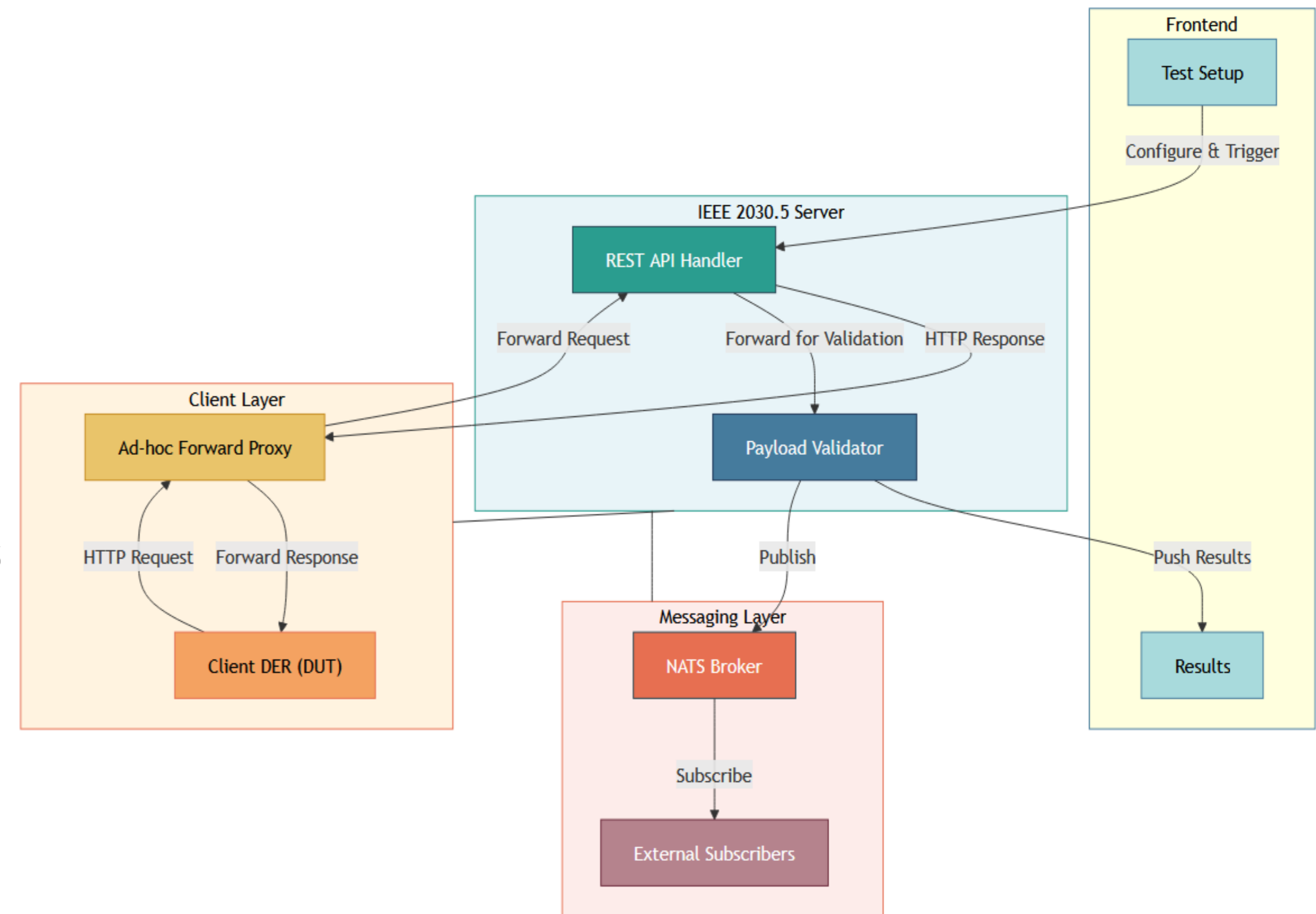
Nithin Manuel, Alessandra Martino



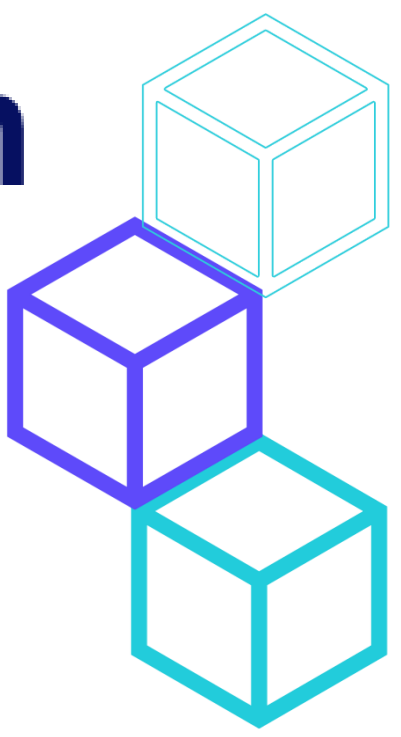
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Testing Software Architecture

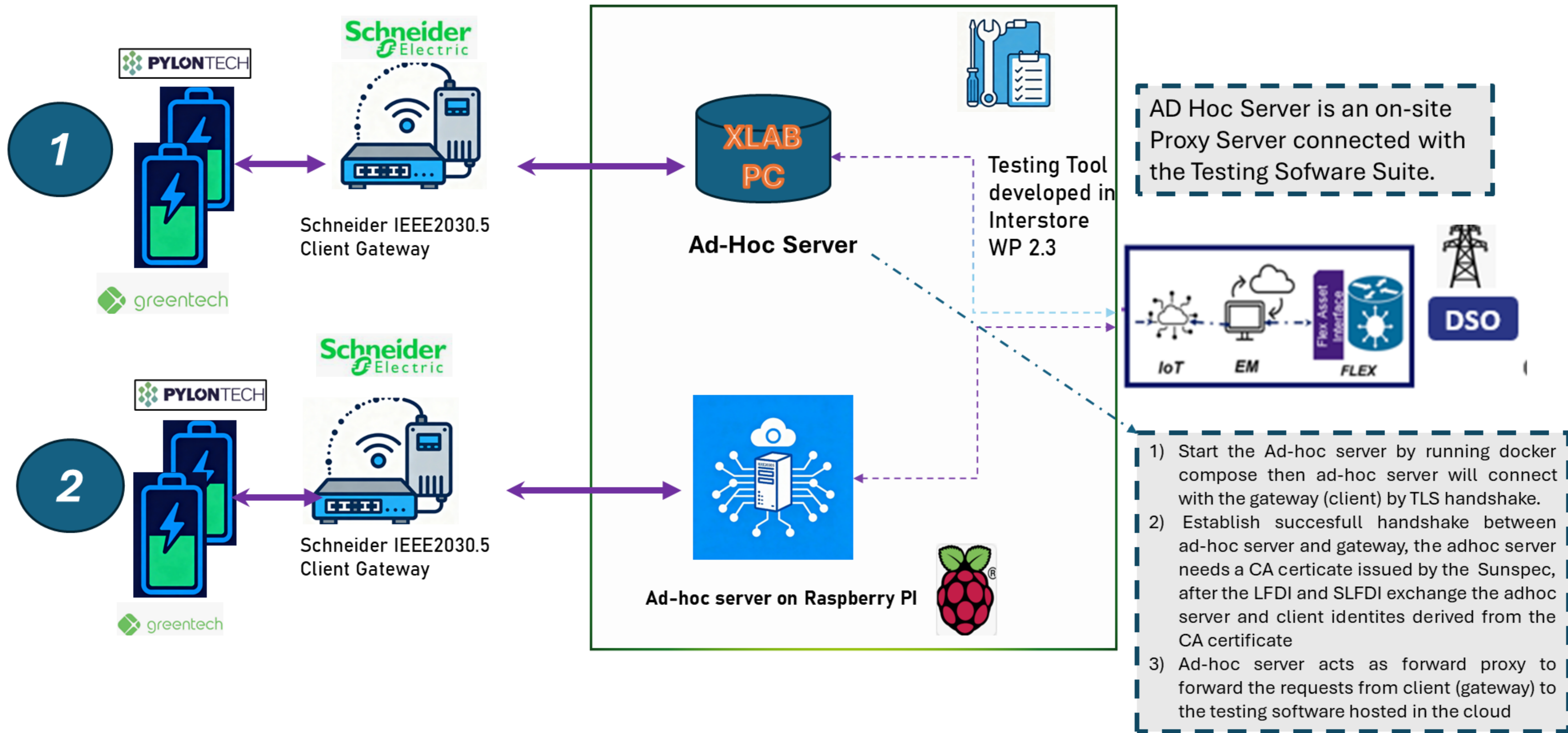
- The Test Set up will add the details of the devices under test from it's UI
- Ahdoc server forwards Proxy initiates/handles the communication from DER (DUT)
- IEEE 2030.5 server handles incoming requests and the response is sent in two channels
- Validator validates the request and response compares it with SunSpec testing procedures, depicts in Results
- Client receives the response from IEEE 2030.5 server
- Results are published via NATS for other actors such as EMS or platforms



Interstore project - Italian Pilot - IEEE2030.5 Implementation

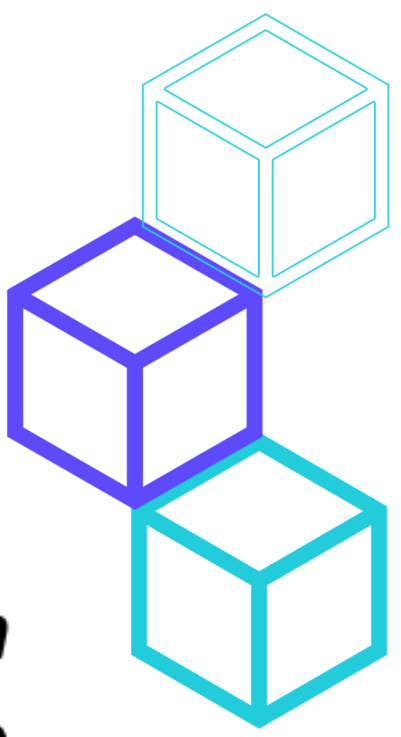


IEEE2030.5 Client-Server integration: Architecture implemented in XLAB



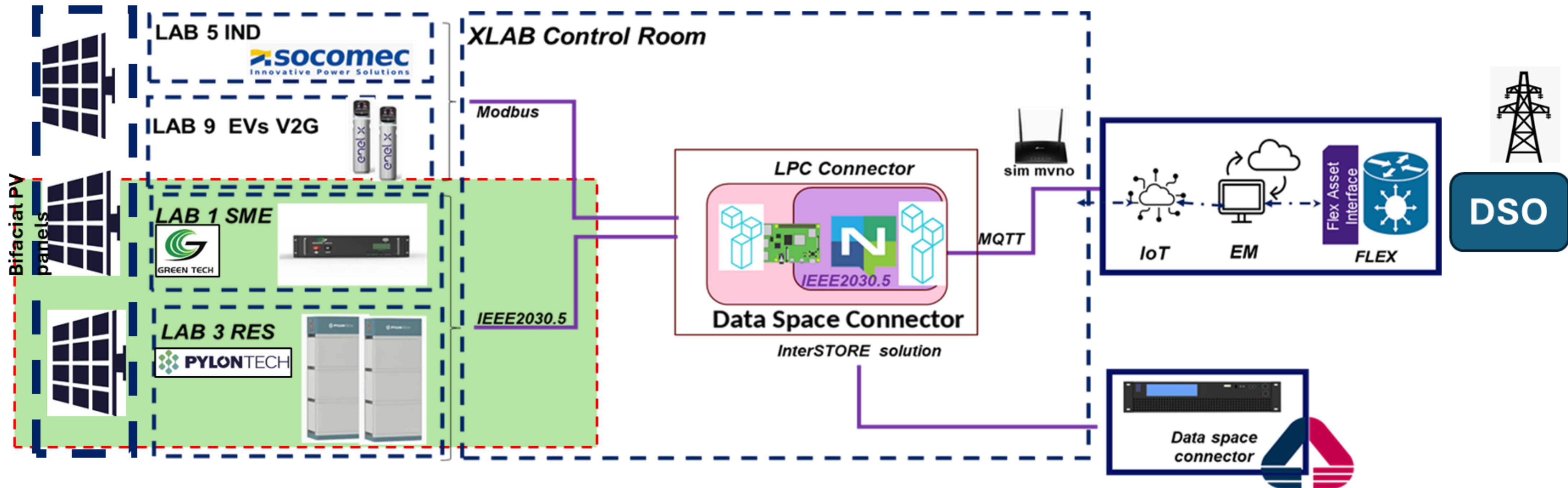
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Interstore project - Italian Pilot - Uses Case 9



- Use case 9 development to provide (E2E) Flexibility services to the Network (DSO) using different types of Asset (**PV, Ind. and Res. Storage, EV chargers**)

- **Implementation Client-Server integration in IEEE2030.5 Protocol** in Test Environment to implement Flex Use case with Legacy Protocol Converter SW tool development



The architecture realized in ENELX LAB to implement E2E process for Flex Energy Services to DSO



Interstore project - Italian Pilot XLAB Rome - UseCase 9

Management of EV charging clusters as HESS

Key aspects:

- ✓ Test of local ancillary services for DSO
- ✓ EV V2G Chademo chargers, PVs System, different size (Li-Ion) Batteries, Supercap
- ✓ Monitoring and control aggregated loading area
- ✓ Integration of IEEE2030.5 native Client device-Server
- ✓ Test IEEE2030.5 Client-Server Integration

1- EV-V2G CHAdEMO



2- PV-inverter



3- XLAB Control Room



7 - XLAB Photovoltaic shelter in EV parking



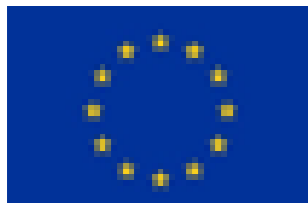
6- RES Battery- Pylontech- IEEE2030.5XWPRO Gateway



5- C&I Battery- GREENTECH



4- Utility scale Battery-SOCOMEK



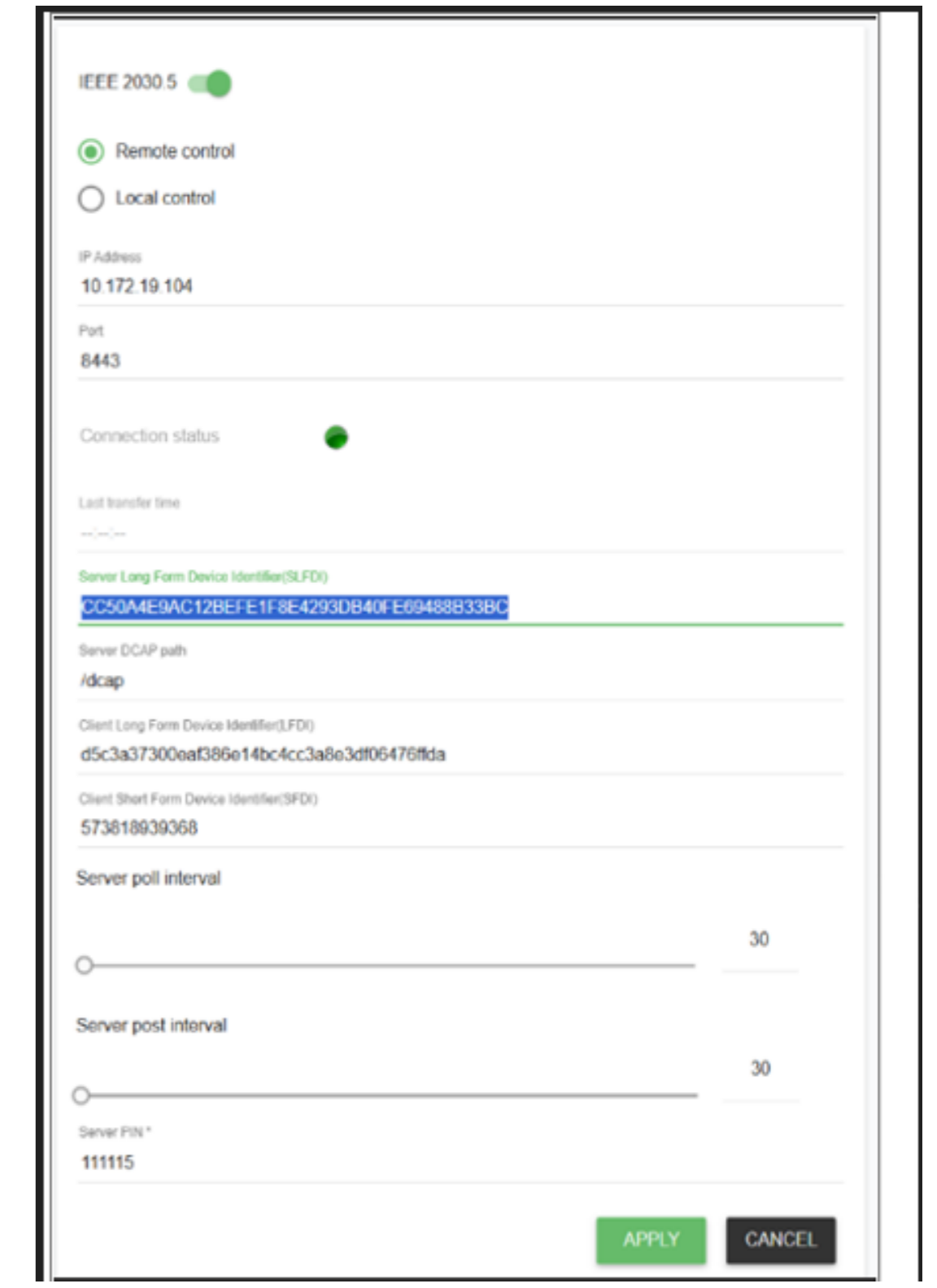
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Software in the Loop

- An open source Epru IEEE 2030.5 Client chosen as Client instead of real device
- Supports both both NATS and REST with self signed certificates
- Supports both one by one of resource testing and multiple resources on single test

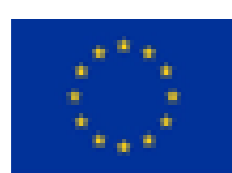
Power Hardware in Loop

- Tested device is XW pro Schinder Inverter in Enel X lab
- CA certificates from SunSpec is a must in Testing
- Testing Software Hosted in Linux computer
- XW pro will change it status from red to green upon successful connection



Epru IEEE 2030.5 Client software hosted in cloud

XW pro gateway in Enel X Lab on premise device



Testing Software in Action Configuration on Server Side



IEEE 2030.5 Test Configuration

Configure and store test parameters for IEEE 2030.5 conformance testing

[View Test Results →](#)

Device Capability & End Device

Basic device configuration and registration

8 TESTS

Device Capability

Get All End Devices

Create End Device

Get An End Device

Register End Device

Get Registered End Device

Time

Advanced Time

Function Sets and DER

Function set assignments and DER management

6 TESTS

DER Programs

DER program configuration and controls

8 TESTS

DER Capability and Settings

Advanced DER capabilities and settings

3 TESTS

Create End Device

DEVICE CAPABILITY & END DEVICE

CACHED



Reset

Save Configuration

Part 1: Basic Device Setup

Lfdi

c63fb011cd6be6951d36b85a6261566d316af3c2

Device Category

1

Sfdi

532170017563

Registration Link

rg

Function Set Assignment Link

fsa

Subscription Link

sub

Device Status Link

dstat

End Device List Link

edev

DER List Link

der



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Testing Results

Test Results & XML Validation

Compare device responses with expected server payloads

[Auto-Refresh ON](#) [Refresh Now](#) [Clear All](#) [← Back to Tests](#)

8 Total Tests	8 Passed	0 Failed	100% Success Rate
-------------------------	--------------------	--------------------	-----------------------------

✓ VALID GET `edev/{endDeviceID}/rg`
2/3/2026, 3:36:34 pm

XML Comparison ▼

✓ VALID GET `edev/{id}/fsa`
2/3/2026, 3:36:35 pm

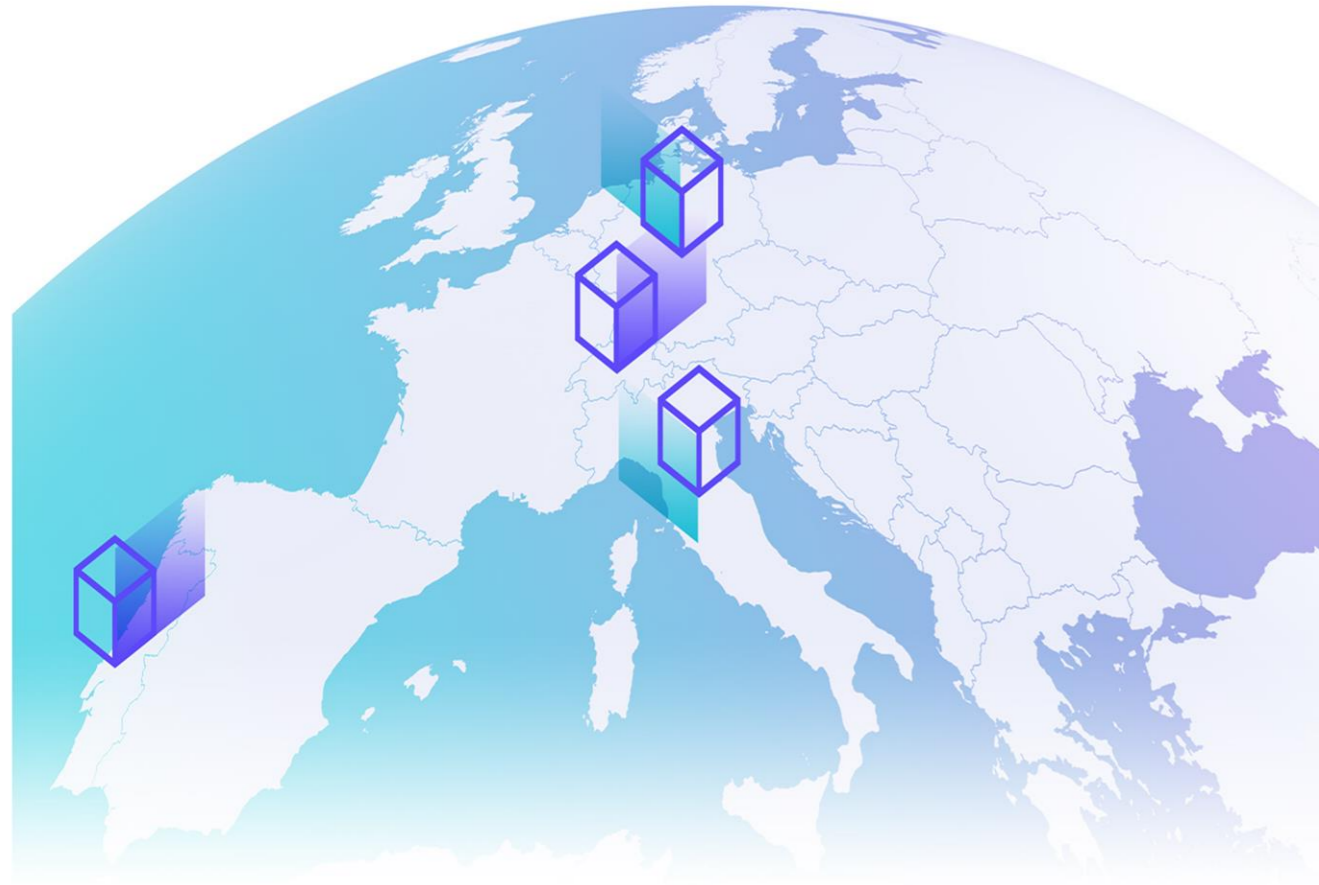
XML Comparison ▲

Expected XML (Server)

```
<FunctionSetAssignmentsList xmlns="urn:ieee:std:2030.5:ns" all="2" href="/edev/3/fsa1" results="2" subscribable="0">
  <FunctionSetAssignments href="/edev/3/fsa1/0" subscribable="0">
    <DemandResponseProgramListLink all="2" href="/edev/3/fsa1/0/drpl"/>
    <MessagingProgramListLink all="1" href="/edev/3/fsa1/0/msg1"/>
    <nRID>0ED38F5A0000</nRID>
    <description>FunctionSetAssignment Suave</description>
  </FunctionSetAssignments>
  <FunctionSetAssignments href="/edev/3/fsa1/1" subscribable="0">
    <MessagingProgramListLink all="1" href="/edev/3/fsa1/1/msg1"/>
    <nRID>0ED38F5A0001</nRID>
    <description>FunctionSetAssignment Guttural</description>
  </FunctionSetAssignments>
</FunctionSetAssignmentsList>
```

Actual XML (Device Response)

```
<FunctionSetAssignmentsList xmlns="urn:ieee:std:2030.5:ns" all="1" href="/edev/1/fsa" results="1" subscribable="0">
  <FunctionSetAssignments href="/edev/1/fsa/1" subscribable="1">
    <UsagePointListLink href="//edev/1/fsa/1/upt" all="0"/>
    <DERProgramListLink href="/derp" all="1"/>
    <DemandResponseProgramListLink href="//edev/1/fsa/1/dr" all="0"/>
    <TariffProfileListLink href="//edev/1/fsa/1/tp" all="0"/>
    <FileListLink href="//edev/1/fsa/1/file" all="0"/>
    <nRID>0ED38F5A0000</nRID>
    <description>example of Function set assignment</description>
  </FunctionSetAssignments>
</FunctionSetAssignmentsList>
```



interstore

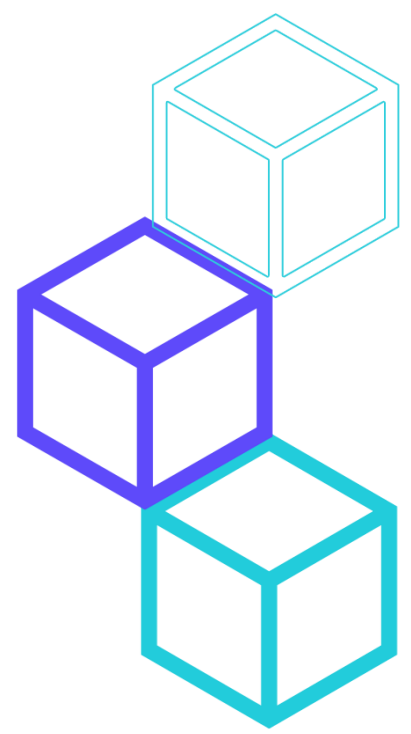
Architectures and environments tested, lessons
learned and main KPIs reached

Daniele Carta



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Architectures and environments tested, lessons learned and main KPIs reached – Austrian pilot

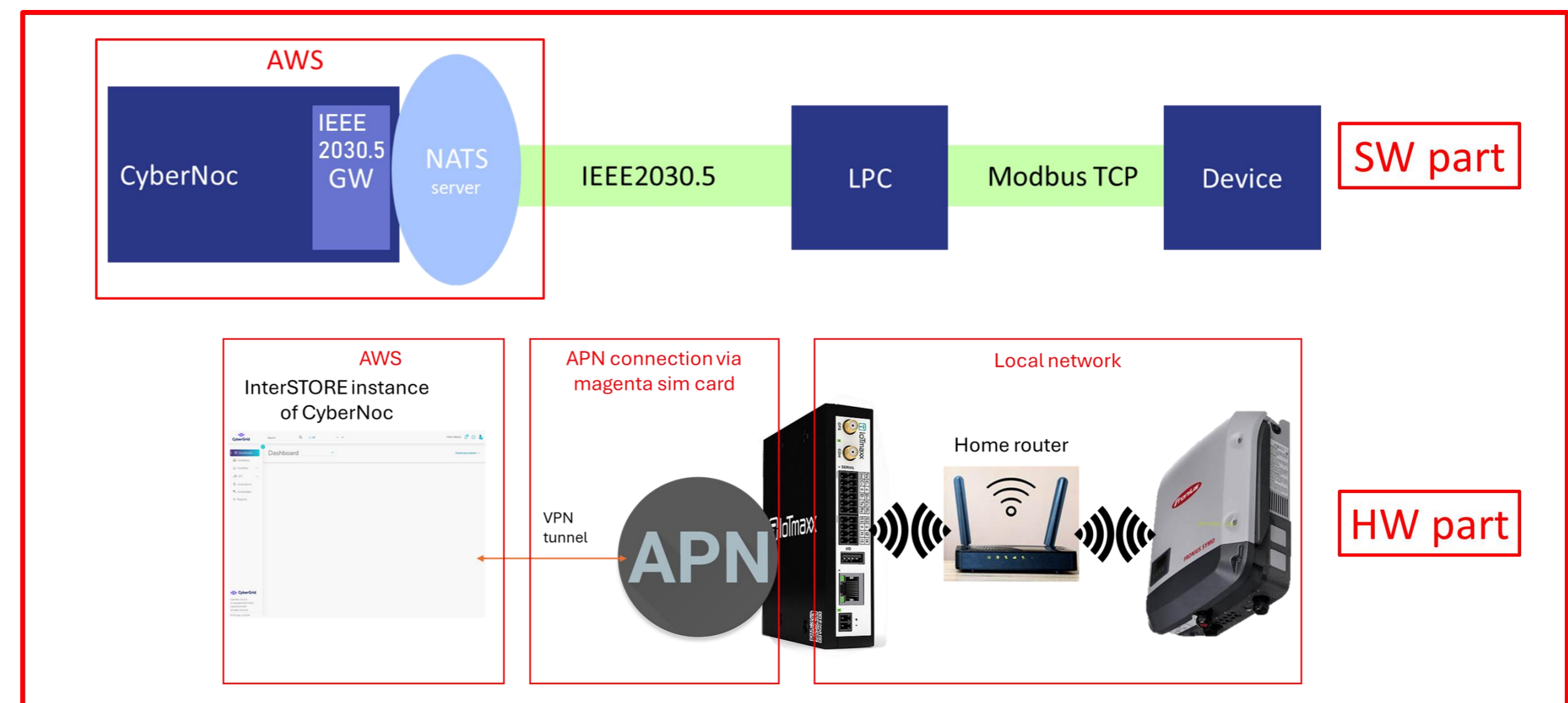


Use cases

- ❖ UC1: DES Flexibility Market Monetisation
- ❖ UC2: Energy Community DES Utilisation

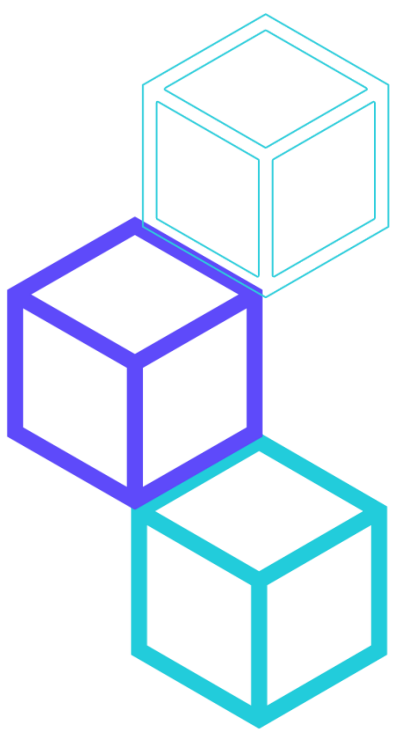
Key aspects

- ❖ Local energy community
- ❖ Monitoring and control
- ❖ Multi-vendor inverters
- ❖ Cellular communication infrastructure



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Architectures and environments tested, lessons learned and main KPIs reached – German pilot

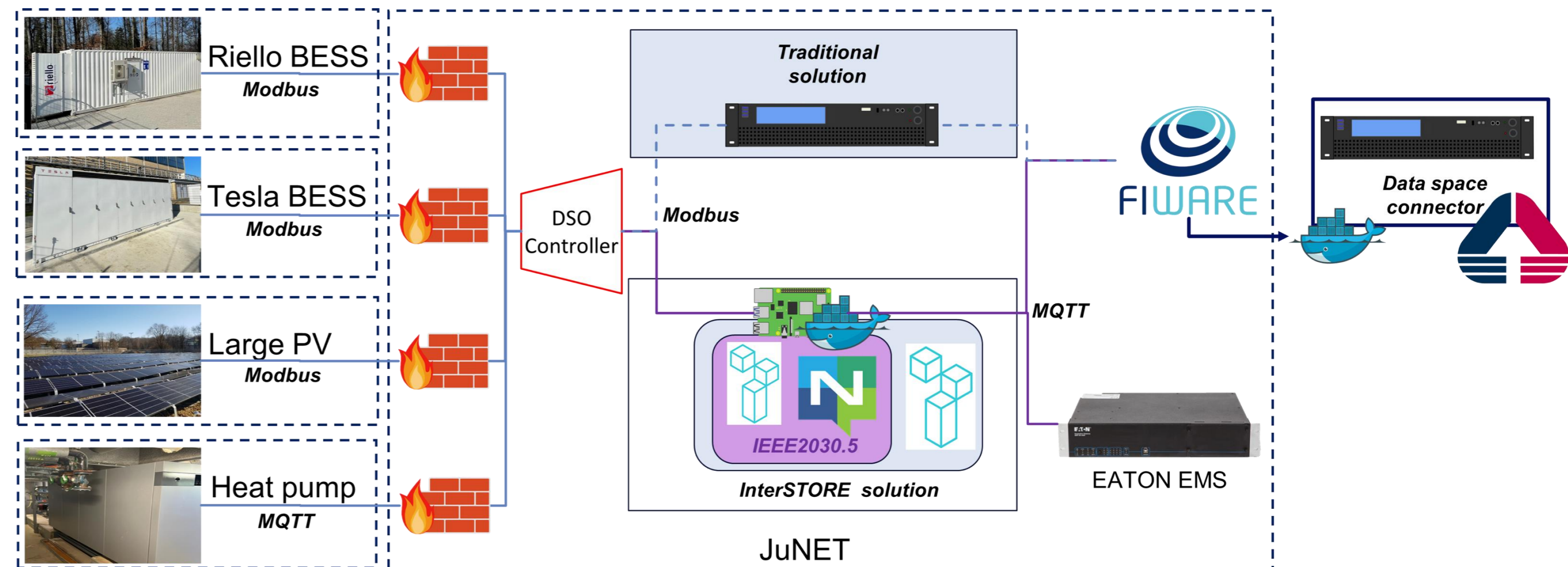


Use cases

- ❖ UC3: Grid-supporting Battery Energy Storage Systems (BESS)
- ❖ UC8: Multiphysics flexibility optimisation for Home Management Systems and their global integration

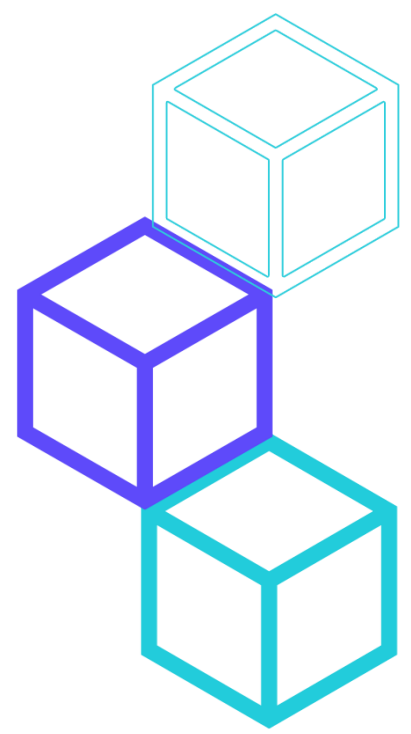
Key aspects

- ❖ Multi-physics and large-scale systems
- ❖ Monitoring and control
- ❖ LPC implementation on low-cost hardware
- ❖ Analysis of deployment and commissioning times



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Architectures and environments tested, lessons learned and main KPIs reached – Italian pilot

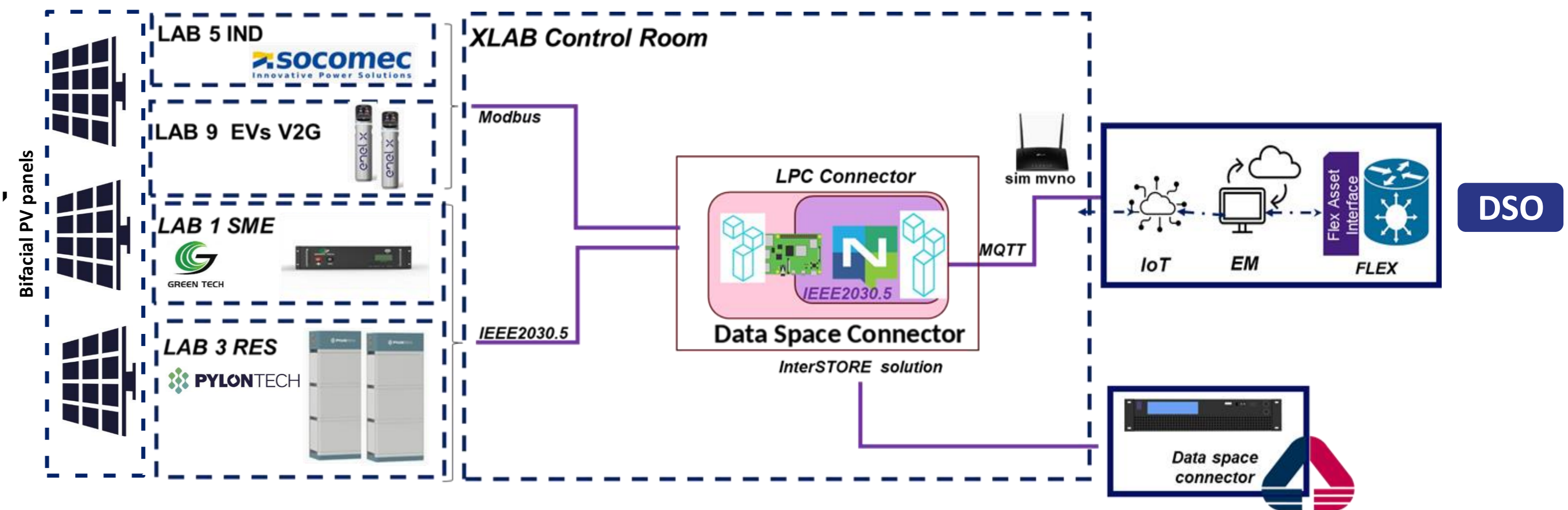


Use cases

- ❖ UC9: Management of EV charging clusters as Hybrid Energy Storage Systems (HESS)

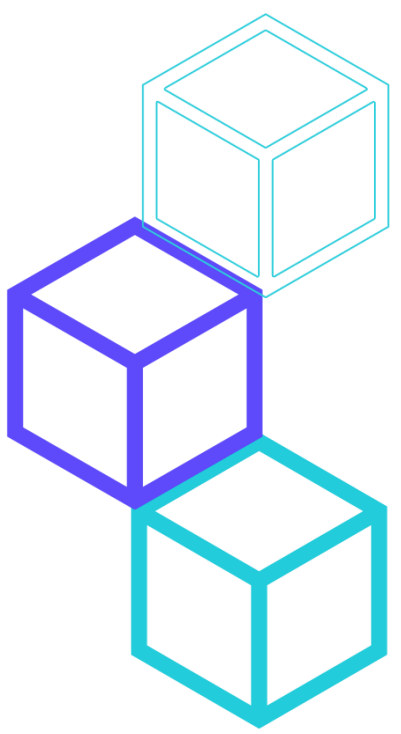
Key aspects

- ❖ Hybrid storage (EV charging clusters, batteries, supercapacitors, PV)
- ❖ Monitoring and control
- ❖ Provision of local ancillary services for DSO
- ❖ Native IEEE 2030.5 integration



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Architectures and environments tested, lessons learned and main KPIs reached – Portuguese pilot

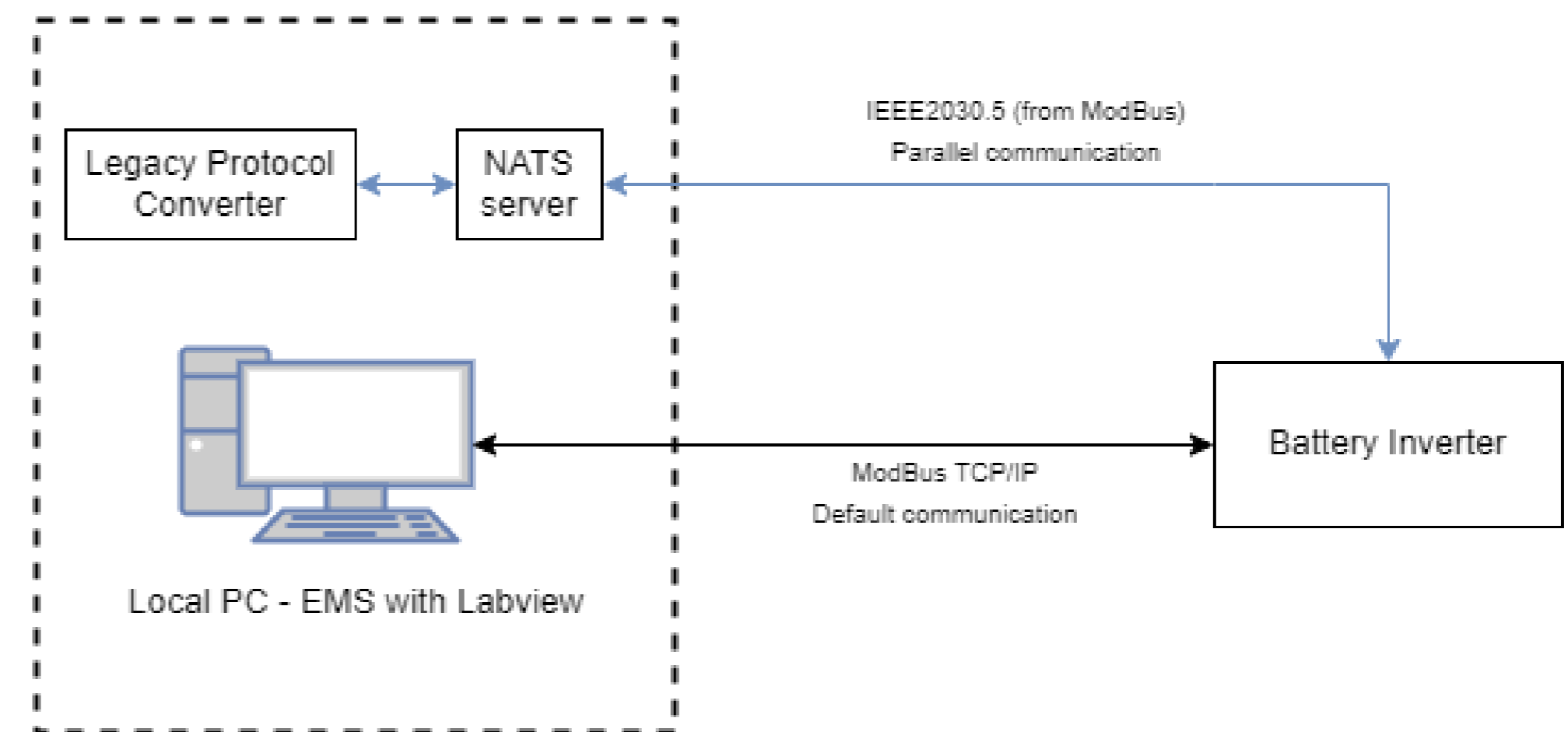


Use cases

- ❖ UC5: Hybrid storage higher performance and flexibility provision
- ❖ UC6: Management of battery systems for node capacity increase and user demand response

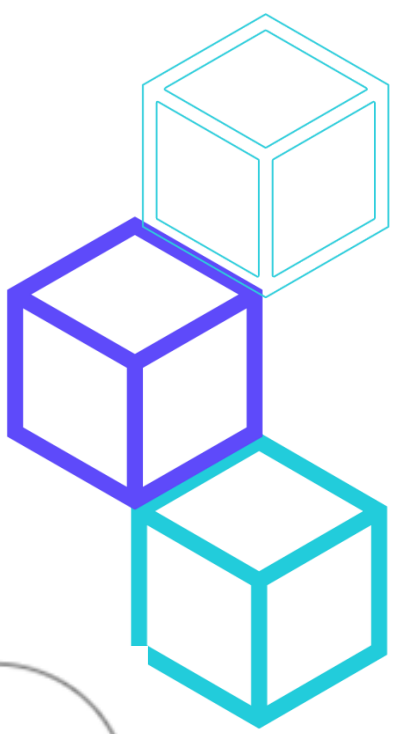
Key aspects

- ❖ Hybrid battery systems (multi-technology and second-life)
- ❖ Monitoring via LPC
- ❖ Control using LabVIEW
- ❖ Industrial demand response (node capacity increase) and EV driver engagement



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Architectures and environments tested, lessons learned and main KPIs reached – Spanish laboratory

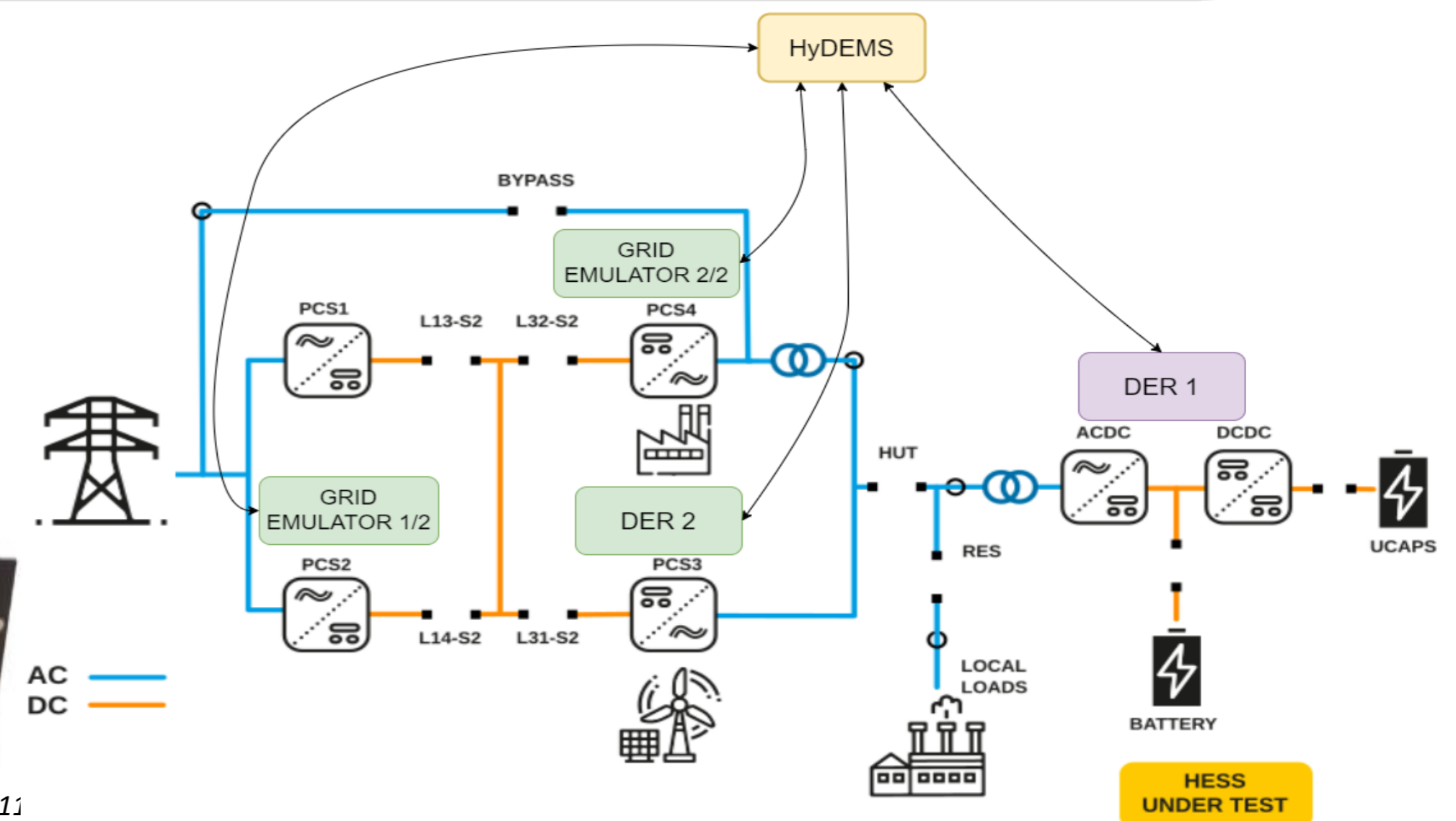
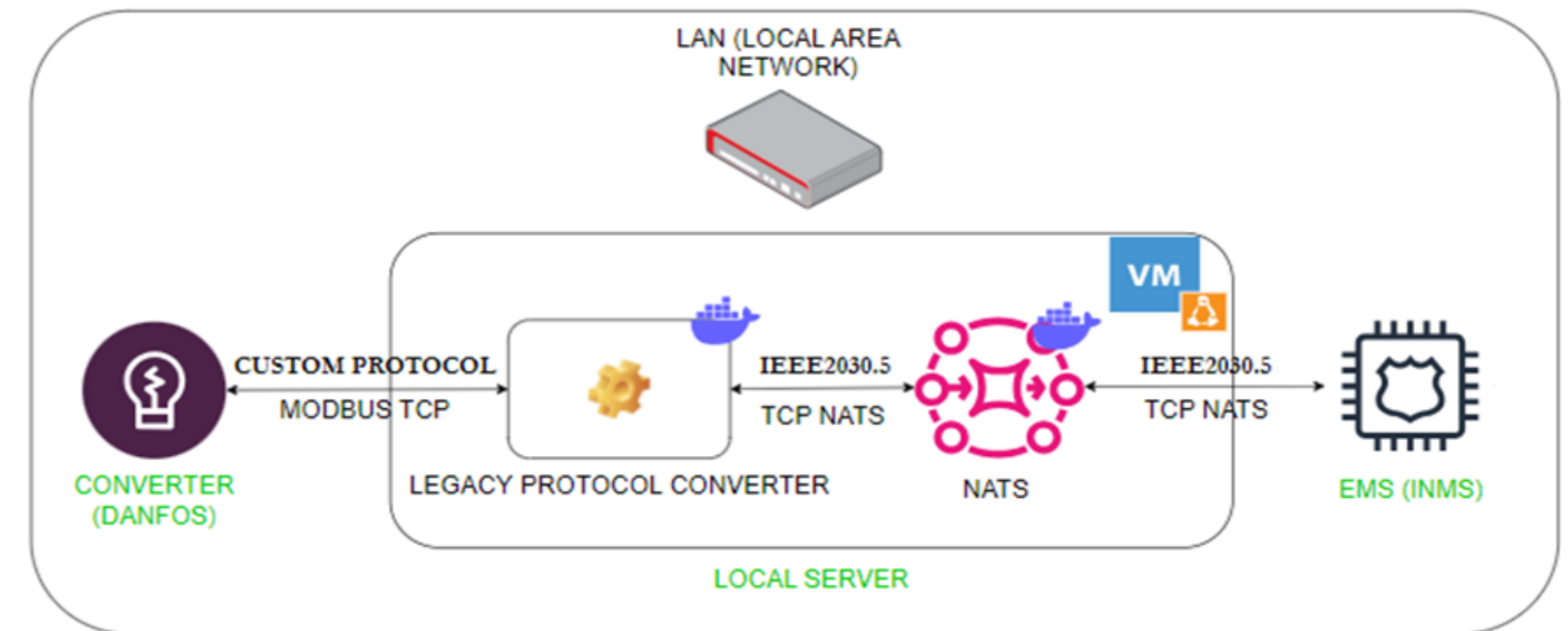


Use cases

- ❖ UC4: Innovative frequency services
- ❖ UC7: Adaptive BESS management for autonomous grid operation

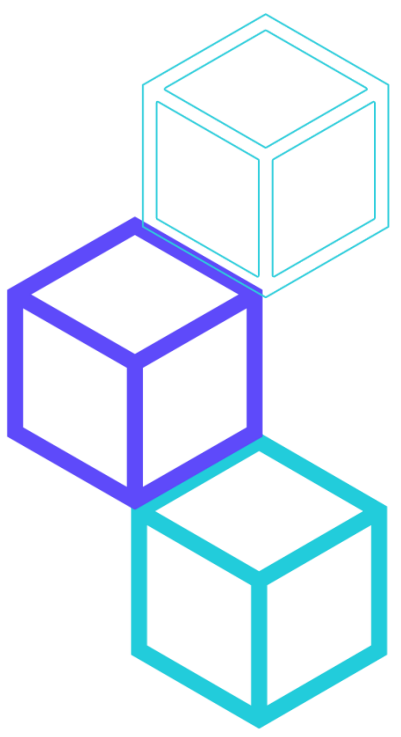
Key aspects

- ❖ Fast frequency services and autonomous grid operation
- ❖ Monitoring and control
- ❖ LPC response time analysis



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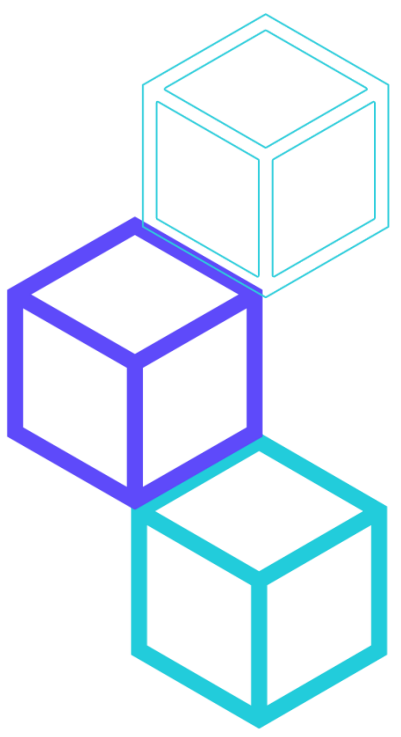
Architectures and environments tested, lessons learned and main KPIs reached – Main KPIs



KPI ID	KPI Name	Relevant Use Cases	Actual Value (Project level)	Target Value (Project level)	Status
3	Battery capacity	All	3.94	≥ 0.2 MWh	Achieved
4	Diversity of DER	All	33.00	≥ 25 n.n.	Achieved
5	Asset management monitored by EMS	All	62.00	≥ 50 n.n.	Achieved
7	Number of end users involved in HESS	3, 5, 6, 8, 9	30.00	≥ 20 n.n.	Achieved
10	Number of DER assets and EMS tested with IEEE2030.5	1, 2, 3, 5, 7, 8, 9	21.00	≥ 10 n.n.	Achieved
11	Data space digitized assets	1, 2, 3, 5, 7, 8, 9	93.55	≥ 50 %	Achieved
17	Data Valorisation cases	3, 5, 8 and 9	4.00	4	Achieved
19	Data Spaces	3, 5, 8 and 9	2713.00	≥ 20	Achieved
25	Integrated capacity	All	4.24	≥ 1 MWh	Achieved
26	Increase of flexibility	All	75.48	> 20 %	Achieved



Architectures and environments tested, lessons learned and main KPIs reached – lessons learned



LPC

- ❖ Ease of deployment via GUI, also for not-expert users
 - ❖ Reduction of deployment times (i.e., KPI 9 -> 14% of traditional solution)
 - ❖ Reduction of installation costs (i.e., KPI 8 -> 42 €/kWh)
- ❖ Light-weight and flexible solutions for various frameworks
 - ❖ Can be deployed on low-cost hardware (Rpi 4b) with a limited usage of resources (<30% CPU)
 - ❖ Can be integrated in high-demanding frameworks with small time delays (i.e., KPI 14 -> 0.25 sec.)

Services for users and system operators derived from the integration and coordination

- ❖ DERs from various manufacturers, different technologies, and different scales, can be integrated (i.e., KPI 3,4,5,25)
- ❖ Peak load consumptions can be reduced (i.e., KPI 9 -> 40% of reference)
- ❖ Node capacity can be increased without replacing cables/transformers (i.e., KPI 6 -> +20% of reference)





interstore

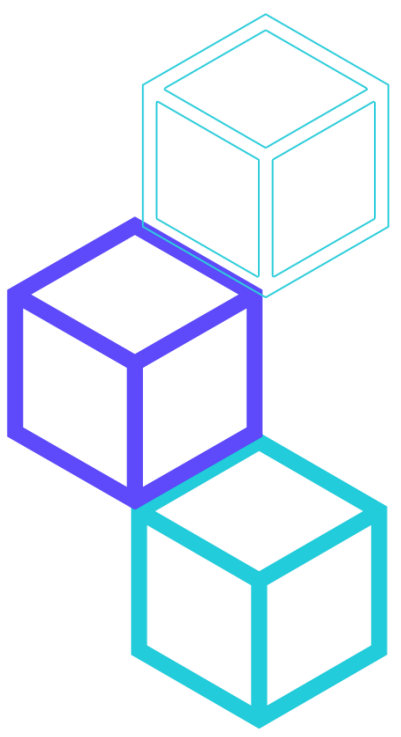
Practical example of the IEEE 2030.5 (client/server library) and LPC implementation on EMS and REC sides

Nikolaj Candellari



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Austrian Energy Communities

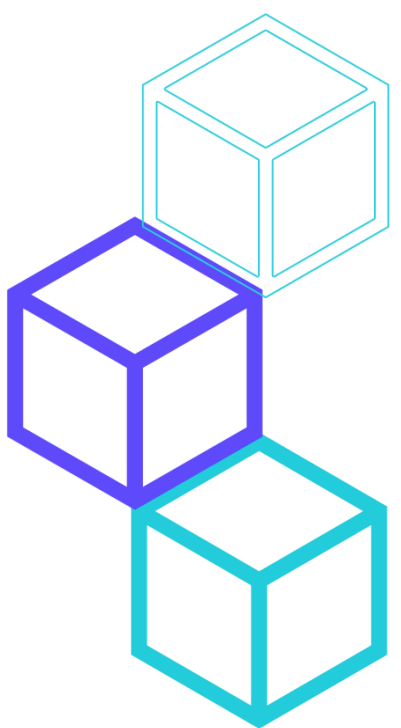


Over 4000 Communities in operation (3650 RECs & 685 CECs)

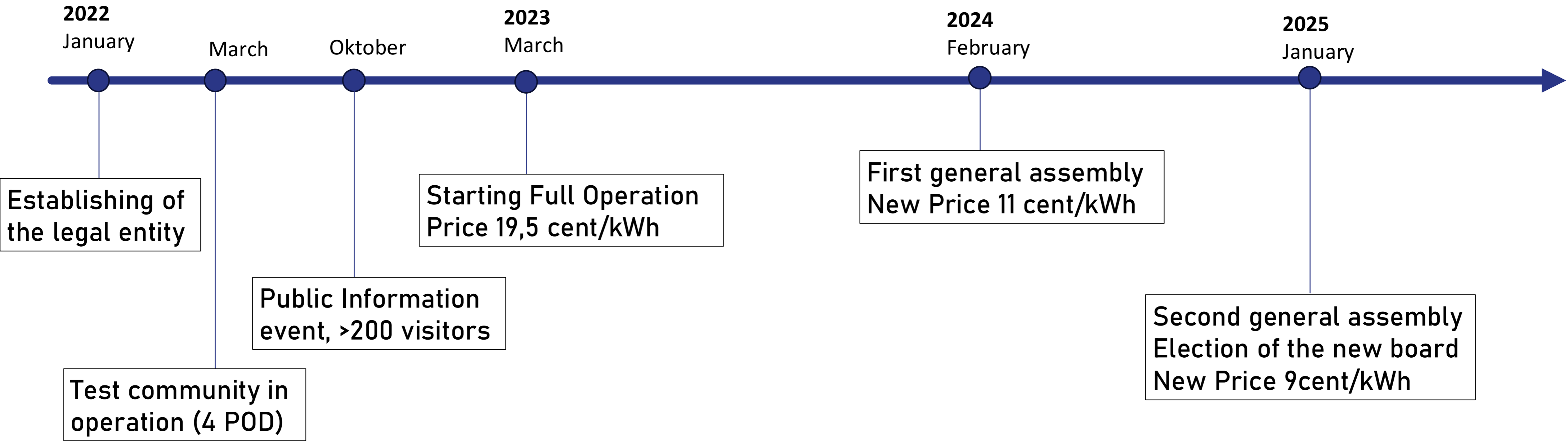
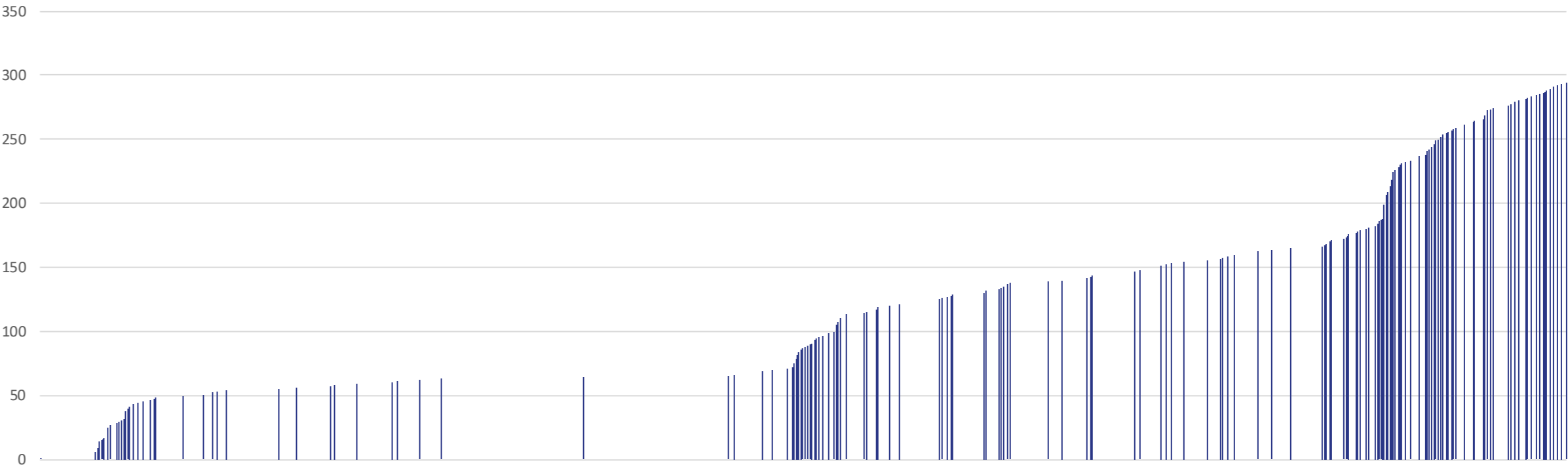
- ❖ Features of the communities:
 - ❖ Incentives: grid fee and tax discounts (if members are connected to the same substation or transformer)
 - ❖ Community as a legal entity
 - ❖ Energy price defined by members of the community
- ❖ Energy allocation through the DSOs
 - ❖ DSO is sending the energy data of member to the REC on the following day in a 15min resolution
 - ❖ Smart Meter are necessary, in Austria already over 95% share



Austrian Pilot - Dietach

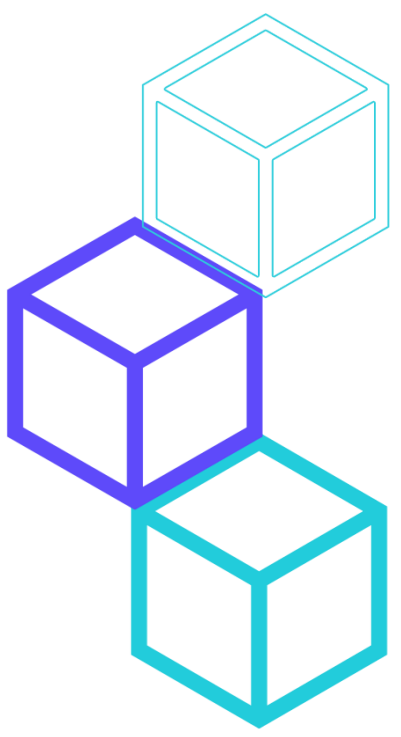


Development of the REC Dietach



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Austrian Pilot - Dietach



Our members

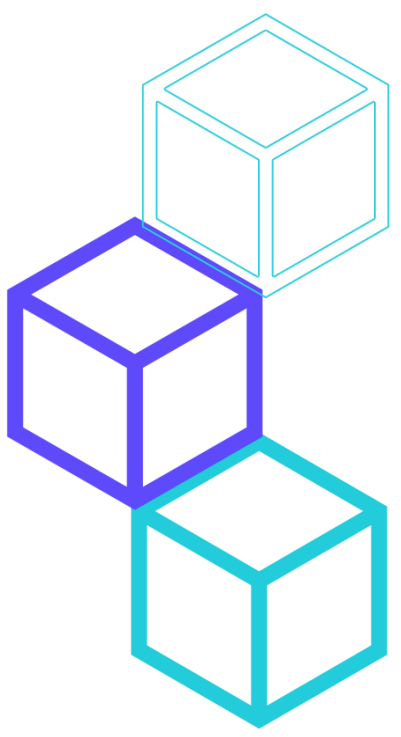
- ❖ Almost 300 members
- ❖ 175 PV Systems with 2846 kWp
- ❖ Yearly overall consumption of 3 000 000 kWh

- ❖ Biggest consumers: Restaurants, Cinema, Water Pump station, ...
- ❖ Biggest producers: buildings of the municipality, farmers
- ❖ Most members live in one family houses

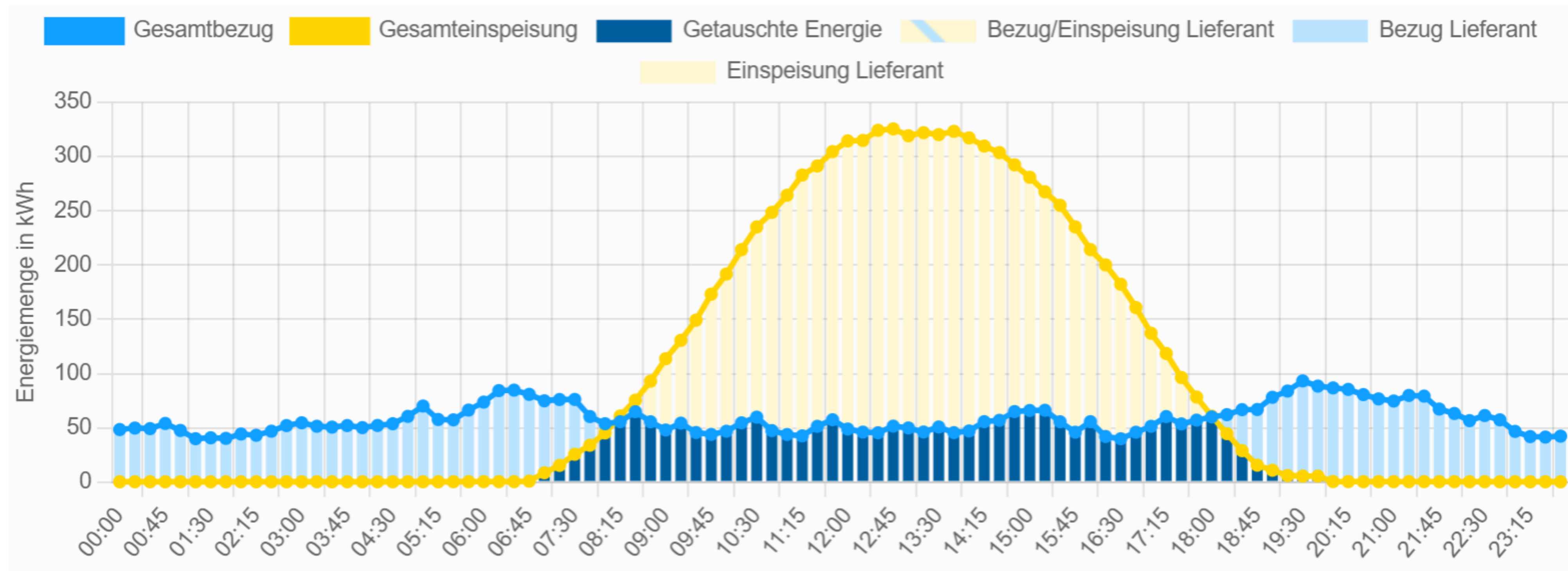


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Austrian Pilot - Dietach

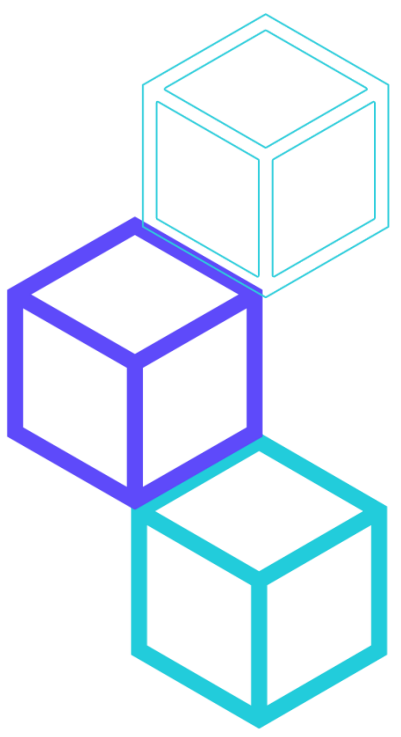


Current Challenges



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Austrian Pilot - Dietach



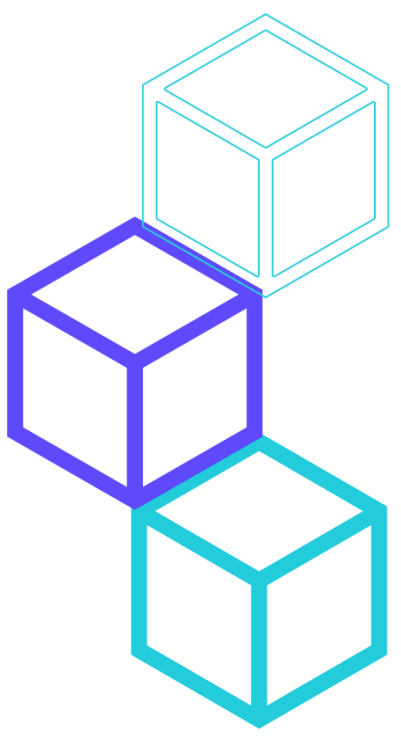
Benefits from the Project of InterSTORE

- ❖ Real time monitoring of production and consumption
 - ❖ Members can see, where their electricity is coming from (REC or their energy supplier)
- ❖ Overview of the devices of the members
- ❖ Possibility to change the behavior of devices
 - ❖ Delay the charging of household batteries

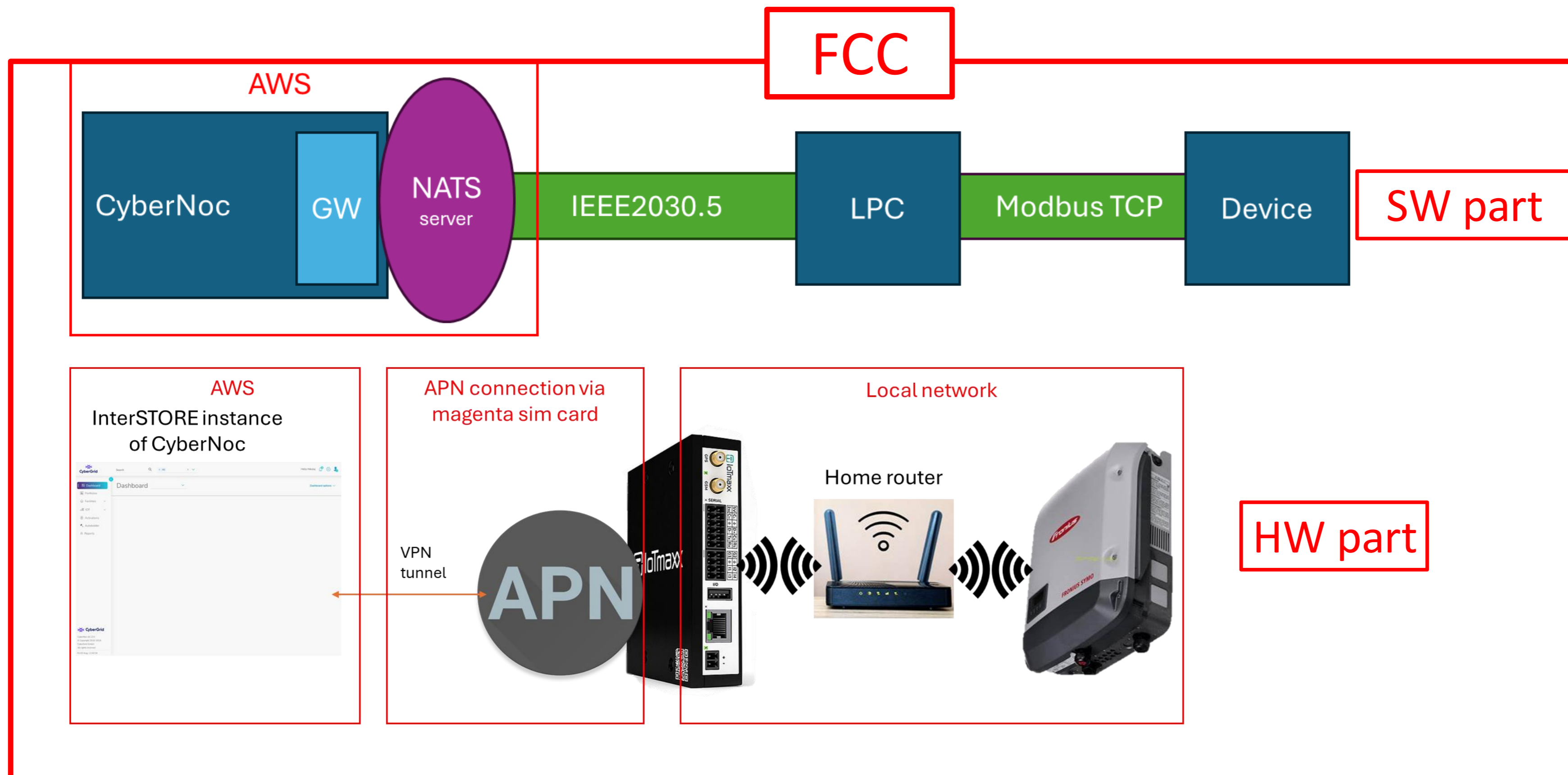


Austrian Pilot – High Level view of connection

Full chain communication – FCC

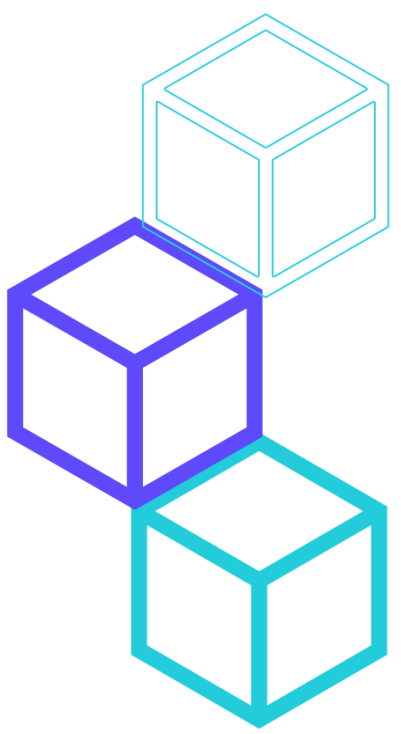


CyberGrid connected 20 DER from REC Dietach.

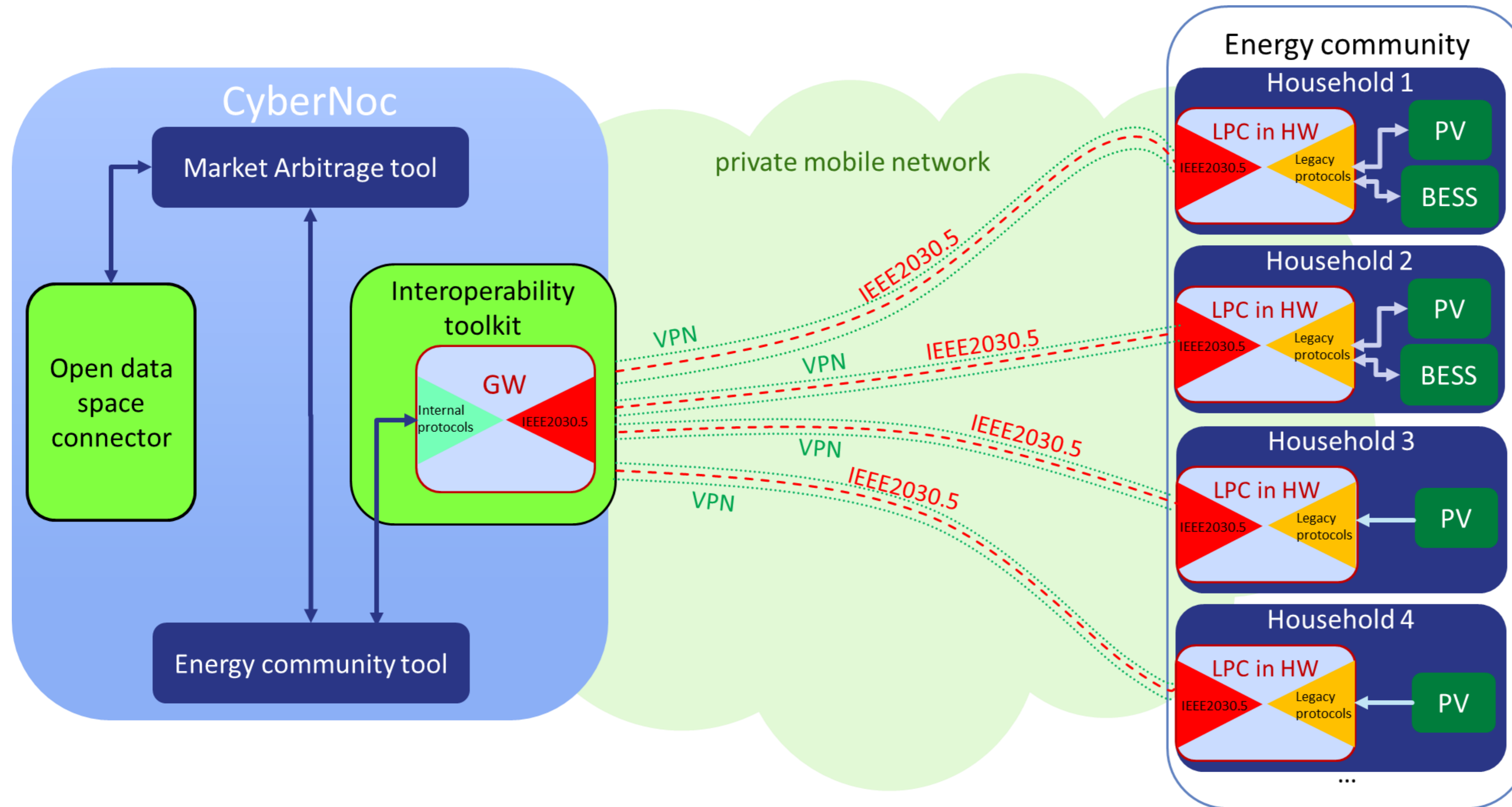


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Austrian Pilot – High level view of connection

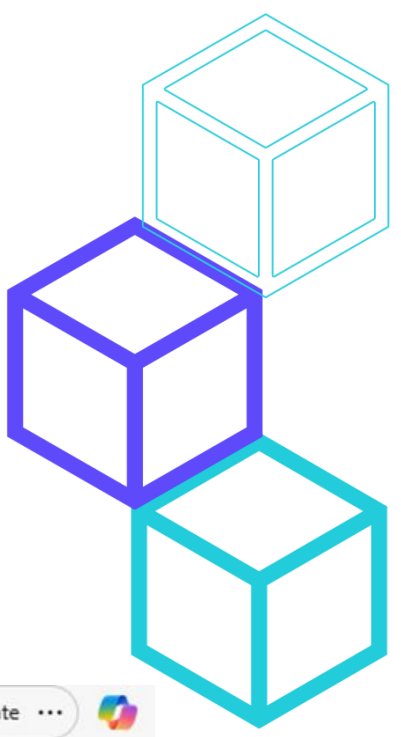


Connection of asset is secure, scalable and autonomous



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Austrian Pilot – UC1: DES Flexibility Market Monetisation



Goal: Maximization of energy produced with market participation

The main objectives of UC1 are to:

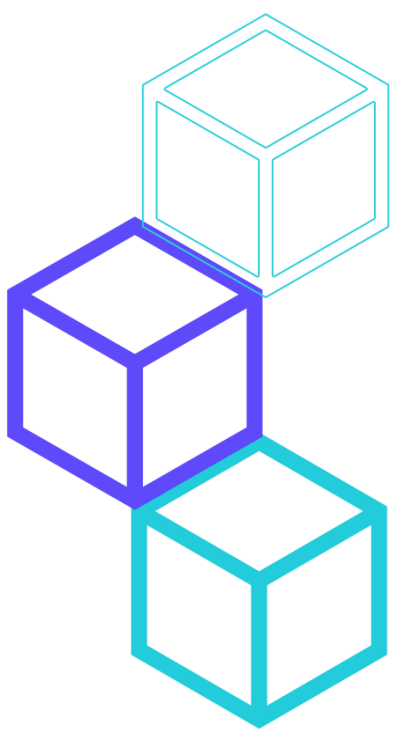
- ❖ Enable DER flexibility monetization through aggregation and market participation.
- ❖ Validate both the technical and economic feasibility of market participation for residential assets.

Device Name	Description	Gateway Type	Connection	Created	Updated
02.08 - Fronius ...	192.168.178.117 Symo	IEEE 2030.5	Online	04/09/2025 19:38	01/11/2025 12:50
06.19 - Fronius ...	192.168.121.194 SYMO 10	IEEE 2030.5	Online	25/06/2025 19:24	02/11/2025 20:43
07.13 - Fronius ...	192.168.188.84 GEN24	IEEE 2030.5	Online	03/07/2025 17:20	31/10/2025 23:33
10.08 - Fronius ...	192.168.11.11 SYMO	IEEE 2030.5	Online	11/07/2025 15:12	04/11/2025 06:28
10.08 - Fronius ...	192.168.11.12 SYMO	IEEE 2030.5	Online	11/07/2025 15:12	04/11/2025 06:28
10.08 - Fronius S...	192.168.11.4 SYMO ModbusRTU->TCP->RTU because the inverter...	IEEE 2030.5	Offline	11/07/2025 15:12	08/10/2025 09:51
10.12 - Fronius ...	192.168.178.83 SYMO GEN24	IEEE 2030.5	Online	10/06/2025 18:50	31/10/2025 23:33
10.12 - Fronius ...	192.168.178.84 SYMO	IEEE 2030.5	Online	10/06/2025 18:50	31/10/2025 23:33
13.19 - Fronius ...	192.168.2.102 SYMO	IEEE 2030.5	Online	02/04/2025 09:51	31/10/2025 23:33
13.19 - Fronius ...	192.168.2.101 SYMO Hybrid	IEEE 2030.5	Online	02/04/2025 09:50	31/10/2025 23:33
15.12 - Fronius ...	192.168.178.27 SYMO	IEEE 2030.5	Online	02/06/2025 19:21	04/11/2025 06:25
19.07 - Fronius ...	192.168.1.116 GEN24	IEEE 2030.5	Online	03/07/2025 19:31	31/10/2025 23:33
19.07 - Fronius ...	192.168.1.177 SYMO	IEEE 2030.5	Online	03/07/2025 19:31	04/11/2025 06:25
23.23 - Fronius ...	192.168.31.99 SYMO	IEEE 2030.5	Online	11/06/2025 19:30	31/10/2025 23:33
Device for Cyber...		IEEE 2030.5	Offline	13/02/2025 15:28	13/02/2025 15:28
EngagePV/CellC...	BESS	IEEE 2030.5	Offline	30/10/2025 13:42	04/11/2025 13:11
EngagePV/CellC...	BESS	IEEE 2030.5	Online	15/10/2025 17:30	31/10/2025 23:33
SGL - Fronius SY...	192.168.8.111 SYMO	IEEE 2030.5	Offline	17/02/2025 13:24	29/10/2025 06:09
SGL - Fronius SY...	192.168.8.110 SYMO Hybrid; 5kW max charge/discharge power	IEEE 2030.5	Offline	17/02/2025 13:24	29/10/2025 06:09



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Austrian Pilot – UC2: Energy community DES utilisation

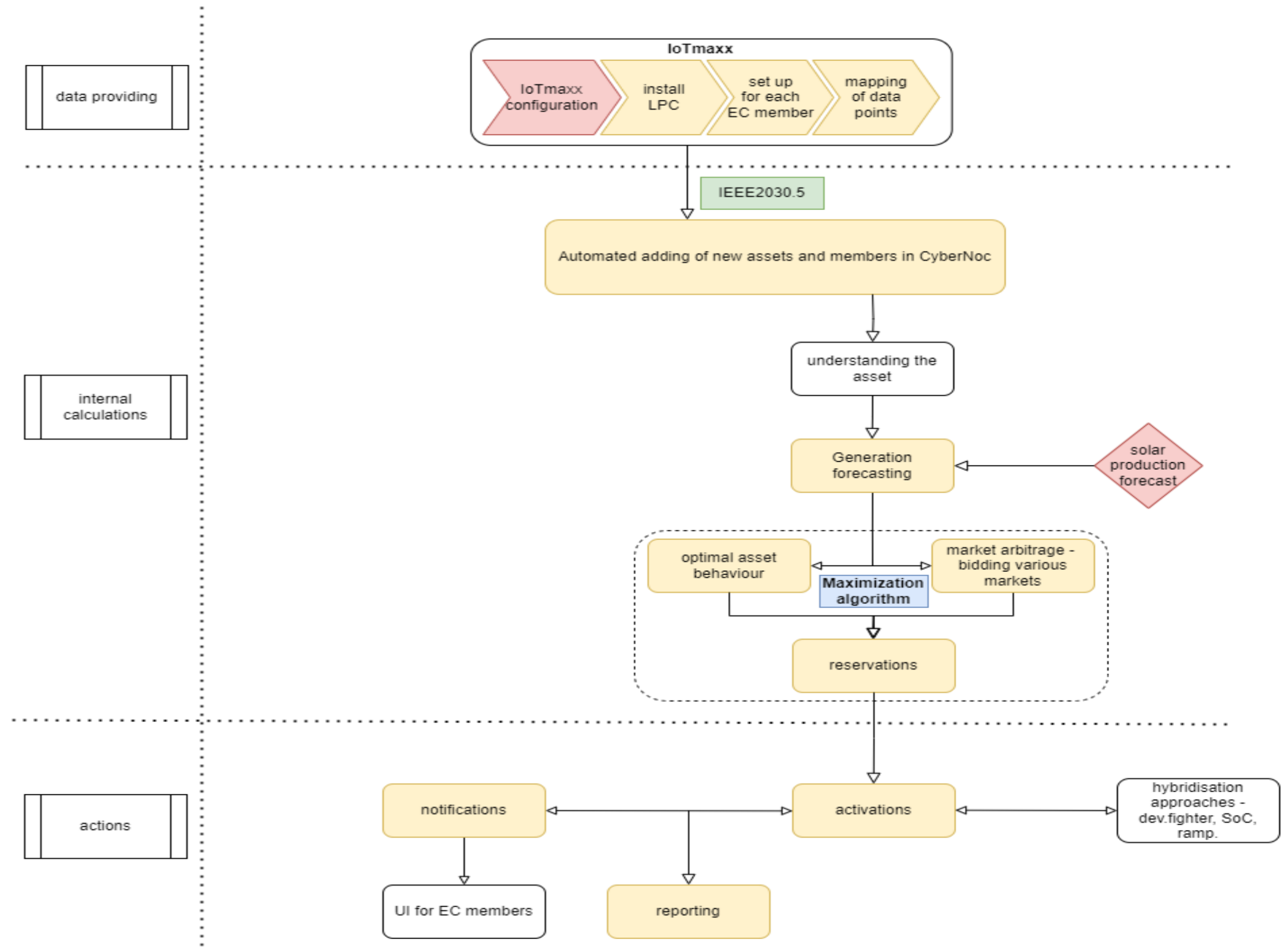


Goal: optimally managing DER assets to increase self-sufficiency

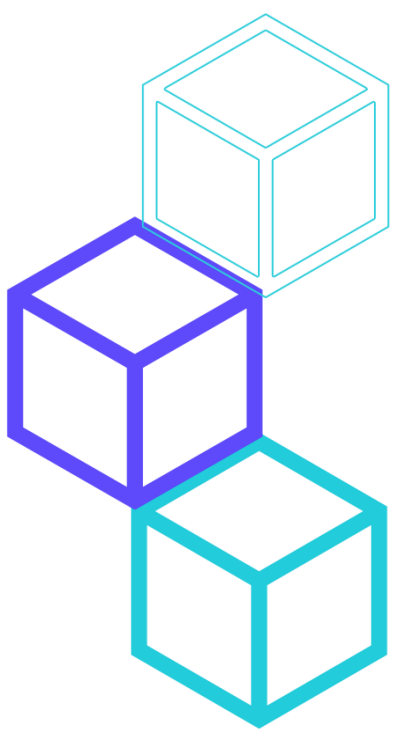
Optimization algorithm focused on maximizing the produced energy by allocating energy for the needs of community members and offering the rest on energy markets.

Steps:

1. Get data in real time
2. Check solar production forecast
3. Predict energy generation of each asset
4. Set optimal asset behavior and/or generate balancing service bids
5. In case any of the bids are accepted, deliver the service



Austrian Pilot - Dietach



Lessons learned

- ❖ Avoiding the installation of devices at the members' places
- ❖ Instead → Use of already existing interfaces
 - ❖ Cloud connection of the battery or inverter
- ❖ Or installation of devices is plug&play
 - ❖ Device should find the battery or inverter itself
 - ❖ App/ graphical interface to guide the user





interstore

THANK YOU!



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